Proofs for file C:\Escher\Customers\prang\prang.c Generated by Escher C Verifier Critical Systems Edition at 07:25:05 UTC on Tuesday July 14th 2020

Escher Verification Studio file versions

EscherTool 7.00 ecv 7.00.00.00 rubric 7.00.00.01

Proved 172 of 179 verification conditions.

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Proof of verification condition: Type constraint satisfied in explicit conversion from 'short int' to 'int'
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 $\textbf{Condition generated at: } C:\ \ Customers \ \ prang \ \ (47,22)$

Condition defined at:

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To prove: minof(int) \leq \$heap_{funcstart\_724,1}.p1
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Given:

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\label{eq:heap} \begin{split} &\text{\$heap}_{init}.\text{LIMIT} == (\textbf{int})80 \\ &\text{\$heap}_{init}.\text{M1} == \textbf{asType} < \textbf{short int} > ((\textbf{int})30269) \\ &\text{\$heap}_{init}.\text{r1} == \textbf{asType} < \textbf{short int} > ((\textbf{int})171) \\ &\text{\$heap}_{init}.\text{a1} == \textbf{asType} < \textbf{short int} > ((\textbf{int})177) \\ &\text{\$heap}_{init}.\text{b1} == \textbf{asType} < \textbf{short int} > ((\textbf{int})2) \end{split}
```

 $\$heap_{init}.M2 == \mathbf{asType} < \mathbf{short\ int} > ((\mathbf{int})30307)$

 $\hat{\mathbf{s}}_{init}.r2 == \mathbf{asType} < \mathbf{short\ int} > ((\mathbf{int})172)$

 $$heap_{init}.a2 == asType < short int > ((int)176)$ $$heap_{init}.b2 == asType < short int > ((int)35)$

 $heap_{init}.M3 == asType < short int > ((int)30323)$

 $\label{eq:short_int} $$ $ = asType < short int > ((int)170) $$$

 $\theta_{init}.a3 == asType < short int > ((int)178)$

 $\$heap_{init}.b3 == \mathbf{asType} < \mathbf{short\ int} > ((\mathbf{int})63)$

 $heap_{init}.p1 == asType < short int > ((int)1)$

 $\theta_{init}.p2 == asType < short int > ((int)2)$

 $\theta = asType < short int > ((int)3)$

invariant1(heapIs $heap_{funcstart_{-724,1}}$)

Proof:

[Take given term]

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[5.0] invariant1(heapIs heap_{funcstart_{-724,1}})
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
[5.1] (((((0 < asType<integer>(sheap_{funcstart\_724,1}.p1)) &&
(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M1})))~\&\&~(0<
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2})))\ \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [simplify]
[5.3] (((((0 < \theta_{funcstart\_724,1.p1) && (\theta_{funcstart\_724,1.p1)
\mathbf{asType} \small{<} \mathbf{integer} \small{>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M1}))) \ \&\& \ (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > (\$heap_{funcstart_{-724,1}}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.4] (((((0 < \text{heap}_{funcstart\_724,1}.p1) && (\text{heap}_{funcstart\_724,1}.p1 <
asType < integer > (\$heap_{init}.M1))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p2) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M2})))~\&\&~(0<
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < $heap_{funcstart_724,1}.p1) && ($heap_{funcstart_724,1}.p1 < 
asType<integer>(asType<short int>((int)30269)))) && (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724.1}.M3))
\rightarrow [simplify]
[5.16] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
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asType<integer>(heap_{funcstart\_724,1}.M2))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.17] \left( \left( \left( \left( -30269 < -\$ \text{heap}_{funcstart\_724,1}.\text{p1} \right) \right. \wedge \left. \left( 0 < \$ \text{heap}_{funcstart\_724,1}.\text{p1} \right) \right. \wedge \right. \right)
(0 < \text{$heap}_{funcstart\_724,1}.p2)) \&\& (\text{$heap}_{funcstart\_724,1}.p2 <
asType < integer > (\$heap_{init}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M3}))
\rightarrow [simplify]
[5.30] ((-30307 < -$heap_funcstart_724,1.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{heap}_{funcstart\_724,1.p2} \land (0 < \text{heap}_{funcstart\_724,1.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.p3 < asType < integer > (\text{\$heap}_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -\$heap_{funcstart\_724,1}.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{724,1}.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.\text{p3} < \mathbf{asType} < \mathbf{integer} > (\text{\$heap}_{init}.\text{M3}))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{724,1}.p3})) \&\&
(\$heap_{funcstart\_724,1}.p3 < \mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{short}
int > ((int)30323)))
\rightarrow [simplify]
[5.40] (-30323 < -\$heap_{funcstart\_724,1}.p3) \land (-30307 < -30307)
-\$heap_{funcstart\_724,1}.p2) \land (-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < -\$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.\text{p1}) \land (0 < \text{Sheap}_{funcstart\_724,1}.\text{p2}) \land (0 <
heap_{funcstart_{-724,1}.p3}
[Work on sub-term 4 of conjunction in term 5.40]
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[8.0] 0 < \text{$heap}_{funcstart\_724,1}.p1
[Take goal term]
[1.0] minof(int) \leq $heap<sub>funcstart_724,1</sub>.p1
\rightarrow [simplify]
[1.3] -32769 < heap_{funcstart\_724,1}.p1
\rightarrow [from term 8.0, literala < $heap<sub>funcstart_724,1</sub>.p1 is true whenever (-1 +
literala) < 0
   Proof of rule precondition:
   [1.3.0](-32769 + -1) < 0
   \rightarrow [simplify]
   [1.3.2] true
[1.4] true
Proof of verification condition: Type constraint satisfied in explicit
conversion from 'short int' to 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (47,22)
Condition defined at:
To prove: heap_{funcstart\_724,1}.p1 \le maxof(int)
Given:
heap_{init}.LIMIT == (int)80
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta
heap_{init}.M2 == asType < short int > ((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
\theta = asType < short int > ((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta
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\rho_{init}.p2 == asType < short int > ((int)2)
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart\_724,1})
Proof:
[Take given term]
[5.0] invariant1(heapIs heap_{funcstart\_724,1}
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
[5.1] (((((0 < asType<integer>(sheap_{funcstart\_724,1}.p1)) &&
(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 < funcstart\_724,1)
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [simplify]
[5.3] (((((0 < \theta_{funcstart\_724,1.p1}) && (\theta_{funcstart\_724,1.p1})
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M1})))~\&\&~(0<
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M2})))~\&\&~(0<
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p3) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [const static or extern object]
[5.4] (((((0 < $heap_{funcstart_{724,1}}.p1) && ($heap_{funcstart_{724,1}}.p1 < ])
asType<integer>(heap_{init}.M1))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
\mathbf{asType} \small{<} \mathbf{integer} \small{>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M2}))) \ \&\& \ (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})))\ \&\&
(asType < integer > (\$heap_{funcstart_{-724.1}}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M1' at prang.c (14.20)]
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 
asType<integer>(heap_{funcstart\_724,1}.M2))) && (0 <
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asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M3}))
\rightarrow [simplify]
[5.16] \left( \left( \left( \left( -30269 < -\$ \text{heap}_{funcstart\_724,1}.\text{p1} \right) \right. \wedge \left. \left( 0 < \$ \text{heap}_{funcstart\_724,1}.\text{p1} \right) \right. \wedge \right. \right)
(0 < \text{$heap}_{funcstart\_724.1}.p2)) \&\& (\text{$heap}_{funcstart\_724.1}.p2 <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [const static or extern object]
[5.17] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < \text{\$heap}_{funcstart\_724,1}.\text{p2})) && (\text{\$heap}_{funcstart\_724,1}.\text{p2} <
asType < integer > (\$heap_{init}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] \; ((((-30269 < -\$ heap_{funcstart\_724,1}.p1) \; \land \; (0 < \$ heap_{funcstart\_724
(0 < \text{$heap}_{funcstart\_724,1}.p2)) \&\& (\text{$heap}_{funcstart\_724,1}.p2 < 
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType<integer>($heap_funcstart_724,1.p3) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.30] ((-30307 < -$heap<sub>funcstart_724,1</sub>.p2) \wedge (-30269 <
 -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1.p2}) \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.p3 < asType < integer > (\text{\$heap}_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -$heap_funcstart_724,1.p2) \land (-30269 <
 -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1.p2} \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.p3 < asType < integer > (\text{\$heap}_{init}.M3))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \wedge (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{-724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{-724,1}.p3})) \&\&
(\$heap_{funcstart\_724,1}.p3 < \mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{short}
int > ((int)30323)))
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\rightarrow [simplify]
[5.40] (-30323 < -\text{$heap}_{funcstart\_724,1}.p3) \land (-30307 < -\text{$partstart}_{funcstart}]
-\$heap_{funcstart\_724,1}.p2) \land (-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < -\$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.\text{p1}) \land (0 < \text{Sheap}_{funcstart\_724,1}.\text{p2}) \land (0 <
heap_{funcstart_{724,1}.p3}
[Work on sub-term 3 of conjunction in term 5.40]
\label{eq:condition} \mbox{[7.0] -30269} < -\$ \mbox{heap}_{funcstart\_724,1}.\mbox{p1}
[Take goal term]
[1.0] $heap<sub>funcstart_724,1</sub>.p1 \leq maxof(int)
\rightarrow [simplify]
\label{eq:condition} \mbox{$[1.9]$ -32768} < -\$ heap_{funcstart\_724,1}.p1
\rightarrow [from term 7.0, literala < –$heap_{uncstart\_724,1}.p1 is true whenever (-1 +
literala) < -30269
   Proof of rule precondition:
   [1.9.0](-32768 + -1) < -30269
   \rightarrow [simplify]
   [1.9.2] true
[1.10] true
Proof of verification condition: Type constraint satisfied in explicit
conversion from 'short int const' to 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (47,31)
Condition defined at:
To prove: minof(int) \leq \text{$heap}_{funcstart\_724,1}.a1
Given:
heap_{init}.LIMIT == (int)80
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
\label{eq:short_int} $$ \theta_{init}.r1 == asType < short int > ((int)171)$
\theta
\theta
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\theta_{init}.r2 == asType<short int>((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta
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heap_{init}.M3 == asType < short int > ((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType<short int>((int)178)
heap_{init}.b3 == asType < short int > ((int)63)
\theta
\theta
\theta = asType < short int > ((int)3)
invariant
1<br/>({\bf heapIs}\ \${\rm heap}_{funcstart\_724,1})
Proof:
[Take goal term]
[1.0] minof(int) \leq $heap<sub>funcstart_724,1</sub>.a1
\rightarrow [simplify]
\textit{[1.1] -32768} \leq \$ \text{heap}_{funcstart\_724,1}.\text{a1}
\rightarrow [const static or extern object]
[1.2] -32768 \leq $heap<sub>init</sub>.a1
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
[1.3] -32768 \le asType < short int > ((int)177)
\rightarrow [simplify]
[1.6] true
Proof of verification condition: Type constraint satisfied in explicit
conversion from 'short int const' to 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (47,31)
Condition defined at:
To prove: heap_{funcstart\_724,1}.a1 \leq maxof(int)
Given:
heap_{init}.LIMIT == (int)80
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
\theta
\theta
\theta
heap_{init}.M2 == asType < short int > ((int)30307)
\theta
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heap_{init}.b2 == asType<short int>((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
heap_{init}.b3 == asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart_724,1})
Proof:
[Take goal term]
[1.0] heap_{funcstart\_724,1}.a1 \leq maxof(int)
\rightarrow [const static or extern object]
[1.1] $heap<sub>init</sub>.a1 \leq maxof(int)
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
[1.2] asType<short int>((int)177) \le maxof(int)
\rightarrow [simplify]
[1.6] true
Proof of verification condition: Precondition of 'div' satisfied
Condition generated at: C:\Escher\Customers\prang\prang.c (47,18)
Condition defined at: C:\Escher\ecv\standard\stdlib.h (94,10)
To prove: 0 < asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta = asType < short int > ((int)2)
heap_{init}.M2 == asType < short int > ((int)30307)
heap_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
```

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heap_{init}.b2 == asType < short int > ((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
heap_{init}.b3 == asType < short int > ((int)63)
\theta
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart\_724,1})
Proof:
[Take goal term]
[1.0] 0 < asType<integer>(asType<int>($heap_{funcstart\_724,1}.a1))
\rightarrow [const static or extern object]
[1.1] 0 < asType < integer > (asType < int > (\$heap_{init}.a1))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
[1.2] 0 < asType<integer>(asType<int>(asType<short
int>((int)177))
\rightarrow [simplify]
[1.7] true
Proof of verification condition: Assertion valid
Condition generated at: C:\Escher\Customers\prang\prang.c (48,48)
To prove: (asType<integer>($heap_{funcstart\_724,1}.a1) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
Given:
heap_{init}.LIMIT == (int)80
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
```

```
\theta_{init}.a2 == asType<short int>((int)176)
heap_{init}.b2 == asType<short int>((int)35)
\theta sheap<sub>init</sub>.M3 == asType<short int>((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
heap_{init}.b3 == asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart\_724,1})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \ \operatorname{\$heap}_{funcstart\_724,1},
\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(asType<integer>(asType<int>($heap_{tuncstart\_724.1}.p1)) /
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}))) = =
asType<integer>(div1.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1})) =>
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) ==
asType<integer>(div1.rem))
Proof:
[Take given term]
[5.0] invariant1(heapIs heapIs 
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
[5.1] ((((((0 < asType < integer > (heap_{funcstart_{-724,1}}.p1)) &&
(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 
as
Type<integer>(\rho_{funcstart\_724,1}.M1))) & (0 <
asType < integer > (\$heap_{funcstart_{-724,1},p2}))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 < funcstart\_724,1)
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p3) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [simplify]
```

```
[5.3] (((((0 < $heap_{funcstart_{724,1}}.p1) && ($heap_{funcstart_{724,1}}.p1 < ])
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 < funcstart\_724,1)
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}))) \ \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.4] (((((0 < \text{\$heap}_{funcstart\_724,1}.p1) \&\& (\text{\$heap}_{funcstart\_724,1}.p1 <
asType<integer>(heap_{init}.M1))) && (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2})))\ \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p2) < 
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < $heap_{funcstart_{724,1}}.p1) && ($heap_{funcstart_{724,1}}.p1 < 
asType<integer>(asType<short int>((int)30269)))) && (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))~\&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 < 1)
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})))\ \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M3}))
\rightarrow [simplify]
[5.16] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [const static or extern object]
[5.17] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \; \land \; (0 < \$heap_{funcstart\_724,1}.p1) \; \land 
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType < integer > (\$heap_{init}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M3}))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
```

```
[5.18] ((((-30269 < -$heap<sub>funcstart_724,1.</sub>p1) \land (0 < $heap<sub>funcstart_724,1.</sub>p1) \land
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType<integer>($heap_funcstart_724,1.M3))
\rightarrow [simplify]
[5.30] ((-30307 < -$heap_{funcstart\_724,1}.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{724,1}.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.p3 < asType < integer > (\text{\$heap}_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -\$heap_{funcstart\_724,1}.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{724,1}.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.\text{p3} < \mathbf{asType} < \mathbf{integer} > (\text{\$heap}_{init}.\text{M3}))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{724,1}.p3})) \&\&
($heap_funcstart_724.1.p3 < asType<integer>(asType<short)
int > ((int)30323)))
\rightarrow [simplify]
[5.40] (-30323 < -$heap_{funcstart\_724,1}.p3) \land (-30307 <
-\$heap_{funcstart\_724,1}.p2) \land (-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < -\$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.\text{p1}) \land (0 < \text{Sheap}_{funcstart\_724,1}.\text{p2}) \land (0 <
heap_{funcstart\_724,1}.p3
[Work on sub-term 4 of conjunction in term 5.40]
[8.0] 0 < $heap_{funcstart_724,1}.p1
[Take given term]
[11.0] div1 == div(heapIs heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
asType < int > (\$heap_{funcstart\_724.1}.a1))
\rightarrow [simplify]
[11.1] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \operatorname{\$heap}_{funcstart\_724,1}, \operatorname{\$heap}_{funcstart\_724,1}.p1,
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
\rightarrow [const static or extern object]
[11.2] div1 == div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1},
asType < int > (\$heap_{init}.a1))
```

```
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
[11.3] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType<int>(asType<short int>((int)177)))
\rightarrow [simplify]
[11.6] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}, \ 177)
[Take goal term]
[1.0] (asType<integer>(heap_{funcstart\_724,1}.a1) \leq
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1})) => !(0 ==
asType<integer>(div1.quot))
\rightarrow [const static or extern object]
[1.1] (asType<integer>($heap_{init}.a1) \leq
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1})) => !(0 ==
asType<integer>(div1.quot))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
[1.2] (asType<integer>(asType<short int>((int)177)) \le \tag{7.2}
asType < integer > (\$heap_{funcstart-724.1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
\rightarrow [simplify]
[1.8] (176 < \text{$heap}_{funcstart\_724,1}.\text{p1}) => !(0 ==
asType<integer>(div1.quot))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724.1},
heap_{funcstart_{-724,1}}.p1, 177
[1.9] (176 < heap_{funcstart\_724,1}.p1) => !(0 ==
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).quot))
\rightarrow [simplify]
 [1.13] ! (0 == \operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}. \operatorname{p1}, 
177).quot) \vee (-177 < -\$heap_{funcstart\_724,1}.p1)
\rightarrow [negate goal and search for contradiction]
[1.14] (0 == div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).quot) \land !(-177 < -\$heap_{funcstart\_724.1}.p1)
\rightarrow [simplify]
[1.17] (0 == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).quot) \land (176 < \text{$heap}_{funcstart\_724,1}.p1)
\rightarrow [separate conjunction and work on first sub-term]
[1.18] 0 == \text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}
```

```
[Assume known post-assertion, class invariant or type constraint for term 11.6]
[14.0] (asType<integer>($heap_{funcstart\_724,1}.p1) /
asType<integer>(177)) == asType<integer>(div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).quot)
\rightarrow [simplify]
[14.2] ($heap<sub>funcstart_724,1.</sub>p1 / 177) == asType<integer>(div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).quot
→ [expand definition of operator './' in class 'int' at built in declaration]
[14.3] \; ([\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) < 0] :
-(-asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177), []:
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) \ / \ 177) = =
asType<integer>(div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1,
177).quot)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[14.4] ([asType<integer>(heap_{funcstart\_724,1}.p1) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 0)]:
\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) \ / \ 177) = =
\mathbf{asType} {<} \mathbf{integer} {>} ( \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}, \\
177).quot)
\rightarrow [simplify]
[14.7] ([0 < -\$heap_{funcstart\_724,1}.p1]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177) ==
asType<integer>(div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1,
177).quot)
\rightarrow [from term 8.0, literala < -$heap<sub>funcstart_724.1</sub>.p1 is false whenever -2 < (0
+ literala)
    Proof of rule precondition:
    [14.7.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [14.7.2] true
[14.8] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) \; / \; 177),
[!(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177) ==
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).quot)
\rightarrow [simplify]
```

```
[14.11] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177), [!(0 < integer > (\$heap_{funcstart\_724,1}.p1) / 177), [!(0 < integer > (\$heap_{funcstart\_724,1}.p1) / 177)
-\$heap_{funcstart\_724,1}.p1)]: asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177)
== asType < integer > (div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177).quot
\rightarrow [from term 8.0, literala < -$heap<sub>funcstart_724.1</sub>.p1 is false whenever -2 < (0
+ literala)]
    Proof of rule precondition:
    [14.11.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [14.11.2] true
[14.12] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) \; / \; 177),
[!false]: asType<integer>($heap<sub>funcstart_724,1</sub>.p1) / 177) ==
\mathbf{asType} < \mathbf{integer} > (\mathbf{div}(\mathbf{heapIs} \ \$ \mathbf{heap}_{funcstart\_724,1}, \ \$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}, \\
177).quot)
\rightarrow [simplify]
[14.17] \ 0 == (-\text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).quot + ({\rm \$heap}_{funcstart\_724,1}.{\rm p1} \ / \ 177))
\rightarrow [from\ term\ 1.18,\ div(\textbf{heapIs}\ \$heap_{funcstart\_724,1},\ \$heap_{funcstart\_724,1}.p1,
177).quot is equal to 0
[14.18] 0 == (-0 + (\text{$heap}_{funcstart\_724,1}.p1 / 177))
\rightarrow [simplify]
[14.20] 0 == (\text{$heap}_{funcstart\_724,1}.p1 / 177)
[Work on sub-term 2 of conjunction in term 1.17]
\label{eq:25.0} \ 176 < \$ heap_{funcstart\_724,1}.p1
[Create new term from term 14.20 using rule: condition for equality of division]
[26.0] \; ((0*177) < (1 + \$ heap_{funcstart\_724,1}.p1)) \; \wedge \; (\$ heap_{funcstart\_724,1}.p1 < 1.00) \; \wedge \; (\$ heap_{funcstart\_724,1}.p1) < 1.000 \; \wedge \; (\$ heap_{funcstart\_724,1}.p1) 
(177 * (0 + 1)))
\rightarrow [simplify]
[26.3] (-1 < \text{$heap}_{funcstart\_724,1}.p1) \land (\text{$heap}_{funcstart\_724,1}.p1 < (177 * (0 + 
\rightarrow [from term 25.0, literala < $heap_{funcstart\_724,1}.p1 is true whenever (-1 +
literala) < 176
    Proof of rule precondition:
    [26.3.0](-1+-1)<176
    \rightarrow [simplify]
    [26.3.2] true
```

```
[26.4] true \land ($heap<sub>funcstart_724,1</sub>.p1 < (177 * (0 + 1)))
\rightarrow [simplify]
[26.9] true \wedge (-177 < -$heap<sub>funcstart_724,1.</sub>p1)
\rightarrow [from term 25.0, literala < -$heap<sub>funcstart_724,1</sub>.p1 is false whenever -2 <
(176 + literala)
   Proof of rule precondition:
   [26.9.0] - 2 < (-177 + 176)
   \rightarrow [simplify]
   [26.9.2] true
[26.10] true \wedge false
\rightarrow [simplify]
[26.11] false
Proof of verification condition: Assertion valid
Condition generated at: C:\Escher\Customers\prang\prang.c (48,20)
To prove: (asType<integer>(peq_{funcstart\_724,1}.p1) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) ==
asType<integer>(div1.rem))
Given:
heap_{init}.LIMIT == (int)80
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\theta_{init}.r2 == asType<short int>((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
heap_{init}.b2 == asType < short int > ((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
```

```
\rho_{init}.p2 == asType < short int > ((int)2)
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart\_724,1})
div1 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}))~\%
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}))) = =
asType<integer>(div1.rem)
Proof:
[Take given term]
[5.0] invariant1(heapIs $heap_{tuncstart_724.1})
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
[5.1] ((((((0 < asType < integer > (\theta_{funcstart\_724,1.p1)) &&
(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 
as
Type<integer>($heap_{funcstart\_724,1}.M1))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})))\ \&\&
(asType<integer>($heap_{tuncstart\_724.1}.p3) <
asType < integer > (\$heap_{funcstart_{-724.1}}.M3))
\rightarrow [simplify]
[5.3] (((((0 < $heap_{funcstart_724,1}.p1) && ($heap_{funcstart_724,1}.p1 < ])
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
as
Type<integer>(\rho_{funcstart\_724,1}.M2))) & (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})))\ \&\&
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.4] (((((0 < $heap_{funcstart_724.1}.p1) && ($heap_{funcstart_724.1}.p1 < function for the content of the 
asType < integer > (\$heap_{init}.M1))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(asType<integer>($heap_funcstart_724.1.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
```

```
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] \ (((((0 < \$heap_{funcstart\_724,1}.p1) \&\& \ (\$heap_{funcstart\_724,1}.p1 < (
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p2) <
asType<integer>(heap_{funcstart\_724,1}.M2))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [simplify]
[5.16] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \; \land \; (0 < \$heap_{funcstart\_724,1}.p1) \; \land 
(0 < \text{$heap}_{funcstart\_724,1}.p2)) \&\& (\text{$heap}_{funcstart\_724,1}.p2 < 
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.17] \left( \left( \left( \left( -30269 < -\$ \text{heap}_{funcstart\_724,1}.\text{p1} \right) \right. \wedge \left. \left( 0 < \$ \text{heap}_{funcstart\_724,1}.\text{p1} \right) \right. \wedge \right. \right) \\
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType < integer > (\$heap_{init}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M3}))
\rightarrow [simplify]
[5.30] ((-30307 < -$heap_funcstart_724,1.p2) \land (-30269 <
 -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.p2) \land (0 < \text{Sheap}_{funcstart\_724,1}.p3)) \&\&
(\text{\$heap}_{funcstart\_724,1}.p3 < asType < integer > (\text{\$heap}_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -$heap_{funcstart\_724,1}.p2) \land (-30269 <
-\text{Sheap}_{funcstart\_724,1}.\text{p1}) \wedge (0 < \text{Sheap}_{funcstart\_724,1}.\text{p1}) \wedge (0 <
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\text{Sheap}_{funcstart\_724,1.p2}) \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.\text{p3} < \mathbf{asType} < \mathbf{integer} > (\text{\$heap}_{init}.\text{M3}))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap_funcstart_724,1.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\theta_{funcstart_{724,1}.p2} \land (0 < \theta_{funcstart_{724,1}.p3}) \& 
(\text{sheap}_{funcstart\_724,1}.\text{p3} < \text{asType} < \text{integer} > (\text{asType} < \text{short})
int > ((int)30323)))
\rightarrow [simplify]
[5.40] (-30323 < -$heap_{funcstart\_724,1}.p3) \land (-30307 <
-\$heap_{funcstart\_724,1}.p2) \land (-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < -\$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.\text{p1}) \land (0 < \text{Sheap}_{funcstart\_724,1}.\text{p2}) \land (0 <
$heap_{funcstart\_724,1}.p3)
[Work on sub-term 4 of conjunction in term 5.40]
[8.0] 0 < \text{$heap}_{funcstart\_724,1}.p1
[Take given term]
[11.0] div1 == div(heapIs heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
\rightarrow [simplify]
[11.1] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \operatorname{\$heap}_{funcstart\_724,1}, \operatorname{\$heap}_{funcstart\_724,1}.p1,
asType < int > (\$heap_{funcstart\_724,1}.a1))
\rightarrow [const static or extern object]
[11.2] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType < int > (\$heap_{init}.a1))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
[11.3] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
asType<int>(asType<short int>((int)177)))
\rightarrow [simplify]
[11.6] div1 == div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p1, 177)
[Take goal term]
\textit{[1.0]} \ (\textbf{asType} < \textbf{integer} > (\$ \text{heap}_{funcstart\_724,1}.\text{p1}) <
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a1})) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) ==
asType<integer>(div1.rem))
\rightarrow [simplify]
[1.1] (\text{heap}_{funcstart\_724,1}.\text{p1} < \text{asType} < \text{integer} > (\text{heap}_{funcstart\_724,1}.\text{a1}))
```

```
=>(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1})==
asType<integer>(div1.rem))
\rightarrow [const static or extern object]
[1.2] (\text{heap}_{funcstart\_724,1}.\text{p1} < \text{asType} < \text{integer} > (\text{heap}_{init}.\text{a1})) =>
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) ==
asType<integer>(div1.rem))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
[1.3] \; (\$ heap_{funcstart\_724,1}.p1 < \mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{short})
int>((int)177))) => (asType< integer>($heap_{funcstart\_724.1}.p1) ==
asType<integer>(div1.rem))
\rightarrow [simplify]
[1.10] (-177 < -$heap<sub>funcstart_724,1.</sub>p1) => ($heap<sub>funcstart_724,1.</sub>p1 ==
asType<integer>(div1.rem))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart_{724,1}},
heap_{funcstart_{-724,1}}.p1, 177
[1.11] (-177 < -$heap<sub>funcstart_724,1.</sub>p1) => ($heap<sub>funcstart_724,1.</sub>p1 ==
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).rem))
\rightarrow [simplify]
[1.17] (0 == (-$heap<sub>funcstart_724,1</sub>.p1 + div(heapIs $heap<sub>funcstart_724,1</sub>,
\$heap_{funcstart\_724,1}.p1,\ 177).rem)) \lor (176 < \$heap_{funcstart\_724,1}.p1)
\rightarrow [negate goal and search for contradiction]
[1.18]!(0 == (-\$heap_{funcstart\_724,1}.p1 + div(heapIs \$heap_{funcstart\_724,1},
\$heap_{funcstart\_724,1}.p1,\ 177).rem)) \land !(176 < \$heap_{funcstart\_724,1}.p1)
\rightarrow [simplify]
[1.20]!(0 == (-\$heap_{funcstart\_724,1}.p1 + div(heapIs \$heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}) \land (-177 < -\text{Sheap}_{funcstart\_724,1}.\text{p1})
\rightarrow [separate conjunction and work on first sub-term]
[1.21] -177 < -$heap<sub>funcstart_724,1</sub>.p1
[Assume known post-assertion, class invariant or type constraint for term 11.6]
[15.0] (asType<integer>(sheap_{funcstart=724,1}.p1) %
asType < integer > (177)) == asType < integer > (div(heapIs))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}
\rightarrow [simplify]
[15.2] (heap_{funcstart\_724,1}.p1 \% 177) == asType<integer>(div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}
→ [expand definition of operator '.%' in class 'int' at built in declaration]
```

```
[15.3] ([asType<integer>(peqtention = 15.3] ([asType<integer>(peqtention = 15.3]) ([asType<integer>(peqtention = 15.3])
-(-asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177), []:
asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177) ==
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).rem)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[15.4] \; ([\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) < 0] :
-(-\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) \% \ 177),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177) ==
asType<integer>(div(heapIs $heap_{tuncstart\_724.1}, $heap_{tuncstart\_724.1}.p1,
177).rem)
\rightarrow [simplify]
[15.7] ([0 < -$heap<sub>funcstart_724,1.</sub>p1]:
-(-asType < integer > (\$heap_{funcstart\_724.1}.p1) \% 177),
[!(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177) ==
asType<integer>(div(heapIs p_{funcstart\_724,1}, p_{funcstart\_724,1}),
177).rem)
\rightarrow [from term 8.0, literala < -$heap<sub>funcstart_724.1</sub>.p1 is false whenever -2 < (0
+ literala)]
   Proof of rule precondition:
   [15.7.0] - 2 < (0 + 0)
   \rightarrow [simplify]
   [15.7.2] true
[15.8] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 0)]:
asType < integer > (\$heap_{funcstart\_724.1}.p1) \% 177) = =
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).\text{rem}
\rightarrow [simplify]
[15.11] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177), [!(0
< -$heap<sub>funcstart_724.1</sub>.p1)]: asType<integer>($heap<sub>funcstart_724.1</sub>.p1) %
177) == asType < integer > (div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p1, 177}.rem
\rightarrow [from term 8.0, literala < –$heap_{uncstart\_724,1}.p1 is false whenever -2 < (0
+ literala)]
   Proof of rule precondition:
   [15.11.0] - 2 < (0 + 0)
```

```
\rightarrow [simplify]
    [15.11.2] true
[15.12] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177),
[!false]: asType<integer>($heap_{funcstart\_724,1}.p1) % 177) ==
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).rem)
\rightarrow [simplify]
[15.17] 0 == (-\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem + (\text{$heap}_{funcstart\_724,1}.p1 \% 177))
[Work on sub-term 2 of conjunction in term 1.20]
[24.0] ! (0 == (-\$heap_{funcstart\_724,1}.p1 + div(heapIs \$heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p1, 177).rem}
[Copy term 24.0]
[25.0] !(0 == (-\$heap<sub>funcstart_724,1</sub>.p1 + div(heapIs \$heap<sub>funcstart_724,1</sub>,
heap_{funcstart_{-724,1}.p1, 177).rem}
\rightarrow [from\ term\ 15.17,\ div(\textbf{heapIs}\ \$heap_{funcstart\_724,1},\ \$heap_{funcstart\_724,1}.p1,
177).rem is equal to \text{$heap_{funcstart\_724,1}.p1 \% 177]}
[25.1]!(0 == (-\$heap_{funcstart\_724,1}.p1 + (\$heap_{funcstart\_724,1}.p1 \% 177)))
\rightarrow [remainder with larger divisor]
    Proof of rule precondition 1:
    [25.1.0.0]~\mathrm{literald} < -\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}
    \rightarrow [unify with term 1.21]
    [25.1.0.1] true
    Proof of rule precondition 2:
    [25.1.1.0]~\mathrm{literalc} < \$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}
    \rightarrow [unify with term 8.0]
    [25.1.1.1] true
    Proof of rule precondition 3:
    [25.1.2.0] --177 \le 177
    \rightarrow [simplify]
    [25.1.2.2] true
    Proof of rule precondition 4:
    [25.1.3.0] - 2 < 0
    \rightarrow [simplify]
```

```
[25.1.3.1] true
[25.2] ! (0 == (-\$heap_{funcstart\_724,1}.p1 + \$heap_{funcstart\_724,1}.p1))
\rightarrow [simplify]
[25.5] false
Proof of verification condition: Assertion valid
Condition generated at: C:\Escher\Customers\prang\prang.c (49,26)
To prove: !(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta = asType < short int > ((int)2)
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
\theta
\theta = asType < short int > ((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart_{-724,1}})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) /
asType<integer>(asType<int>($heap_{tuncstart\_724.1}.a1))) ==
asType<integer>(div1.quot)
(\mathbf{asType} {<} \mathbf{int} {>} (\mathbf{asType} {<} \mathbf{int} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ \%
```

```
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p1) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p1) = =
asType<integer>(div1.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a1) \le
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
Proof:
[Take given term]
[5.0] invariant1(heapIs heap_{funcstart_{-724,1}})
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
[5.1] ((((((0 < asType < integer > ($heap_{funcstart\_724,1}.p1)) &&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) <
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p2) < 
\mathbf{asType} \small{<} \mathbf{integer} \small{>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M2}))) \ \&\& \ (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})))\ \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.3] (((((0 < $heap_{funcstart_{724,1}}.p1) && ($heap_{funcstart_{724,1}}.p1 < ])
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(asType<integer>($heap_funcstart_724.1.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.4] (((((0 < $heap_{funcstart_{724,1}}.p1) && ($heap_{funcstart_{724,1}}.p1 < ]
asType < integer > (\$heap_{init}.M1))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})))\ \&\&
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
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```
[5.5] (((((0 < $heap_{funcstart_{-724,1}}.p1) && ($heap_{funcstart_{-724,1}}.p1 < 
asType<integer>(asType<short int>((int)30269)))) && (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2})))\ \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p2) < 
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{tuncstart_{-724,1}}.M3))
\rightarrow [simplify]
[5.16] ((((-30269 < -$heap_{funcstart\_724,1}.p1) \lambda (0 < $heap_{funcstart\_724,1}.p1) \lambda
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M2})))~\&\&~(0<
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.17] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \; \land \; (0 < \$heap_{funcstart\_724,1}.p1) \; \land 
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType < integer > (\$heap_{init}.M2))) \&\& (0 <
asType < integer > ($heap_{funcstart\_724,1}.p3))) &&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < \text{$heap}_{funcstart\_724,1}.p2)) \&\& (\text{$heap}_{funcstart\_724,1}.p2 <
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.30] ((-30307 < -$heap_funcstart_724,1.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1.p2} \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\$heap_{funcstart\_724,1}.p3 < \mathbf{asType} < \mathbf{integer} > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -$heap<sub>funcstart_724,1</sub>.p2) \wedge (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1.p2}) \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.\text{p3} < \text{asType} < \text{integer} > (\text{\$heap}_{init}.\text{M3}))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \wedge (-30269 <
```

```
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.p2) \land (0 < \text{Sheap}_{funcstart\_724,1}.p3)) \&\&
(\$heap_{funcstart\_724,1}.p3 < \mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{short}
int > ((int)30323)))
\rightarrow [simplify]
[5.40] (-30323 < -$heap<sub>funcstart_724,1.</sub>p3) \wedge (-30307 <
-\$heap_{funcstart\_724,1}.p2) \land (-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < -\$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.\text{p1}) \land (0 < \text{Sheap}_{funcstart\_724,1}.\text{p2}) \land (0 <
heap_{funcstart_{-724,1}.p3}
[Work on sub-term 4 of conjunction in term 5.40]
[8.0] 0 < $\text{heap}_{funcstart_724.1}.p1
[Take given term]
[11.0] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \ \text{$heap}_{funcstart\_724.1},
asType < int > (\$heap_{funcstart\_724.1}.p1),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathtt{a1}))
\rightarrow [simplify]
[11.1] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
\rightarrow [const static or extern object]
[11.2] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
asType < int > (\$heap_{init}.a1))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
[11.3] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType<int>(asType<short int>((int)177)))
\rightarrow [simplify]
[11.6] div1 == div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177)
[Take goal term]
[1.0]!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1},p1,177}
[1.1]!(0 == asType < integer > (div(heapIs $heap_{funcstart\_724,1},
\theta_{funcstart\_724,1.p1, 177).rem} | | !(0 == asType < integer > (div1.quot)) |
\rightarrow [simplify]
[1.2] !(0 == \operatorname{div}(\mathbf{heapIs} \ \text{$heap}_{funcstart\_724,1}, \ \text{$heap}_{funcstart\_724,1}.p1, \ 177).rem)
||!(0 == asType < integer > (div1.quot))|
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
```

```
heap_{funcstart_{-724,1}}.p1, 177)
[1.3]!(0 == \text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem})
||!(0 == asType < integer) = (div(heapIs $heap_{funcstart\_724,1}, 
heap_{funcstart_{724,1}}.p1, 177).quot)
\rightarrow [simplify]
[1.5] ! (0 == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).quot) \vee!(0 == div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1,
177).rem)
\rightarrow [negate goal and search for contradiction]
[1.6] \ (0 == \operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, \ 177).\operatorname{quot})
\land \ (0 == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}, \ 177).\mathrm{rem})
→ [separate conjunction and work on first sub-term]
[1.7] 0 == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, 177).\operatorname{quot}
[Work on sub-term 2 of conjunction in term 1.6]
[26.0] 0 == \text{div}(\text{heapIs } \text{$heap}_{funcstart\_724,1}, \text{$heap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}
[Take given term]
[24.0] (asType<integer>(sheap_{funcstart\_724,1}.p1) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) ==
asType<integer>(div1.rem))
\rightarrow [simplify]
[24.1] \ (\$heap_{funcstart\_724,1}.p1 < \mathbf{asType} < \mathbf{integer} > (\$heap_{funcstart\_724,1}.a1))
=> (asType < integer > ($heap_{funcstart\_724,1}.p1) ==
asType<integer>(div1.rem))
\rightarrow [const static or extern object]
[24.2] ($heap<sub>funcstart_724,1</sub>.p1 < asType<integer>($heap<sub>init</sub>.a1)) =>
(asType < integer > (\$heap_{funcstart\_724,1}.p1) = =
asType<integer>(div1.rem))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
[24.3] \ (\$heap_{funcstart\_724,1}.p1 < \mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{short})
int>((int)177))) => (asType< integer>($heap_{tuncstart\_724,1}.p1) ==
asType<integer>(div1.rem))
\rightarrow [simplify]
[24.10] (-177 < -\$heap_{funcstart\_724,1}.p1) => (\$heap_{funcstart\_724,1}.p1) ==
asType<integer>(div1.rem))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177
```

```
[24.11] (-177 < -\$heap_{funcstart\_724,1}.p1) => (\$heap_{funcstart\_724,1}.p1 ==
\mathbf{asType} < \mathbf{integer} > (\mathbf{div}(\mathbf{heapIs} \$ \mathbf{heap}_{funcstart\_724,1}, \$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1},
177).rem))
\rightarrow [simplify]
[24.17] (0 == (-$heap_{funcstart_{724,1}}.p1 + div(heapIs $heap_{funcstart_{724,1}},
\$heap_{funcstart\_724,1}.p1,\ 177).rem)) \lor (176 < \$heap_{funcstart\_724,1}.p1)
\rightarrow [from\ term\ 26.0,\ div(\textbf{heapIs}\ \$heap_{funcstart\_724,1},\ \$heap_{funcstart\_724,1}.p1,
177).rem is equal to 0
[24.18] (0 == (-\$heap_{funcstart\_724.1}.p1 + 0)) \lor (176 < \$heap_{funcstart\_724.1}.p1)
\rightarrow [simplify]
[24.19] (0 == -\$heap_{funcstart\_724,1}.p1) \lor (176 < \$heap_{funcstart\_724,1}.p1)
\rightarrow [from term 8.0, -$heap<sub>funcstart_724,1</sub>.p1 == literala is false whenever -1 <
(0 + literala)
   Proof of rule precondition:
   [24.19.0] -1 < (0 + 0)
   \rightarrow [simplify]
   [24.19.2] true
[24.20] false \vee (176 < \text{$heap}_{funcstart\_724,1}.p1)
\rightarrow [simplify]
[24.21]~176 < \$ heap_{funcstart\_724,1}.p1
[Take given term]
[25.0] (asType<integer>(sheap_{funcstart\_724,1}.a1) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
\rightarrow [const static or extern object]
[25.1] (asType<integer>($heap_{init}.a1) \le
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
[25.2] (asType<integer>(asType<short int>((int)177)) <
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
\rightarrow [simplify]
[25.8] (176 < $heap_{funcstart\_724,1}.p1) => !(0 ==
asType<integer>(div1.quot))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
```

```
heap_{funcstart_{-724,1}}.p1, 177
[25.9] (176 < $\text{heap}_{funcstart\_724,1}.p1) => !(0 ==
asType<integer>(div(heapIs $heap_{funcstart_724,1}, $heap_{funcstart_724,1}.p1,
177).quot))
\rightarrow [simplify]
[25.13] ! (0 == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1},
177).quot) \vee (-177 < -\$heap_{funcstart\_724,1}.p1)
\rightarrow [from term 24.21, literala < –$heap_{uncstart\_724,1}.p1 is false whenever -2 <
(176 + literala)
   Proof of rule precondition:
   [25.13.0] - 2 < (-177 + 176)
   \rightarrow [simplify]
   [25.13.2] true
[25.14] false \vee !(0 == div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p1,
177).quot)
\rightarrow [from term 1.7, div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1,
177).quot is equal to 0
[25.15] false \vee !(0 == 0)
\rightarrow [simplify]
[25.18] false
Proof of verification condition: Type constraint satisfied in explicit
conversion from 'short int' to 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (51,22)
Condition defined at:
To prove: minof(int) \leq \$heap_{funcstart\_724,1}.p2
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType<short int>((int)177)
\theta
heap_{init}.M2 == asType < short int > ((int)30307)
\rho_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
```

```
\theta sheap<sub>init</sub>.b2 == asType<short int>((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
heap_{init}.b3 == asType < short int > ((int)63)
\theta
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart\_724,1})
div1 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ / \ 
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) = =
asType<integer>(div1.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathtt{a1}) \leq
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1})) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
Proof:
[Take given term]
[5.0] invariant1(heapIs heap_{funcstart\_724,1})
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
[5.1] ((((((0 < asType < integer > ($heap_{funcstart\_724,1}.p1)) &&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) <
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))~\&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
as
Type<integer>(\rho_{funcstart\_724,1}.M2))) & (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
```

```
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.3] (((((0 < $heap_{funcstart\_724,1}.p1) && ($heap_{funcstart\_724,1}.p1 < 
asType<integer>(heap_{funcstart\_724,1}.M1))) && (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2})))\ \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.4] \; (((((0 < \mathrm{\$heap}_{funcstart\_724,1}.\mathrm{p1}) \; \&\& \; (\mathrm{\$heap}_{funcstart\_724,1}.\mathrm{p1} <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{init}.\mathrm{M1})))~\&\&~(0<
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
(asType < integer > (\$heap_{funcstart_{-724,1}}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < \text{heap}_{funcstart\_724,1}.p1) && (\text{heap}_{funcstart\_724,1}.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p2) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M2})))~\&\&~(0<
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.16] ((((-30269 < -$heap_{funcstart\_724,1}.p1) \lambda (0 < $heap_{funcstart\_724,1}.p1) \lambda
(0 < \text{$heap}_{funcstart\_724,1}.p2)) \&\& (\text{$heap}_{funcstart\_724,1}.p2 <
asType<integer>($heap_{funcstart\_724,1}.M2))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.17] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \; \land \; (0 < \$heap_{funcstart\_724,1}.p1) \; \land 
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType < integer > (\$heap_{init}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
```

```
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < \text{\$heap}_{funcstart\_724,1}.\text{p2})) && (\text{\$heap}_{funcstart\_724,1}.\text{p2} <
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType < integer > ($heap_{funcstart\_724,1}.p3))) &&
(asType<integer>($heap_{tuncstart\_724,1}.p3) <
asType<integer>($heap_funcstart_724,1.M3))
\rightarrow [simplify]
[5.30] ((-30307 < -$heap<sub>funcstart_724.1.</sub>p2) \wedge (-30269 <
-\$ heap_{funcstart\_724,1}.p1) \land (0 < \$ heap_{funcstart\_724,1}.p1) \land (0 < \$ heap_{funcstart\_724,1}.p1) \land (0 < \$ heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.p2) \land (0 < \text{Sheap}_{funcstart\_724,1}.p3)) \&\&
(\$heap_{funcstart\_724,1}.p3 < \mathbf{asType} < \mathbf{integer} > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \land (-30269 <
 -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1.p2}) \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.p3 < asType < integer > (\text{\$heap}_{init}.M3))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap_{funcstart\_724,1}.p2) \land (-30269 <
-\$heap_{funcstart_{724,1}.p1}) \land (0 < \$heap_{funcstart_{724,1}.p1}) \land (0 <
\text{Sheap}_{funcstart_{724,1},p2} \land (0 < \text{Sheap}_{funcstart_{724,1},p3})) \&\&
(\$heap_{funcstart\_724,1}.p3 < \textbf{asType} < \textbf{integer} > (\textbf{asType} < \textbf{short}
int > ((int)30323)))
\rightarrow [simplify]
[5.40] \; (-30323 < -\$ heap_{funcstart\_724,1}.p3) \; \wedge \; (-30307 < -30307) \; \wedge \; (-30307 < -30307) \; \wedge \; (-30307) \; \wedge \; (-3030
  -\$heap_{funcstart_{724,1}.p2}) \land (-30269 < -\$heap_{funcstart_{724,1}.p1}) \land (0 < -\$heap_{funcstart_{724,1}.p2})
\text{Sheap}_{funcstart_{724,1}.p1} \land (0 < \text{Sheap}_{funcstart_{724,1}.p2}) \land (0 <
\$ heap_{funcstart\_724,1}.p3)
[Work on sub-term 5 of conjunction in term 5.40]
\textit{[9.0] 0} < \$ heap_{funcstart\_724,1}.p2
[Take goal term]
[1.0] \mathbf{minof(int)} \leq \$ heap_{funcstart\_724,1}.p2
\rightarrow [simplify]
[1.3] -32769 < $heap_{tuncstart_724.1}.p2
\rightarrow [from term 9.0, literala < $heap_{funcstart\_724,1}.p2 is true whenever (-1 +
literala) < 0
```

```
Proof of rule precondition:
```

```
[1.3.0] (-32769 + -1) < 0

\rightarrow [simplify]

[1.3.2] true

[1.4] true
```

Proof of verification condition: Type constraint satisfied in explicit conversion from 'short int' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (51,22)

Condition defined at:

```
To prove: \text{$heap}_{funcstart\_724,1.p2} \leq \max_{fine}(\text{int})
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
\theta
\theta
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart_{-724,1}})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) /
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}))) = =
```

```
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heap_{tuncstart_724,1}.p1)) %
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))) = =
asType<integer>(div1.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1})) =>
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) ==
asType<integer>(div1.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathtt{a1}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
Proof:
[Take given term]
[5.0] invariant1(heapIs heap_{funcstart\_724,1})
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
 \texttt{[5.1]} \left( \left( \left( \left( \left( 0 < \mathbf{asType} < \mathbf{integer} > \left( \$ \mathsf{heap}_{funcstart\_724,1}.\mathsf{p1} \right) \right) \right. \&\& \right. \right. 
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) <
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType<integer>(heap_{funcstart\_724,1}.M2))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M3}))
\rightarrow [simplify]
[5.3] (((((0 < $heap_{funcstart_724,1}.p1) && ($heap_{funcstart_724,1}.p1 < function for the content of the 
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart_{-724,1}}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.4] \; (((((0 < \$ heap_{funcstart\_724,1}.p1) \; \&\& \; (\$ heap_{funcstart\_724,1}.p1 <
asType < integer > (\$heap_{init}.M1))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(asType<integer>($heap_{tuncstart\_724.1}.p2) <
```

```
asType<integer>(heap_{funcstart\_724,1}.M2))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < $heap_{funcstart_{724,1}}.p1) && ($heap_{funcstart_{724,1}}.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
(asType<integer>($heap_{tuncstart\_724,1}.p3) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
|5.16| \left( \left( \left( \left( -30269 < -\$ \text{heap}_{funcstart\_724,1}.\text{p1} \right) \right. \wedge \left. \left( 0 < \$ \text{heap}_{funcstart\_724,1}.\text{p1} \right) \right. \wedge \right. |
(0 < \mathrm{\$heap}_{funcstart\_724,1}.\mathrm{p2})) && (\mathrm{\$heap}_{funcstart\_724,1}.\mathrm{p2} <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M2})))~\&\&~(0<
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > (\$heap_{tuncstart_{-724,1}}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.17] ((((-30269 < -$heap_{funcstart\_724,1}.p1) \lambda (0 < $heap_{funcstart\_724,1}.p1) \lambda
(0 < $heap_{funcstart\_724,1}.p2)) && ($heap_{funcstart\_724,1}.p2 <
asType < integer > (\$heap_{init}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \; \land \; (0 < \$heap_{funcstart\_724,1}.p1) \; \land 
(0 < \text{$heap}_{funcstart\_724,1}.p2)) \&\& (\text{$heap}_{funcstart\_724,1}.p2 <
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724.1}.M3))
\rightarrow [simplify]
[5.30] ((-30307 < -$heap_{funcstart\_724,1}.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.\text{p2}) \land (0 < \text{Sheap}_{funcstart\_724,1}.\text{p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.\text{p3} < \text{asType} < \text{integer} > (\text{\$heap}_{funcstart\_724,1}.\text{M3}))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -$heap_{tuncstart\_724,1}.p2) \land (-30269 <
```

```
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.p2) \land (0 < \text{Sheap}_{funcstart\_724,1}.p3)) \&\&
(\$heap_{funcstart\_724,1}.p3 < \mathbf{asType} < \mathbf{integer} > (\$heap_{init}.M3))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \wedge (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{724,1}.p3})) \&\&
(\text{sheap}_{funcstart\_724,1}.\text{p3} < \text{asType} < \text{integer} > (\text{asType} < \text{short})
int > ((int)30323)))
\rightarrow [simplify]
[5.40] (-30323 < -$heap<sub>funcstart_724.1</sub>.p3) \land (-30307 <
-\$heap_{funcstart\_724,1}.p2) \land (-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < -\$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.\text{p1}) \land (0 < \text{Sheap}_{funcstart\_724,1}.\text{p2}) \land (0 <
heap_{funcstart_{-724,1}.p3}
[Work on sub-term 2 of conjunction in term 5.40]
[6.0] -30307 < -$heap<sub>funcstart_724,1</sub>.p2
[Take goal term]
[1.0] \text{heap}_{funcstart\_724,1}.\text{p2} \leq \text{maxof(int)}
\rightarrow [simplify]
[1.9] -32768 < -\$heap_{funcstart\_724,1}.p2
\rightarrow [from term 6.0, literala < -$heap<sub>funcstart-724.1</sub>.p2 is true whenever (-1 +
literala) < -30307
    Proof of rule precondition:
    [1.9.0] (-32768 + -1) < -30307
    \rightarrow [simplify]
    [1.9.2] true
[1.10] true
Proof of verification condition: Type constraint satisfied in explicit
conversion from 'short int const' to 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (51,31)
Condition defined at:
To prove: minof(int) \leq \$heap_{funcstart\_724,1}.a2
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
```

```
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta
heap_{init}.M2 == asType < short int > ((int)30307)
\theta_{init}.r2 == asType<short int>((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
heap_{init}.a3 == asType<short int>((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs $heap_{tuncstart_724.1})
div1 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1})) \ / \\
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(\mathbf{asType} {<} \mathbf{integer} {>} (\mathbf{asType} {<} \mathbf{int} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1})) =>
(asType < integer > (\$heap_{funcstart\_724.1}.p1) = =
asType<integer>(div1.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a1) \le
asType < integer > (\$heap_{funcstart\_724,1}.p1)) => !(0 ==
asType < integer > (div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
Proof:
[Take goal term]
[1.0] minof(int) \leq $heap<sub>funcstart_724,1</sub>.a2
```

```
\rightarrow [simplify]
[1.1] -32768 \leq $heap<sub>funcstart_724,1</sub>.a2
\rightarrow [const static or extern object]
[1.2] -32768 \le \text{$heap}_{init}.a2
\rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
[1.3] - 32768 \le asType < short int > ((int)176)
\rightarrow [simplify]
[1.6] true
Proof of verification condition: Type constraint satisfied in explicit
conversion from 'short int const' to 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (51,31)
Condition defined at:
To prove: heap_{funcstart\_724,1}.a2 \le maxof(int)
Given:
heap_{init}.LIMIT == (int)80
\theta
\theta_{init}.r1 == asType < short int > ((int)171)
\theta
\theta
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\rho_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
\theta = asType < short int > ((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
\theta == asType<short int>((int)178)
\theta = asType < short int > ((int)63)
\theta
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart_{-724,1}})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
```

```
asType < int > (\$heap_{funcstart\_724,1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ / \\
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}))) = =
asType<integer>(div1.quot)
(asType < int > (asType < int > (\$heap_{funcstart\_724,1}.p1)) \%
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}))) = =
asType<integer>(div1.rem)
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) <
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a1})) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p1) = =
asType<integer>(div1.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathtt{a1}) \leq
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1})) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
Proof:
[Take goal term]
[1.0] $heap<sub>funcstart_724,1</sub>.a2 \leq maxof(int)
\rightarrow [const static or extern object]
[1.1] $heap<sub>init</sub>.a2 \leq maxof(int)
\rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
[1.2] asType<short int>((int)176) \le maxof(int)
\rightarrow [simplify]
[1.6] true
Proof of verification condition: Precondition of 'div' satisfied
Condition generated at: C:\Escher\Customers\prang\prang.c (51,18)
Condition defined at: C:\Escher\ecv\standard\stdlib.h (94,10)
To prove: 0 < asType < integer > (asType < int > (\$heap_{funcstart\_724.1}.a2))
Given:
heap_{init}.LIMIT == (int)80
\theta
\theta
\theta_{init}.a1 == asType<short int>((int)177)
```

```
heap_{init}.M2 == asType < short int > ((int)30307)
\theta_{init}.r2 == asType<short int>((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
heap_{init}.b2 == asType < short int > ((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
heap_{init}.a3 == asType<short int>((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\rho = asType < short int > ((int)2)
\theta = asType < short int > ((int)3)
invariant1(heapIs $heap_{tuncstart_724.1})
div1 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1})) \ / \\
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p1) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1})) =>
(asType < integer > (\$heap_{funcstart\_724.1}.p1) = =
asType<integer>(div1.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathtt{a1}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
Proof:
[Take goal term]
[1.0] 0 < asType<integer>(asType<int>($heap_{tuncstart, 724.1}.a2))
\rightarrow [const static or extern object]
[1.1] 0 < asType < integer > (asType < int > (\$heap_{init}.a2))
```

```
\rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
[1.2] 0 < asType<integer>(asType<int>(asType<short
int > ((int)176))
\rightarrow [simplify]
[1.7] true
Proof of verification condition: Assertion valid
Condition generated at: C:\Escher\Customers\prang\prang.c (52,48)
To prove: (asType<integer>(sheap_{funcstart\_724,1}.a2) \leq
asType < integer > (\$heap_{funcstart\_724.1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
\theta
\theta
heap_{init}.M2 == asType < short int > ((int)30307)
\rho_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType<short int>((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\rho = asType < short int > ((int)2)
\theta = asType < short int > ((int)3)
invariant1(heapIs $heap_{tuncstart_{724.1}})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \ \operatorname{\$heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1})) \ / \\
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
```

```
(asType < integer > (asType < int > (\$heap_{funcstart\_724.1}.p1)) \%
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}))) = =
asType<integer>(div1.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}) ==
asType<integer>(div1.rem))
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}) \leq
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1})) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}),
asType < int > (\$heap_{funcstart\_724,1}.a2))
(asType<integer>(asType<int>($heap_{tuncstart\_724.1}.p2)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))) ==
asType<integer>(div2.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p2) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2})) =>
(asType < integer > (\$heap_{funcstart\_724,1}.p2) = =
asType<integer>(div2.rem))
Proof:
[Take given term]
[5.0] invariant1(heapIs heap_{funcstart\_724,1})
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
[5.1] ((((((0 < asType<integer>(sheap_{funcstart\_724.1}.p1)) &&
(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2})))\ \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.3] (((((0 < \text{\$heap}_{funcstart\_724,1}.p1) \&\& (\text{\$heap}_{funcstart\_724,1}.p1 <
```

```
asType<integer>(heap_{funcstart\_724,1}.M1))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > ($heap_{funcstart\_724,1}.p3))) &&
(asType<integer>($heap_{tuncstart\_724,1}.p3) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.4] (((((0 < \theta_{funcstart\_724,1.p1) && (\theta_{funcstart\_724,1.p1)
asType<integer>($heap<sub>init</sub>.M1))) && (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2})))\ \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})))\ \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < \text{heap}_{funcstart\_724,1}.p1) && (\text{heap}_{funcstart\_724,1}.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) <
asType<integer>(heap_{funcstart\_724,1}.M2))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [simplify]
[5.16] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \; \land \; (0 < \$heap_{funcstart\_724,1}.p1) \; \land 
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 < 0
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType<integer>($heap_funcstart_724.1.p3) <
asType < integer > (\$heap_{funcstart\_724.1}.M3))
\rightarrow [const static or extern object]
[5.17] \left( \left( \left( \left( -30269 < -\$ \text{heap}_{funcstart\_724,1}.\text{p1} \right) \right. \wedge \left. \left( 0 < \$ \text{heap}_{funcstart\_724,1}.\text{p1} \right) \right. \wedge \right. \right)
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType < integer > (\$heap_{init}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > (\$heap_{funcstart\_724.1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
```

```
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType<integer>(asType<short int>((int)30307)))) && (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.30] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \wedge (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.p2) \land (0 < \text{Sheap}_{funcstart\_724,1}.p3)) \&\&
(\text{\$heap}_{funcstart\_724,1}.p3 < asType < integer > (\text{\$heap}_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -$heap_funcstart_724,1.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.p2) \land (0 < \text{Sheap}_{funcstart\_724,1}.p3)) \&\&
(\text{\$heap}_{funcstart\_724,1}.\text{p3} < \mathbf{asType} < \mathbf{integer} > (\text{\$heap}_{init}.\text{M3}))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap_{funcstart\_724,1}.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.p2) \land (0 < \text{Sheap}_{funcstart\_724,1}.p3)) \&\&
(\$heap_{funcstart\_724,1}.p3 < \mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{short}
int > ((int)30323)))
\rightarrow [simplify]
[5.40] (-30323 < -$heap<sub>funcstart_724,1.</sub>p3) \land (-30307 <
-\$heap_{funcstart\_724,1}.p2) \land (-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < -\$heap_{funcstart\_724,1}.p1)
\theta_{funcstart\_724,1}.p1) \land (0 < \theta_{funcstart\_724,1}.p2) \land (0 < \theta_{funcstart\_724,1}.p2) \land (0 < \theta_{funcstart\_724,1}.p2)
heap_{funcstart\_724,1}.p3
[Work on sub-term 5 of conjunction in term 5.40]
[9.0] 0 < \text{$heap}_{funcstart\_724,1}.p2
[Take given term]
[27.0] div2 == div(heapIs $heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
\rightarrow [simplify]
[27.1]~{\rm div2} == {\rm div}(\mathbf{heapIs}~\$ \mathrm{heap}_{funcstart\_724,1},\,\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2},
asType < int > (\$heap_{funcstart\_724.1}.a2))
\rightarrow [const static or extern object]
[27.2]~{\rm div2} == {\rm div}(\mathbf{heapIs}~\$ \mathrm{heap}_{funcstart\_724,1},\,\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2},
asType < int > (\$heap_{init}.a2))
```

```
\rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
[27.3] \text{ div2} == \text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724.1}, \$ \text{heap}_{funcstart\_724.1}.\text{p2},
asType<int>(asType<short int>((int)176)))
\rightarrow [simplify]
[27.6] div2 == div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2, 176)
[Take goal term]
[1.0] (asType<integer>($heap_{tuncstart\_724.1}.a2) \leq
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})) => !(0 ==
asType<integer>(div2.quot))
\rightarrow [const static or extern object]
[1.1] (asType<integer>($heap_{init}.a2) \leq
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})) => !(0 ==
asType<integer>(div2.quot))
\rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
[1.2] (asType<integer>(asType<short int>((int)176)) \le 
asType < integer > (\$heap_{funcstart-724.1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
\rightarrow [simplify]
[1.8] (175 < $\text{heap}_{funcstart_724,1}.p2) => !(0 ==
asType<integer>(div2.quot))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{funcstart\_724.1},
heap_{funcstart_{-724,1}}.p2, 176)
[1.9] (175 < heap_{funcstart\_724,1}.p2) => !(0 ==
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2,
176).quot))
\rightarrow [simplify]
[1.13] ! (0 == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p2},
176).quot) \vee (-176 < -\$heap_{funcstart\_724,1}.p2)
\rightarrow [negate goal and search for contradiction]
[1.14] (0 == div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
176).quot) \land !(-176 < -\$heap_{funcstart\_724.1}.p2)
\rightarrow [simplify]
[1.17] (0 == div(heapIs $heap_{funcstart_{-724,1}}, $heap_{funcstart_{-724,1}}.p2,]
176).quot) \land (175 < $heap<sub>funcstart_724,1.</sub>p2)
\rightarrow [separate conjunction and work on first sub-term]
[1.18] 0 == \text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot}
```

```
[Assume known post-assertion, class invariant or type constraint for term 27.6]
[30.0] (asType<integer>(heap_{funcstart\_724,1}.p2) /
asType<integer>(176)) == asType<integer>(div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).quot)
\rightarrow [simplify]
[30.2] ($heap<sub>funcstart_724.1</sub>.p2 / 176) == asType<integer>(div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).quot
→ [expand definition of operator './' in class 'int' at built in declaration]
[30.3] \; ([\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) < 0] :
-(-asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176), []:
asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176) ==
asType<integer>(div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2,
176).quot)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[30.4] ([asType<integer>($heap_{funcstart\_724,1}.p2) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176) ==
asType<integer>(div(heapIs $heap_{tuncstart\_724.1}, $heap_{tuncstart\_724.1}.p2,
176).quot)
\rightarrow [simplify]
[30.7] ([0 < -\$heap_{funcstart\_724,1}.p2]:
-(-\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}) \ / \ 176),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176) ==
asType<integer>(div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p2,
176).quot)
\rightarrow [from term 9.0, literala < -$heap<sub>funcstart_724.1</sub>.p2 is false whenever -2 < (0
+ literala)
   Proof of rule precondition:
   [30.7.0] - 2 < (0 + 0)
   \rightarrow [simplify]
   [30.7.2] true
[30.8] ([\mathbf{false}]: -(-\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p2) \ / \ 176),
[!(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176) = =
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2,
176).quot)
\rightarrow [simplify]
```

```
[30.11] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176), [!(0 <
-\$heap_{funcstart\_724,1}.p2): asType<integer>(\$heap_{funcstart\_724,1}.p2) / 176)
== asType < integer > (div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p2, 176).quot
\rightarrow [from term 9.0, literala < -$heap<sub>funcstart_724.1</sub>.p2 is false whenever -2 < (0
+ literala)]
    Proof of rule precondition:
    [30.11.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [30.11.2] true
[30.12] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176),
[!false]: asType<integer>(\ensuremath{\text{sheap}}_{funcstart\_724,1}.p2) / 176) ==
\mathbf{asType} < \mathbf{integer} > (\mathbf{div}(\mathbf{heapIs} \ \$ \mathbf{heap}_{funcstart\_724,1}, \ \$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}, \\
176).quot)
\rightarrow [simplify]
[30.17] 0 == (-\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p2},
176).quot + (heap_{funcstart\_724,1}.p2 / 176))
\rightarrow [from term 1.18, div(heapIs $heap_{funcstart\_724,1}$, $heap_{funcstart\_724,1}.p2$,
176).quot is equal to 0]
[30.18] 0 == (-0 + (\text{\$heap}_{funcstart\_724,1}.p2 / 176))
\rightarrow [simplify]
[30.20] \; 0 == (\$ heap_{funcstart\_724,1}.p2 \; / \; 176)
[Work on sub-term 2 of conjunction in term 1.17]
\label{eq:funcstart_724,1.p2} \mbox{$41.0$} \mbox{$175$} < \mbox{$heap}_{funcstart\_724,1}.p2
[Create new term from term 30.20 using rule: condition for equality of division]
[45.0] \; ((0*176) < (1 + \$ heap_{funcstart\_724,1}.p2)) \; \wedge \; (\$ heap_{funcstart\_724,1}.p2 < 1.5) \; + \; (\$ heap_{funcstart\_724,1}.p2) < 1.5) \; + \; (\$ heap_{funcstart\_724,1}.p2) 
(176 * (0 + 1)))
\rightarrow [simplify]
[45.3] (-1 < \text{$heap_{funcstart\_724,1}.p2}) \land (\text{$heap_{funcstart\_724,1}.p2} < (176 * (0 + 
\rightarrow [from term 41.0, literala < $heap_{funcstart\_724,1}.p2 is true whenever (-1 +
literala) < 175
    Proof of rule precondition:
    [45.3.0](-1+-1)<175
    \rightarrow [simplify]
    [45.3.2] true
```

```
[45.4] true \land ($heap<sub>funcstart_724,1</sub>.p2 < (176 * (0 + 1)))
\rightarrow [simplify]
[45.9] true \wedge (-176 < -$heap<sub>funcstart_724,1.</sub>p2)
\rightarrow [from term 41.0, literala < -$heap<sub>funcstart_724,1</sub>.p2 is false whenever -2 <
(175 + literala)
   Proof of rule precondition:
   [45.9.0] - 2 < (-176 + 175)
   \rightarrow [simplify]
   [45.9.2] true
[45.10] true \wedge false
\rightarrow [simplify]
[45.11] false
Proof of verification condition: Assertion valid
Condition generated at: C:\Escher\Customers\prang\prang.c (52,20)
To prove: (asType<integer>(peq_{funcstart\_724,1}.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}) ==
asType<integer>(div2.rem))
Given:
heap_{init}.LIMIT == (int)80
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\theta_{init}.r2 == asType<short int>((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
heap_{init}.b2 == asType < short int > ((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
heap_{init}.a3 == asType<short int>((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
```

```
\rho_{init}.p2 == asType < short int > ((int)2)
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart\_724,1})
div1 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}))~\%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(asType<integer>($heap_funcstart_724.1.p1) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p1) = =
asType<integer>(div1.rem))
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.quot)
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2})) \ \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))) ==
asType<integer>(div2.rem)
Proof:
[Take given term]
[5.0] invariant1(heapIs heap_{funcstart\_724,1})
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
 \texttt{[5.1]} \; (((((0 < \mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p1)) \; \&\& \\
(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 <
asType < integer > (\$heap_{funcstart_{-724,1}}.p2))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p2) <
```

```
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.3] (((((0 < $heap_{funcstart_{724,1}}.p1) && ($heap_{funcstart_{724,1}}.p1 < 
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
(asType<integer>($heap_{tuncstart\_724,1}.p3) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.4] \ (((((0 < \$heap_{funcstart\_724,1}.p1) \&\& \ (\$heap_{funcstart\_724,1}.p1 < 
asType<integer>($heap<sub>init</sub>.M1))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{M3}))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < $heap_{funcstart_724,1}.p1) && ($heap_{funcstart_724,1}.p1 < 
asType<integer>(asType<short int>((int)30269)))) && (0 <
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}))) \ \&\& \\
(asType < integer > (\$heap_{funcstart\_724,1}.p2) <
as
Type<integer>(\rho_{funcstart\_724,1}.M2))) & (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.16] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \; \land \; (0 < \$heap_{funcstart\_724,1}.p1) \; \land 
(0 < \text{$heap}_{funcstart_{724,1}.p2})) \&\& (\text{$heap}_{funcstart_{724,1}.p2} <
asType<integer>(heap_{funcstart\_724,1}.M2))) && (0 <
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}))) \ \&\& \\
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
\label{eq:final_start_724,1.p1} [(((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$he
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
```

```
asType < integer > (\$heap_{init}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] \left( \left( \left( \left( -30269 < -\$ \text{heap}_{funcstart\_724,1}.\text{p1} \right) \right. \wedge \left. \left( 0 < \$ \text{heap}_{funcstart\_724,1}.\text{p1} \right) \right. \wedge \right. \right)
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType < integer > (asType < short int > ((int)30307)))) && (0 < footnote{integer}) && (0 < footnote
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [simplify]
[5.30] ((-30307 < -\$heap_{funcstart\_724,1}.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{724,1}.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.\text{p3} < \text{asType} < \text{integer} > (\text{\$heap}_{funcstart\_724,1}.\text{M3}))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{724,1}.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.p3 < asType < integer > (\text{\$heap}_{init}.M3))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{724,1}.p3})) \&\&
(\text{sheap}_{funcstart\_724,1}.p3 < asType < integer > (asType < short)
int > ((int)30323)))
\rightarrow [simplify]
[5.40] (-30323 < -$heap<sub>funcstart_724,1.</sub>p3) \land (-30307 <
-\$heap_{funcstart\_724,1}.p2) \land (-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < -\$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.\text{p1}) \land (0 < \text{Sheap}_{funcstart\_724,1}.\text{p2}) \land (0 <
heap_{funcstart_{-724,1}.p3}
[Work on sub-term 5 of conjunction in term 5.40]
[9.0] 0 < \text{heap}_{funcstart\_724,1.p2}
[Take given term]
[27.0] \operatorname{div2} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
\rightarrow [simplify]
```

```
\label{eq:continuous} \textit{[27.1]} \ \text{div2} == \ \text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p2},
asType < int > (\$heap_{funcstart\_724,1}.a2))
\rightarrow [const static or extern object]
\label{eq:continuous} \mbox{[27.2] div2} == \mbox{div}(\mathbf{heapIs} \ \mbox{\$heap}_{funcstart\_724,1}, \ \mbox{\$heap}_{funcstart\_724,1}.p2,
asType < int > (\$heap_{init}.a2))
\rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
[27.3] \operatorname{div2} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p2,
asType<int>(asType<short int>((int)176)))
\rightarrow [simplify]
[27.6] div2 == div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p2, 176)
[Take goal term]
[1.0] (asType<integer>(\theta_{funcstart\_724,1}.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p2) = =
asType<integer>(div2.rem))
\rightarrow [simplify]
[1.1] (\text{heap}_{funcstart\_724,1}.p2 < \text{asType} < \text{integer} > (\text{heap}_{funcstart\_724,1}.a2))
=>(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})==
asType<integer>(div2.rem))
\rightarrow [const static or extern object]
[1.2] ($heap<sub>funcstart_724,1</sub>.p2 < asType<integer>($heap<sub>init</sub>.a2)) =>
(asType < integer > (\$heap_{funcstart\_724,1}.p2) = =
asType<integer>(div2.rem))
\rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
[1.3] \ (\$heap_{funcstart\_724,1}.p2 < \mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{short})
int>((int)176))) => (asType < integer>($heap_{funcstart\_724,1}.p2) ==
asType<integer>(div2.rem))
\rightarrow [simplify]
[1.10] (-176 < -$\text{heap}_{funcstart_724,1}.p2) => ($\text{heap}_{funcstart_724,1}.p2 ==
asType<integer>(div2.rem))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p2, 176
[1.11] (-176 < -$heap<sub>funcstart_724,1.</sub>p2) => ($heap<sub>funcstart_724,1.</sub>p2 ==
\mathbf{asType} \small{<} \mathbf{integer} \small{>} ( \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}, \\
176).rem))
\rightarrow [simplify]
[1.17] (0 == (-$heap_{tuncstart_724,1}.p2 + div(heapIs $heap_{tuncstart_724,1},
```

```
\text{Sheap}_{funcstart_{724,1},p2, 176}.\text{rem}) \vee (175 < \text{Sheap}_{funcstart_{724,1},p2})
\rightarrow [negate goal and search for contradiction]
[1.18]!(0 == (-\$heap_{funcstart\_724,1}.p2 + div(heapIs \$heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p2, 176).rem) \land !(175 < heap_{funcstart\_724,1}.p2)
\rightarrow [simplify]
[1.20]!(0 == (-\$heap_{funcstart\_724,1}.p2 + div(heapIs \$heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).rem) \land (-176 < -\text{Sheap}_{funcstart\_724,1.p2})
\rightarrow [separate conjunction and work on first sub-term]
[1.21] -176 < -\$heap_{funcstart\_724,1}.p2
[Assume known post-assertion, class invariant or type constraint for term 27.6]
[31.0] (asType<integer>(sheap_{funcstart}_724.1.p2) %
asType<integer>(176)) == asType<integer>(div(heapIs
\text{Sheap}_{funcstart_{-724,1}}, \text{Sheap}_{funcstart_{-724,1}}.p2, 176).rem
\rightarrow [simplify]
[31.2] ($heap<sub>funcstart_724,1.</sub>p2 % 176) == asType<integer>(div(heapIs)
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, 2, 176).rem
→ [expand definition of operator '.%' in class 'int' at built in declaration]
[31.3] ([asType<integer>(sheap_{funcstart\_724,1}.p2) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176), []:
asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176) = =
asType<integer>(div(heapIs p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1})
176).rem)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[31.4] ([asType<integer>($heap_{funcstart\_724,1}.p2) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176) ==
asType<integer>(div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p2,
176).rem)
\rightarrow [simplify]
[31.7] ([0 < -\$heap_{funcstart\_724,1}.p2]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176) ==
asType<integer>(div(heapIs $heap_{tuncstart\_724.1}, $heap_{tuncstart\_724.1}.p2,
176).rem)
\rightarrow [from term 9.0, literala < -$heap<sub>funcstart_724,1</sub>.p2 is false whenever -2 < (0
+ literala)
```

```
Proof of rule precondition:
```

```
[31.7.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [31.7.2] true
\textit{[31.8]} \ (\textbf{[false]: -(-asType<integer>(\$heap_{funcstart\_724,1}.p2) \% 176)},
[!(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p2) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176) = =
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2,
176).rem)
\rightarrow [simplify]
[31.11] ([false]: -(-asType < integer > ($heap_{funcstart\_724,1}.p2) \% 176), [!(0
<-$heap<sub>funcstart_724,1.</sub>p2)]: asType<integer>($heap<sub>funcstart_724,1.</sub>p2) %
176) == asType < integer > (div(heapIs $heap_{funcstart\_724,1},
\theta_{funcstart\_724,1}.p2, 176).rem
\rightarrow [from term 9.0, literala < -$heap<sub>funcstart_724,1</sub>.p2 is false whenever -2 < (0
+ literala)]
    Proof of rule precondition:
    [31.11.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [31.11.2] true
[31.12] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176),
[!false]: asType<integer>(peq_{funcstart\_724,1}.p2) % 176) ==
\mathbf{asType} \small{<} \mathbf{integer} \small{>} ( \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}, \\
176).rem)
\rightarrow [simplify]
\textit{[31.17] 0} == (-\text{div}(\textbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p2},
176).rem + (\text{$heap}_{funcstart\_724,1}.p2 \% 176))
[Work on sub-term 2 of conjunction in term 1.20]
[40.0]!(0 == (-\$heap_{funcstart\_724,1}.p2 + div(heapIs \$heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p2, 176).rem
[Copy term 40.0]
[44.0]!(0 == (-\$heap_{funcstart\_724,1}.p2 + div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p2, 176).rem
\rightarrow [from\ term\ 31.17,\ div(\textbf{heapIs}\ \$heap_{funcstart\_724,1},\ \$heap_{funcstart\_724,1}.p2,
176).rem is equal to heap_{funcstart\_724,1}.p2 \% 176
[44.1]!(0 == (-\$heap_{funcstart\_724,1}.p2 + (\$heap_{funcstart\_724,1}.p2 \% 176)))
\rightarrow [remainder with larger divisor]
```

```
Proof of rule precondition 1:
   [44.1.0.0] literald < -$heap_{funcstart\_724,1}.p2
   \rightarrow [unify with term 1.21]
   [44.1.0.1] true
   Proof of rule precondition 2:
   [44.1.1.0]~\mathrm{literalc} < \$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}
   \rightarrow [unify with term 9.0]
   [44.1.1.1] true
   Proof of rule precondition 3:
   [44.1.2.0] --176 \le 176
   \rightarrow [simplify]
   [44.1.2.2] true
   Proof of rule precondition 4:
   [44.1.3.0] - 2 < 0
   \rightarrow [simplify]
   [44.1.3.1] true
[44.2]!(0 == (-\$heap_{funcstart\_724,1}.p2 + \$heap_{funcstart\_724,1}.p2))
\rightarrow [simplify]
[44.5] false
Proof of verification condition: Assertion valid
Condition generated at: C:\Escher\Customers\prang\prang.c (53,26)
To prove: !(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
Given:
heap_{init}.LIMIT == (int)80
\theta
\theta
\theta
\theta = asType < short int > ((int)2)
heap_{init}.M2 == asType < short int > ((int)30307)
```

 ρ_{init} .r2 == asType<short int>((int)172) ρ_{init} .a2 == asType<short int>((int)176)

```
\theta sheap<sub>init</sub>.b2 == asType<short int>((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
heap_{init}.b3 == asType < short int > ((int)63)
\theta
\theta
\theta = asType < short int > ((int)3)
invariant
1(heap<br/>Is \theta_{funcstart\_724,1}
div1 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1})) \ / \\
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))) = =
asType<integer>(div1.quot)
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(asType < integer > ($heap_{funcstart\_724,1}.p1) < 
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) ==
asType<integer>(div1.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathtt{a1}) \leq
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1})) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p2})) \ / \\
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))) ==
asType<integer>(div2.quot)
(asType < integer > (asType < int > (\$heap_{tuncstart\_724.1}.p2)) \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.rem)
(asType<integer>($heap_{tuncstart\_724,1}.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
```

```
(asType < integer > (\$heap_{funcstart_{-724,1}}.p2) = =
asType<integer>(div2.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a2}) \leq
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2})) = > !(0 = =
asType<integer>(div2.quot))
Proof:
[Take given term]
[5.0] invariant1(heapIs heap_{funcstart\_724,1})
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
[5.1] ((((((0 < asType < integer > (heap_{funcstart_{-724,1}}.p1)) &&
(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M1})))~\&\&~(0<
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(asType<integer>($heap_funcstart_724.1.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
asType<integer>(sheap_{funcstart_{-724,1}}.M1))) && (0 <
asType < integer > (\$heap_{funcstart_{-724,1}}.p2))) \&\&
(asType<integer>($heap_funcstart_724,1.p2) <
\mathbf{asType} \small{<} \mathbf{integer} \small{>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M2}))) \ \&\& \ (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.4] (((((0 < $heap_{funcstart_{724,1}}.p1) && ($heap_{funcstart_{724,1}}.p1 < ]
asType < integer > (\$heap_{init}.M1))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(asType<integer>($heap_funcstart_724,1.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < $heap_{funcstart_724,1}.p1) && ($heap_{funcstart_724,1}.p1 < footnote{in the content of the c
\mathbf{asType} \small{<} \mathbf{integer} \small{>} (\mathbf{asType} \small{<} \mathbf{short} \ \mathbf{int} \small{>} ((\mathbf{int})30269)))) \ \&\& \ (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p2) <
```

```
asType<integer>(heap_{funcstart\_724,1}.M2))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.16] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1
(0 < \text{$heap}_{funcstart\_724,1}.p2)) \&\& (\text{$heap}_{funcstart\_724,1}.p2 <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M3}))
\rightarrow [const static or extern object]
[5.17] ((((-30269 < -$heap_{funcstart\_724,1}.p1) \lambda (0 < $heap_{funcstart\_724,1}.p1) \lambda
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType < integer > (\$heap_{init}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M3}))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < \text{$heap}_{funcstart\_724,1}.p2)) \&\& (\text{$heap}_{funcstart\_724,1}.p2 <
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p3) < 
asType<integer>($heap_funcstart_724,1.M3))
\rightarrow [simplify]
[5.30] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\$heap_{funcstart\_724,1}.p2) \land (0 < \$heap_{funcstart\_724,1}.p3)) \&\&
(\text{\$heap}_{funcstart\_724,1}.\text{p3} < \text{asType} < \text{integer} > (\text{\$heap}_{funcstart\_724,1}.\text{M3}))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -$heap_funcstart_724,1.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1.p2} \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.\text{p3} < \text{asType} < \text{integer} > (\text{\$heap}_{init}.\text{M3}))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \wedge (-30269 <
 -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.p2) \land (0 < \text{Sheap}_{funcstart\_724,1}.p3)) \&\&
(\text{sheap}_{funcstart\_724,1}.p3 < asType < integer > (asType < short)
int > ((int)30323)))
```

```
\rightarrow [simplify]
[5.40] (-30323 < -$heap_{funcstart\_724,1}.p3) \land (-30307 <
-\$heap_{funcstart\_724,1}.p2) \wedge (-30269 < -\$heap_{funcstart\_724,1}.p1) \wedge (0 <
\text{Sheap}_{funcstart\_724,1}.\text{p1}) \land (0 < \text{Sheap}_{funcstart\_724,1}.\text{p2}) \land (0 <
heap_{funcstart_{-724,1}.p3}
[Work on sub-term 5 of conjunction in term 5.40]
\textit{[9.0] 0} < \$ heap_{funcstart\_724,1}.p2
[Take given term]
[27.0] div2 == div(heapIs $heap_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
\rightarrow [simplify]
\label{eq:continuous} \textit{[27.1]} \ \text{div2} == \ \text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p2},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
\rightarrow [const static or extern object]
[27.2] div2 == div(heapIs \theta_{funcstart_{-724,1}}, \theta_{funcstart_{-724,1}}, \theta_{funcstart_{-724,1}}
asType < int > (\$heap_{init}.a2))
\rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
\label{eq:continuous} \mbox{[27.3] div2} == \mbox{div}(\mathbf{heapIs} \ \$\mbox{heap}_{funcstart\_724,1}, \ \$\mbox{heap}_{funcstart\_724,1}.\mbox{p2},
asType<int>(asType<short int>((int)176)))
\rightarrow [simplify]
[27.6] div2 == div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p2, 176)
[Take goal term]
[1.0]!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p2, 176)
[1.1]!(0 == asType < integer > (div(heapIs $heap_{funcstart\_724,1},
\theta_{funcstart\_724,1.p2, 176}.rem) || !(0 == asType<integer>(div2.quot))
\rightarrow [simplify]
[1.2] !(0 == \operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p2, 176).rem)
||!(0 == asType < integer > (div2.quot))||
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p2, 176)
[1.3] !(0 == \operatorname{div}(\mathbf{heapIs} \ \text{$heap}_{funcstart\_724,1}, \ \text{$heap}_{funcstart\_724,1}.p2, \ 176).rem)
||!(0 == asType < integer) = (div(heapIs $heap_{funcstart\_724,1}, 
heap_{funcstart_{-724,1}}.p2, 176).quot)
```

```
\rightarrow [simplify]
[1.5]!(0 == \text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p2},
176).quot) \vee !(0 == \text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p2},
176).rem)
\rightarrow [negate goal and search for contradiction]
[1.6] (0 == div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1},p2, 176}).quot)
\wedge (0 == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p2}, 176).\operatorname{rem})
\rightarrow [separate conjunction and work on first sub-term]
[1.7] 0 == div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot
[Work on sub-term 2 of conjunction in term 1.6]
[42.0] 0 == \text{div}(\text{heapIs } \text{$heap}_{funcstart\_724,1}, \text{$heap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem}
[Take given term]
[40.0]~(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p2) = =
asType<integer>(div2.rem))
\rightarrow [simplify]
[40.1] (\text{heap}_{funcstart\_724.1}.p2 < asType < integer > (\text{heap}_{funcstart\_724.1}.a2))
=> (asType<integer>($heap_{funcstart\_724,1}.p2) ==
asType<integer>(div2.rem))
\rightarrow [const static or extern object]
[40.2] \; (\$heap_{funcstart\_724,1}.p2 < \mathbf{asType} < \mathbf{integer} > (\$heap_{init}.a2)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}) ==
asType<integer>(div2.rem))
\rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
[40.3] (heap_{funcstart\_724,1}.p2 < asType < integer > (asType < short)
int>((int)176))) => (asType< integer>($heap_{funcstart\_724,1}.p2) ==
asType<integer>(div2.rem))
\rightarrow [simplify]
[40.10] (-176 < -$\text{heap}_{funcstart_724,1}.p2) => ($\text{heap}_{funcstart_724,1}.p2 ==
asType<integer>(div2.rem))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{funcstart_{724,1}},
heap_{funcstart_{-724,1}}.p2, 176)
[40.11] \; (\text{-}176 < -\$ \text{heap}_{funcstart\_724,1}.\text{p2}) => (\$ \text{heap}_{funcstart\_724,1}.\text{p2} ==
asType<integer>(div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p2,
176).rem))
\rightarrow [simplify]
```

```
[40.17] (0 == (-$heap_{funcstart_{724,1}}.p2 + div(heapIs $heap_{funcstart_{724,1}},
\text{Sheap}_{funcstart\_724,1.p2}, 176).rem)) \lor (175 < \text{Sheap}_{funcstart\_724,1.p2})
\rightarrow [from\ term\ 42.0,\ div(\mathbf{heapIs}\ \$heap_{funcstart\_724,1},\ \$heap_{funcstart\_724,1}.p2,
176).rem is equal to 0
[40.18] (0 == (-\$heap_{funcstart\_724,1}.p2 + 0)) \lor (175 < \$heap_{funcstart\_724,1}.p2)
\rightarrow [simplify]
[40.19] (0 == -$heap<sub>funcstart_724,1.p2</sub>) \vee (175 < $heap<sub>funcstart_724,1.p2</sub>)
\rightarrow [from term 9.0, -$heap<sub>funcstart_724,1</sub>.p2 == literala is false whenever -1 <
(0 + literala)
   Proof of rule precondition:
   [40.19.0] -1 < (0 + 0)
   \rightarrow [simplify]
   [40.19.2] true
[40.20] false \vee (175 < \text{$heap}_{funcstart\_724,1.p2})
\rightarrow [simplify]
[40.21] 175 < $heap_{funcstart_{-724,1}}.p2
[Take given term]
[41.0] (asType<integer>($heap_{funcstart\_724,1}.a2) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
\rightarrow [const static or extern object]
[41.1] (asType<integer>($heap_{init}.a2) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p2)) = > !(0 ==
asType < integer > (div2.quot))
\rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
[41.2] (asType<integer>(asType<short int>((int)176)) \le 
asType < integer > (\$heap_{funcstart\_724.1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
\rightarrow [simplify]
[41.8] (175 < $\text{heap}_{funcstart_724,1.p2}) => !(0 == 10.8]
asType<integer>(div2.quot))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{funcstart\_724.1},
heap_{funcstart_{-724,1},p2,176}
[41.9] (175 < $\text{heap}_{funcstart_724,1}.p2) => !(0 ==
asType < integer > (div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p2,
176).quot))
```

```
\rightarrow [simplify]
\label{eq:continuous} \textit{[41.13] !} (0 == \operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p2},
176).quot) \vee (-176 < -\$heap_{funcstart\_724,1}.p2)
\rightarrow [from term 40.21, literala < -$heap_{funcstart\_724,1}.p2 is false whenever -2 <
(175 + literala)
   Proof of rule precondition:
   [41.13.0] - 2 < (-176 + 175)
   \rightarrow [simplify]
   [41.13.2] true
[41.14] false \vee!(0 == div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2,
176).quot)
\rightarrow [from term 1.7, div(heapIs $heap_{funcstart\_724.1}, $heap_{funcstart\_724.1}.p2,
176).quot is equal to 0]
[41.15] false \vee !(0 == 0)
\rightarrow [simplify]
[41.18] false
Proof of verification condition: Type constraint satisfied in explicit
conversion from 'short int' to 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (55,22)
Condition defined at:
To prove: minof(int) \leq \$heap_{funcstart\_724,1}.p3
Given:
heap_{init}.LIMIT == (int)80
\theta
\theta_{init}.r1 == asType < short int > ((int)171)
\theta
\theta
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\theta_{init}.r2 == asType<short int>((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
```

```
\theta sheap<sub>init</sub>.a3 == asType<short int>((int)178)
heap_{init}.b3 == asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart\_724,1})
\label{eq:div1} \text{div1} == \text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(asType<int>(asType<int>($heap_{tuncstart\_724.1}.p1)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))) ==
asType<integer>(div1.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p1) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p1) = =
asType<integer>(div1.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a1) \le
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart\_724.1},
asType < int > (\$heap_{funcstart\_724.1}.p2),
asType < int > (\$heap_{funcstart\_724.1}.a2))
(asType<integer>(asType<int>($heap_{funcstart\_724.1}.p2)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.quot)
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2})) \ \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(asType < integer > ($heap_{funcstart\_724,1}.p2) = =
asType<integer>(div2.rem))
(asType < integer > (\$heap_{funcstart\_724.1}.a2) \le
\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})) = > !(0 ==
```

```
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
Proof:
[Take given term]
[5.0] invariant1(heapIs heap_{funcstart\_724,1})
\rightarrow [expand definition of function 'invariant1' at prang.c (34.1)]
[5.1] (((((0 < \mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p1)) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 
asType < integer > (\$heap_{funcstart_{-724,1}}.M1))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2})))\ \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart_{-724,1}}.p3))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M3}))
\rightarrow [simplify]
[5.3] \ (((((0 < \$heap_{funcstart\_724,1}.p1) \&\& \ (\$heap_{funcstart\_724,1}.p1 < (
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart_{-724,1}}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
asType < integer > (\$heap_{init}.M1))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 
asType<integer>(sheap_{funcstart\_724,1}.M2)) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType<integer>($heap_{tuncstart_724,1}.p3) <
\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < $heap_{funcstart_724,1}.p1) && ($heap_{funcstart_724,1}.p1 < footnote{in the content of the c
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
\mathbf{asType} \small{<} \mathbf{integer} \small{>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M2}))) \ \&\& \ (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
```

```
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.16] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \; \land \; (0 < \$heap_{funcstart\_724,1}.p1) \; \land 
(0 < \mathrm{\$heap}_{funcstart\_724,1}.\mathrm{p2})) && (\mathrm{\$heap}_{funcstart\_724,1}.\mathrm{p2} <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})))\ \&\&
(asType<integer>($heap_{tuncstart\_724,1}.p3) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [const static or extern object]
[5.17] \left( \left( \left( \left( -30269 < -\$ \text{heap}_{funcstart\_724,1}.\text{p1} \right) \right. \wedge \left. \left( 0 < \$ \text{heap}_{funcstart\_724,1}.\text{p1} \right) \right. \wedge \right. \right)
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType < integer > (\$heap_{init}.M2))) \&\& (0 <
asType < integer > ($heap_{funcstart\_724,1}.p3))) &&
(asType < integer > ($heap_{funcstart\_724,1}.p3) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < \$ heap_{funcstart\_724,1}.p2)) && (\$ heap_{funcstart\_724,1}.p2 <
asType < integer > (asType < short int > ((int)30307)))) && (0 < integer) && (0 < integer
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [simplify]
[5.30] ((-30307 < -\$heap_{funcstart\_724,1}.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.p2) \land (0 < \text{Sheap}_{funcstart\_724,1}.p3)) \&\&
(\text{\$heap}_{funcstart\_724,1}.p3 < asType < integer > (\text{\$heap}_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \land (-30269 <
 -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{724,1}.p3})) \&\&
(\$heap_{funcstart\_724,1}.p3 < \textbf{asType} < \textbf{integer} > (\$heap_{init}.M3))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap_funcstart_724,1.p2) \land (-30269 <
-$heap_{funcstart\_724,1}.p1) \land (0 < $heap_{funcstart\_724,1}.p1) \land (0 <
\text{Sheap}_{funcstart_{724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{724,1}.p3})) \&\&
(\text{sheap}_{funcstart\_724,1}.p3 < asType < integer > (asType < short)
int > ((int)30323)))
\rightarrow [simplify]
```

```
[5.40] (-30323 < -\text{$heap}_{funcstart\_724,1}.p3) \land (-30307 < -\text{$ps.})
-\$heap_{funcstart\_724,1}.p2) \land (-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < -\$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.\text{p1}) \land (0 < \text{Sheap}_{funcstart\_724,1}.\text{p2}) \land (0 <
heap_{funcstart_{-724,1}.p3}
[Work on sub-term 6 of conjunction in term 5.40]
[10.0] 0 < \text{$heap}_{funcstart\_724,1}.p3
[Take goal term]
[1.0] minof(int) \leq $heap<sub>funcstart_724.1</sub>.p3
\rightarrow [simplify]
[1.3] -32769 < heap_{funcstart\_724,1}.p3
\rightarrow [from term 10.0, literala < $heap<sub>funcstart_724,1</sub>.p3 is true whenever (-1 +
literala) < 0
   Proof of rule precondition:
   [1.3.0](-32769 + -1) < 0
   \rightarrow [simplify]
   [1.3.2] true
[1.4] true
Proof of verification condition: Type constraint satisfied in explicit
conversion from 'short int' to 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (55,22)
Condition defined at:
To prove: heap_{funcstart\_724,1}.p3 \le maxof(int)
Given:
heap_{init}.LIMIT == (int)80
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta
\label{eq:heapinit} \$ \mathrm{heap}_{init}.\mathrm{M2} == \mathbf{asType} < \mathbf{short\ int} > ((\mathbf{int})30307)
\theta_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
\theta = asType < short int > ((int)30323)
```

```
\rho_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType<short int>((int)178)
heap_{init}.b3 == asType < short int > ((int)63)
\theta
\theta
heap_{init}.p3 == asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart_724,1})
div1 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ / \ 
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))) = =
asType<integer>(div1.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(asType < integer > ($heap_{funcstart\_724,1}.p1) < 
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p1) = =
asType<integer>(div1.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a1) \le
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}))\ /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heap_{funcstart\_724.1}.p2)) %
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p2) = =
asType<integer>(div2.rem))
```

```
(asType < integer > (\$heap_{funcstart_{-724,1}}.a2) \le
asType < integer > (\$heap_{funcstart\_724,1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType < integer > (div2.quot))
Proof:
[Take given term]
[5.0] invariant1(heapIs heap_{funcstart\_724,1})
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
[5.1] ((((((0 < asType < integer > (heap_{funcstart_{-724,1}}.p1)) &&
(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 
as
Type<integer>(\rho_{funcstart\_724,1}.M1))) & (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(asType<integer>($heap_funcstart_724.1.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
asType<integer>(sheap_{funcstart_{-724,1}}.M1))) && (0 <
asType < integer > (\$heap_{funcstart_{-724,1}}.p2))) \&\&
(asType<integer>($heap_funcstart_724,1.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 < function for the sum of the 
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.4] (((((0 < $heap_{funcstart_{724,1}}.p1) && ($heap_{funcstart_{724,1}}.p1 < ]
asType < integer > (\$heap_{init}.M1))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(asType<integer>($heap_funcstart_724,1.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < $heap_{funcstart_724,1}.p1) && ($heap_{funcstart_724,1}.p1 < footnote{in the content of the c
\mathbf{asType} \small{<} \mathbf{integer} \small{>} (\mathbf{asType} \small{<} \mathbf{short} \ \mathbf{int} \small{>} ((\mathbf{int})30269)))) \ \&\& \ (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p2) <
```

```
asType<integer>(heap_{funcstart\_724,1}.M2))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.16] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1
(0 < \text{$heap}_{funcstart\_724,1}.p2)) \&\& (\text{$heap}_{funcstart\_724,1}.p2 <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M3}))
\rightarrow [const static or extern object]
[5.17] ((((-30269 < -$heap_{funcstart\_724,1}.p1) \lambda (0 < $heap_{funcstart\_724,1}.p1) \lambda
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType < integer > (\$heap_{init}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M3}))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < \text{$heap}_{funcstart\_724,1}.p2)) \&\& (\text{$heap}_{funcstart\_724,1}.p2 <
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p3) < 
asType<integer>($heap_funcstart_724,1.M3))
\rightarrow [simplify]
[5.30] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\$heap_{funcstart\_724,1}.p2) \land (0 < \$heap_{funcstart\_724,1}.p3)) \&\&
(\text{\$heap}_{funcstart\_724,1}.\text{p3} < \text{asType} < \text{integer} > (\text{\$heap}_{funcstart\_724,1}.\text{M3}))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -$heap_funcstart_724,1.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1.p2} \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.\text{p3} < \text{asType} < \text{integer} > (\text{\$heap}_{init}.\text{M3}))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \wedge (-30269 <
 -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.p2) \land (0 < \text{Sheap}_{funcstart\_724,1}.p3)) \&\&
(\text{\$heap}_{funcstart\_724,1}.p3 < asType < integer > (asType < short)
int > ((int)30323)))
```

```
\rightarrow [simplify]
[5.40] (-30323 < -\text{$heap}_{funcstart\_724,1}.p3) \land (-30307 < -\text{$partstart}_{funcstart}]
-\$heap_{funcstart\_724,1}.p2) \land (-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < -\$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.\text{p1}) \land (0 < \text{Sheap}_{funcstart\_724,1}.\text{p2}) \land (0 <
heap_{funcstart_{724,1}.p3}
\rightarrow [separate conjunction and work on first sub-term]
\label{eq:fine_start_724,1.p3} [5.41] \mbox{ -30323} < -\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}
[Take goal term]
[1.0] $heap<sub>funcstart_724,1</sub>.p3 \leq maxof(int)
\rightarrow [simplify]
\label{eq:constant_724,1.p3} \ -32768 < -\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}
\rightarrow [from term 5.41, literala < -$heap<sub>funcstart_724,1</sub>.p3 is true whenever (-1 +
literala) < -30323
   Proof of rule precondition:
   [1.9.0](-32768 + -1) < -30323
   \rightarrow [simplify]
   [1.9.2] true
[1.10] true
Proof of verification condition: Type constraint satisfied in explicit
conversion from 'short int const' to 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (55,31)
Condition defined at:
To prove: minof(int) \leq \$heap_{funcstart\_724,1}.a3
Given:
heap_{init}.LIMIT == (int)80
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
\label{eq:short_int} $$ \theta_{init}.r1 == asType < short int > ((int)171)$
\theta
\theta
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\theta_{init}.r2 == asType<short int>((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
```

```
heap_{init}.M3 == asType < short int > ((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
heap_{init}.b3 == asType < short int > ((int)63)
\theta
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs $heap_{tuncstart_724.1})
div1 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}),
asType < int > (\$heap_{funcstart_{-724,1}}.a1))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) /
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}))) = =
asType<integer>(div1.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) ==
asType<integer>(div1.rem))
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724.1}.a2))) = =
asType<integer>(div2.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a2})) = >
(asType < integer > (\$heap_{funcstart_{-724.1}}.p2) = =
```

```
asType<integer>(div2.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a2) \le
asType < integer > (\$heap_{funcstart\_724,1}.p2)) => !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
Proof:
[Take goal term]
[1.0] minof(int) \leq $heap<sub>funcstart_724,1</sub>.a3
\rightarrow [simplify]
\textit{[1.1] -32768} \leq \$ heap_{funcstart\_724,1}.a3
\rightarrow [const static or extern object]
[1.2] -32768 \leq $heap<sub>init</sub>.a3
\rightarrow [expand definition of constant 'a3' at prang.c (26,20)]
[1.3] -32768 \le asType < short int > ((int)178)
\rightarrow [simplify]
[1.6] true
Proof of verification condition: Type constraint satisfied in explicit
conversion from 'short int const' to 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (55,31)
Condition defined at:
To prove: \text{$heap}_{funcstart\_724,1}.a3 \leq \max(\text{int})
Given:
heap_{init}.LIMIT == (int)80
\theta
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
heap_{init}.M2 == asType < short int > ((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
```

```
\rho_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType<short int>((int)178)
heap_{init}.b3 == asType < short int > ((int)63)
\theta
\theta
heap_{init}.p3 == asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart_724,1})
div1 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}),
asType < int > (\$heap_{funcstart\_724.1}.a1))
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ / \ 
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))) = =
asType<integer>(div1.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(asType < integer > ($heap_{funcstart\_724,1}.p1) < 
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p1) = =
asType<integer>(div1.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a1) \le
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}))\ /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heap_{funcstart\_724.1}.p2)) %
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p2) = =
asType<integer>(div2.rem))
```

```
(asType < integer > (\$heap_{funcstart\_724,1}.a2) \le
\mathbf{asType} \small{<} \mathbf{integer} \small{>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2})) => !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
Proof:
[Take goal term]
[1.0] \text{heap}_{funcstart\_724,1}.a3 \leq \text{maxof(int)}
\rightarrow [const static or extern object]
[1.1] $heap<sub>init</sub>.a3 \leq maxof(int)
\rightarrow [expand definition of constant 'a3' at prang.c (26,20)]
[1.2] asType<short int>((int)178) \le maxof(int)
\rightarrow [simplify]
[1.6] true
Proof of verification condition: Precondition of 'div' satisfied
Condition generated at: C:\Escher\Customers\prang\prang.c (55,18)
Condition defined at: C:\Escher\ecv\standard\stdlib.h (94,10)
To prove: 0 < asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))
Given:
heap_{init}.LIMIT == (int)80
\theta
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta
heap_{init}.M2 == asType < short int > ((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
heap_{init}.b2 == asType < short int > ((int)35)
\theta = asType < short int > ((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
```

```
\theta
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs $heap_{tuncstart_{724.1}})
div1 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ / \\
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}))) = =
asType<integer>(div1.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p1) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1})) =>
(asType < integer > (\$heap_{funcstart\_724,1}.p1) = =
asType<integer>(div1.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a1) \le
asType < integer > (\$heap_{funcstart\_724,1}.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart\_724.1},
asType < int > (\$heap_{funcstart\_724.1}.p2),
asType < int > (\$heap_{funcstart\_724.1}.a2))
(asType<integer>(asType<int>($heap_{funcstart\_724,1}.p2)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p2) = =
asType<integer>(div2.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a2) \le
\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
```

```
asType<integer>(div2.quot))
Proof:
[Take goal term]
[1.0] 0 < asType<integer>(asType<int>($heap_{tuncstart, 724.1}.a3))
\rightarrow [const static or extern object]
[1.1] 0 < asType<integer>(asType<int>($heap_{init}.a3))
\rightarrow [expand definition of constant 'a3' at prang.c (26,20)]
[1.2] 0 < asType<integer>(asType<int>(asType<short
int > ((int)178))
\rightarrow [simplify]
[1.7] true
Proof of verification condition: Assertion valid
Condition generated at: C:\Escher\Customers\prang\prang.c (56,48)
To prove: (asType<integer>(peq_{funcstart_724,1}.a3) \leq
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})) => !(0 ==
asType<integer>(div3.quot))
Given:
heap_{init}.LIMIT == (int)80
\theta
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType<short int>((int)177)
heap_{init}.M2 == asType < short int > ((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta
heap_{init}.M3 == asType < short int > ((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
```

```
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart_{-724,1}})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \ \operatorname{\$heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ / \\
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))) = =
asType<integer>(div1.quot)
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}))) = =
asType<integer>(div1.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p1) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p1) = =
asType<integer>(div1.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathtt{a1}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart_{-724.1}},
asType < int > (\$heap_{funcstart\_724.1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
(asType<integer>(asType<int>($heap_{funcstart\_724,1}.p2)) /
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType < integer > (div2.quot)
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}))~\%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))) ==
asType<integer>(div2.rem)
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) ==
asType<integer>(div2.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a2) \le
asType < integer > (\$heap_{funcstart\_724,1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart_{-724.1}},
asType < int > (\$heap_{funcstart\_724,1}.p3),
```

```
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
(asType<integer>(asType<int>($heap_{funcstart\_724,1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) ==
asType<integer>(div3.rem))
Proof:
[Take given term]
[5.0] invariant1(heapIs heap_{funcstart_{724.1}})
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
 \texttt{[5.1]} \left( \left( \left( \left( \left( 0 < \mathbf{asType} < \mathbf{integer} > \left( \$ \mathsf{heap}_{funcstart\_724,1}.\mathsf{p1} \right) \right) \right. \&\& \right. \right. 
(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 
as
Type<integer>(\rho_{funcstart\_724,1}.M1))) & (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
as
Type<integer>(\rho_{funcstart\_724,1}.M2))) & (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
(asType<integer>($heap_funcstart_724,1.p3) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.3] (((((0 < $heap_{funcstart_724,1}.p1) && ($heap_{funcstart_724,1}.p1 < ])
as
Type<integer>(\rho_{funcstart\_724,1}.M1))) & (0 <
asType < integer > (\$heap_{funcstart_{-724,1}}.p2))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 < function for the start of the start 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
(asType<integer>($heap_{tuncstart\_724,1}.p3) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [const static or extern object]
[5.4] (((((0 < $heap_{funcstart_{724,1}}.p1) && ($heap_{funcstart_{724,1}}.p1 < 
asType < integer > (\$heap_{init}.M1))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
\mathbf{asType} \small{<} \mathbf{integer} \small{>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M2}))) \ \&\& \ (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p3) <
```

```
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M3}))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < $heap_{funcstart_{724,1}}.p1) && ($heap_{funcstart_{724,1}}.p1 < 
asType<integer>(asType<short int>((int)30269)))) && (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2})))\ \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.16] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M2})))~\&\&~(0<
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.17] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \; \land \; (0 < \$heap_{funcstart\_724,1}.p1) \; \land 
(0 < \text{$heap}_{funcstart\_724,1}.p2)) \&\& (\text{$heap}_{funcstart\_724,1}.p2 <
asType < integer > (\$heap_{init}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType<integer>($heap_{tuncstart\_724,1}.p3) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
|5.18| \left( \left( \left( \left( -30269 < -\$ \text{heap}_{funcstart\_724,1}.\text{p1} \right) \right. \wedge \left. \left( 0 < \$ \text{heap}_{funcstart\_724,1}.\text{p1} \right) \right. \wedge \right. |
(0 < \text{$heap}_{funcstart\_724,1}.p2)) \&\& (\text{$heap}_{funcstart\_724,1}.p2 <
asType < integer > (asType < short int > ((int)30307)))) && (0 < integer) && (0 < integer
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p3) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [simplify]
[5.30] ((-30307 < -$heap_{funcstart\_724,1}.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{-724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{-724,1}.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.\text{p3} < \text{asType} < \text{integer} > (\text{\$heap}_{funcstart\_724,1}.\text{M3}))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -$heap_{funcstart\_724,1}.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1.p2}) \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.p3 < asType < integer > (\text{\$heap}_{init}.M3))
```

```
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \wedge (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1.p2} \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\text{sheap}_{funcstart\_724.1}.p3 < asType < integer > (asType < short)
int > ((int)30323)))
\rightarrow [simplify]
[5.40] (-30323 < -$heap_{funcstart\_724,1}.p3) \land (-30307 <
-\$heap_{funcstart_{-724,1}.p2}) \land (-30269 < -\$heap_{funcstart_{-724,1}.p1}) \land (0 < -\$heap_{funcstart_{-724,1}.p2})
\text{Sheap}_{funcstart\_724,1}.\text{p1}) \land (0 < \text{Sheap}_{funcstart\_724,1}.\text{p2}) \land (0 <
heap_{funcstart_{-724,1}.p3}
[Work on sub-term 6 of conjunction in term 5.40]
[10.0] 0 < $heap_{tuncstart_724,1}.p3
[Take given term]
[43.0] div3 == div(heapIs $heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
asType < int > (\$heap_{funcstart\_724,1}.a3))
\rightarrow [simplify]
[43.1] \ \mathrm{div3} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3},
asType < int > (\$heap_{funcstart\_724,1}.a3))
\rightarrow [const static or extern object]
[43.2] div3 == div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p3,
asType < int > (\$heap_{init}.a3))
\rightarrow [expand definition of constant 'a3' at prang.c (26,20)]
[43.3] \text{ div3} == \text{div}(\mathbf{heapIs} \$ heap_{funcstart\_724,1}, \$ heap_{funcstart\_724,1}.p3,
asType<int>(asType<short int>((int)178)))
\rightarrow [simplify]
[43.6] div3 == div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p3, 178)
[Take goal term]
[1.0] (asType<integer>(heap_{funcstart\_724,1}.a3) \leq
asType < integer > (\$heap_{funcstart\_724.1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
\rightarrow [const static or extern object]
[1.1] (asType<integer>($heap_{init}.a3) \le
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})) => !(0 ==
asType<integer>(div3.quot))
\rightarrow [expand definition of constant 'a3' at prang.c (26,20)]
```

```
[1.2] (asType<integer>(asType<short int>((int)178)) <
\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})) = > !(0 ==
asType<integer>(div3.quot))
\rightarrow [simplify]
[1.8] (177 < $\text{heap}_{funcstart_724,1.p3}) => !(0 ==
asType<integer>(div3.quot))
\rightarrow [from term 43.6, div3 is equal to div(heapIs $heap_{tuncstart\_724.1},
heap_{funcstart_{-724,1}}.p3, 178
[1.9] (177 < \text{$heap}_{funcstart\_724,1}.p3) => !(0 ==
\mathbf{asType} < \mathbf{integer} > (\mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3},
178).quot))
\rightarrow [simplify]
[1.13] !(0 == div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p3,
178).quot) \vee (-178 < -\$heap_{funcstart\_724,1}.p3)
→ [negate goal and search for contradiction]
[1.14] (0 == div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3,
178).quot) \land !(-178 < -$heap_{funcstart\_724,1}.p3)
\rightarrow [simplify]
[1.17] (0 == div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3,
178).quot) \land (177 < $heap_{funcstart_724,1}.p3)
\rightarrow [separate conjunction and work on first sub-term]
[1.18] 0 == \text{div}(\text{heapIs } \text{$heap}_{funcstart\_724,1}, \text{$heap}_{funcstart\_724,1.p3}, 178).quot
[Assume known post-assertion, class invariant or type constraint for term 43.6]
[46.0] (asType<integer>($heap_{funcstart\_724,1}.p3) /
asType<integer>(178)) == asType<integer>(div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot}
\rightarrow [simplify]
[46.2] ($heap<sub>funcstart_724,1</sub>.p3 / 178) == asType<integer>(div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot}
→ [expand definition of operator './' in class 'int' at built in declaration]
[46.3] ([asType<integer>($heap_{tuncstart_724.1}.p3) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178), []:
asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178) = =
\mathbf{asType} \small{<} \mathbf{integer} \small{>} ( \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}, \\
178).quot)
\rightarrow [explicitly assert falsehood of skipped guards in subsequent guards]
[46.4] ([asType<integer>(peqtin = 1.46.4] ([asType<integer>(peqtin = 1.46.4) ([a
```

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-(-asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 0)]:
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})~/~178) ==
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3,
178).quot)
\rightarrow [simplify]
[46.7] ([0 < -$heap<sub>funcstart_724,1</sub>.p3]:
-(-\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) \ / \ 178),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178) = =
\mathbf{asType} < \mathbf{integer} > (\mathbf{div}(\mathbf{heapIs} \$ \mathbf{heap}_{funcstart\_724,1}, \$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3},
178).quot)
\rightarrow [from term 10.0, literala < -$heap<sub>funcstart_724.1</sub>.p3 is false whenever -2 <
(0 + literala)
    Proof of rule precondition:
    [46.7.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [46.7.2] true
[46.8] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 0)]:
\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) \ / \ 178) = =
asType<integer>(div(heapIs $heap_{tuncstart_724.1}, $heap_{tuncstart_724.1.p3},
178).quot)
\rightarrow [simplify]
[46.11] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178), [!(0 < integer > (\$heap_{funcstart\_724,1}.p3) / 178)]
-\$heap_{funcstart\_724,1}.p3): asType<integer>(\$heap_{funcstart\_724,1}.p3) / 178)
== asType < integer > (div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p3}, 178).quot
\rightarrow [from term 10.0, literala < -$heap<sub>funcstart_724,1</sub>.p3 is false whenever -2 <
(0 + literala)
    Proof of rule precondition:
    [46.11.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [46.11.2] true
\textit{[46.12]} \; ([\textbf{false}]: \; -(-\textbf{asType} < \textbf{integer} > (\$ \text{heap}_{funcstart\_724,1}.\text{p3}) \; / \; 178),
[!false]: asType<integer>(\theta_{tal}) (\theta_{tal}) | 178) ==
\mathbf{asType} < \mathbf{integer} > (\mathbf{div}(\mathbf{heapIs} \ \$ \mathbf{heap}_{funcstart\_724,1}, \ \$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}, \\
178).quot)
```

```
\rightarrow [simplify]
[46.17] 0 == (-\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.p3,
178).quot + (\text{$heap}_{funcstart\_724,1}.p3 / 178))
\rightarrow [from\ term\ 1.18,\ div(\mathbf{heapIs}\ \$heap_{funcstart\_724,1},\ \$heap_{funcstart\_724,1}.p3,
178).quot is equal to 0]
[46.18] 0 == (-0 + (\text{$heap}_{funcstart\_724,1}.p3 / 178))
\rightarrow [simplify]
[46.20] \; 0 == (\$ heap_{funcstart\_724,1}.p3 \; / \; 178)
[Work on sub-term 2 of conjunction in term 1.17]
[57.0] 177 < heap_{funcstart\_724,1}.p3
[Create new term from term 46.20 using rule: condition for equality of division]
[64.0] \; ((0*178) < (1 + \$heap_{funcstart\_724,1}.p3)) \; \land \; (\$heap_{funcstart\_724,1}.p3) < (\Sheap_{funcstart\_724,1}.p3) < (\Sheap_{funcstart\_724,1}.p3) < (\Sheap_{funcstart\_724,1}.p3) < (\Sheap_{funcstart\_724,1}.p3) < 
(178 * (0 + 1)))
\rightarrow [simplify]
[64.3] (-1 < \text{\$heap}_{funcstart\_724,1}.p3) \land (\text{\$heap}_{funcstart\_724,1}.p3 < (178 * (0 + 
\rightarrow [from term 57.0, literala < $heap_{funcstart\_724,1}.p3 is true whenever (-1 +
literala) < 177
         Proof of rule precondition:
         [64.3.0](-1+-1)<177
         \rightarrow [simplify]
         [64.3.2] true
[64.4] true \land ($heap<sub>funcstart_724,1</sub>.p3 < (178 * (0 + 1)))
\rightarrow [simplify]
[64.9] true \land (-178 < -\$heap_{funcstart\_724,1}.p3)
\rightarrow [from term 57.0, literala < -$heap<sub>funcstart_724,1</sub>.p3 is false whenever -2 <
(177 + literala)
         Proof of rule precondition:
         [64.9.0] - 2 < (-178 + 177)
         \rightarrow [simplify]
         [64.9.2] true
\textit{[64.10]} \; \mathbf{true} \; \land \; \mathbf{false}
\rightarrow [simplify]
[64.11] false
```

```
Proof of verification condition: Assertion valid
Condition generated at: C:\Escher\Customers\prang\prang.c (56,20)
To prove: (asType<integer>(heap_{funcstart\_724,1}.p3) <
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) ==
asType<integer>(div3.rem))
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType<short int>((int)177)
\theta
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta == asType<short int>((int)35)
\theta sheap<sub>init</sub>.M3 == asType<short int>((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType<short int>((int)178)
\theta = asType < short int > ((int)63)
\theta
\theta
heap_{init}.p3 == asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart_{-724,1}})
div1 == div(\mathbf{heapIs} \$ heap_{funcstart\_724.1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
(asType<integer>(asType<int>($heap_{funcstart\_724,1}.p1)) /
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))) = =
asType<integer>(div1.quot)
(asType < int > (asType < int > (\$heap_{funcstart\_724,1}.p1)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1})) =>
(asType < integer > (\$heap_{funcstart\_724,1}.p1) = =
```

```
asType<integer>(div1.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a1) \le
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
\label{eq:div2} \text{div2} == \text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
(asType<int>(asType<int>($heap_{tuncstart\_724.1}.p2)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.quot)
(asType<int>(asType<int>($heap_{funcstart\_724,1}.p2)) %
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{a2})) = >
(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p2) ==
asType<integer>(div2.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a2}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
\label{eq:div3} \text{div3} == \text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1},
\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}),
asType < int > (\$heap_{funcstart\_724.1}.a3))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))) ==
asType<integer>(div3.rem)
Proof:
[Take given term]
[5.0] invariant1(heapIs heapIs 
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
 \texttt{[5.1]} \left( \left( \left( \left( (0 < \mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p1) \right) \& \& \right. \right. \right. 
(asType < integer > (\$heap_{funcstart\_724,1}.p1) <
```

```
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType<integer>($heap_{tuncstart\_724,1}.p3) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.3] (((((0 < \theta_{funcstart\_724,1.p1) && (\theta_{funcstart\_724,1.p1)
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2})))\ \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}) <
asType<integer>(heap_{funcstart\_724,1}.M2))) && (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.4] (((((0 < \text{heap}_{funcstart\_724,1}.p1) && (\text{heap}_{funcstart\_724,1}.p1 <
asType<integer>($heap<sub>init</sub>.M1))) && (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart_{-724,1}}.p3))) \&\&
(asType<integer>($heap_{tuncstart_724.1}.p3) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < $heap_{funcstart_{724,1}}.p1) && ($heap_{funcstart_{724,1}}.p1 <
asType < integer > (asType < short int > ((int)30269)))) && (0 < integer) && (0 < integer
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
as
Type<integer>(\rho_{funcstart\_724,1}.M2))) & (0 <
asType < integer > (\$heap_{funcstart_{-724,1}}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart_{-724.1}}.M3))
\rightarrow [simplify]
[5.16] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \; \land \; (0 < \$heap_{funcstart\_724,1}.p1) \; \land 
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 < 1)
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})))\ \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [const static or extern object]
```

```
[5.17] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{init}.\mathrm{M2})))~\&\&~(0<
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType<integer>($heap_funcstart_724,1.M3))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < \text{$heap}_{funcstart\_724,1}.p2)) \&\& (\text{$heap}_{funcstart\_724,1}.p2 <
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.30] ((-30307 < -$heap_{tuncstart_724,1}.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1.p2}) \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.\text{p3} < \text{asType} < \text{integer} > (\text{\$heap}_{funcstart\_724,1}.\text{M3}))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \wedge (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1.p2} \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\$heap_{funcstart\_724,1}.p3 < \mathbf{asType} < \mathbf{integer} > (\$heap_{init}.M3))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap_{funcstart\_724,1}.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{724,1}.p3})) \&\&
(\text{sheap}_{funcstart\_724,1}.p3 < asType < integer > (asType < short)
int > ((int)30323))
\rightarrow [simplify]
[5.40] (-30323 < -$heap<sub>funcstart_724,1.</sub>p3) \land (-30307 <
 -\$heap_{funcstart\_724,1}.p2) \wedge (-30269 < -\$heap_{funcstart\_724,1}.p1) \wedge (0 <
\text{Sheap}_{funcstart\_724,1}.\text{p1}) \land (0 < \text{Sheap}_{funcstart\_724,1}.\text{p2}) \land (0 <
heap_{funcstart_{-724,1}.p3}
[Work on sub-term 6 of conjunction in term 5.40]
\textit{[10.0]}~0 < \$ heap_{funcstart\_724,1}.p3
[Take given term]
[43.0] div3 == div(heapIs $heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
asType < int > (\$heap_{funcstart\_724,1}.a3))
```

```
\rightarrow [simplify]
[43.1] div3 == div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p3,
asType < int > (\$heap_{funcstart\_724,1}.a3))
\rightarrow [const static or extern object]
[43.2] \operatorname{div3} == \operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p3,
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{init}.\mathrm{a3}))
\rightarrow [expand definition of constant 'a3' at prang.c (26,20)]
[43.3] div3 == div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p3,
asType<int>(asType<short int>((int)178)))
\rightarrow [simplify]
[43.6] \text{ div3} == \text{div}(\mathbf{heapIs} \$ heap_{funcstart\_724,1}, \$ heap_{funcstart\_724,1}.p3, 178)
[Take goal term]
 [1.0] \ (\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) < 
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
\rightarrow [simplify]
[1.1] (\text{sheap}_{funcstart\_724.1}.p3 < asType < integer > (\text{sheap}_{funcstart\_724.1}.a3))
=> (asType<integer>($heap_{funcstart\_724,1}.p3) ==
asType<integer>(div3.rem))
\rightarrow [const static or extern object]
[1.2] (\theta_{init}) (\theta_{init}) (\theta_{init}) (\theta_{init}) (\theta_{init})
(asType < integer > (\$heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
\rightarrow [expand definition of constant 'a3' at prang.c (26,20)]
[1.3] (\theta_{1.3}) (\theta_{1.3}) (\theta_{1.3}) (\theta_{1.3}) (\theta_{1.3}) (\theta_{1.3}) (\theta_{1.3}) (\theta_{1.3})
int>((int)178))) => (asType< integer>($heap_{funcstart\_724,1}.p3) ==
asType<integer>(div3.rem))
\rightarrow [simplify]
[1.10] (-178 < -$\text{heap}_{funcstart_724,1}.p3) => ($\text{heap}_{funcstart_724,1}.p3 ==
asType<integer>(div3.rem))
\rightarrow [from term 43.6, div3 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p3, 178
[1.11] (-178 < -$heap<sub>funcstart_724,1.</sub>p3) => ($heap<sub>funcstart_724,1.</sub>p3 ==
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3,
178).rem))
\rightarrow [simplify]
```

```
[1.17] (0 == (-$heap_{funcstart_{-724,1}}.p3 + div(heapIs $heap_{funcstart_{-724,1}},
\text{Sheap}_{funcstart\_724,1.p3}, 178).rem)) \lor (177 < \text{Sheap}_{funcstart\_724,1.p3})
→ [negate goal and search for contradiction]
[1.18]!(0 == (-\$heap_{funcstart\_724,1}.p3 + div(heapIs \$heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.p3, 178).rem)) \land !(177 < \text{Sheap}_{funcstart\_724,1}.p3)
\rightarrow [simplify]
[1.20]!(0 == (-\$heap_{funcstart\_724,1}.p3 + div(heapIs \$heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724.1}.\text{p3}, 178).\text{rem}) \land (-178 < -\text{Sheap}_{funcstart\_724.1}.\text{p3})
\rightarrow [separate conjunction and work on first sub-term]
[1.21] -178 < -\$heap_{funcstart\_724.1}.p3
[Assume known post-assertion, class invariant or type constraint for term 43.6]
[47.0] (asType<integer>(peq_{funcstart\_724,1}.p3) %
asType<integer>(178)) == asType<integer>(div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p3, 178).rem
\rightarrow [simplify]
[47.2] ($heap<sub>funcstart_724,1.</sub>p3 % 178) == asType<integer>(div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{rem}
→ [expand definition of operator '.%' in class 'int' at built in declaration]
\textit{[47.3]} \; ([\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178), []:
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})~\%~178) ==
asType<integer>(div(heapIs $heap_{tuncstart\_724.1}, $heap_{tuncstart\_724.1}.p3,
178).rem)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[47.4] ([asType<integer>($heap_{funcstart\_724.1}.p3) < 0]:
-(-\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}) \% \ 178),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 0)]:
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})~\%~178) ==
\mathbf{asType} \small{<} \mathbf{integer} \small{>} ( \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}, \\
178).rem)
\rightarrow [simplify]
[47.7] ([0 < -$heap<sub>funcstart_724,1</sub>.p3]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178) ==
\mathbf{asType} < \mathbf{integer} > (\mathbf{div}(\mathbf{heapIs} \ \$ \mathbf{heap}_{funcstart\_724,1}, \ \$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3},
178).rem)
\rightarrow [from term 10.0, literala < -$heap<sub>funcstart-724.1</sub>.p3 is false whenever -2 <
```

```
(0 + literala)
    Proof of rule precondition:
    [47.7.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [47.7.2] true
[47.8] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178),
[!(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178) ==
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3,
178).rem)
\rightarrow [simplify]
[47.11] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178), [!(0)]
<-$heap<sub>funcstart_724,1.</sub>p3)]: asType<integer>($heap<sub>funcstart_724,1.</sub>p3) %
178) == asType < integer > (div(heapIs \$heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p3, 178}.rem
\rightarrow [from term 10.0, literala < -$heap<sub>funcstart_724,1</sub>.p3 is false whenever -2 <
(0 + literala)
    Proof of rule precondition:
    [47.11.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [47.11.2] true
[47.12] \; ([\mathbf{false}]: \; -(\mathbf{-asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}) \; \% \; 178),
[!false]: asType<integer>($heap<sub>funcstart_724.1.</sub>p3) % 178) ==
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3,
178).rem)
\rightarrow [simplify]
[47.17] \ 0 == (-\text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p3},
178).rem + (\text{$heap}_{funcstart\_724,1}.p3 \% 178))
[Work on sub-term 2 of conjunction in term 1.20]
[56.0]!(0 == (-\$heap_{funcstart\_724,1}.p3 + div(heapIs \$heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p3, 178).rem}
[Copy term 56.0]
[63.0]!(0 == (-\$heap_{funcstart\_724,1}.p3 + div(heapIs \$heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p3, 178).rem}
\rightarrow [from\ term\ 47.17,\ div(\mathbf{heapIs}\ \$heap_{funcstart\_724,1},\ \$heap_{funcstart\_724,1}.p3,
178).rem is equal to p_{funcstart_{-724,1}.p3} \% 178
[63.1]!(0 == (-\$heap_{funcstart\_724,1}.p3 + (\$heap_{funcstart\_724,1}.p3 \% 178)))
```

```
\rightarrow [remainder with larger divisor]
         Proof of rule precondition 1:
         [63.1.0.0]~\mathrm{literald} < -\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}
         \rightarrow [unify with term 1.21]
         [63.1.0.1] true
         Proof of rule precondition 2:
         [63.1.1.0] literalc < $heap<sub>funcstart_724,1</sub>.p3
         \rightarrow [unify with term 10.0]
         [63.1.1.1] true
         Proof of rule precondition 3:
         [63.1.2.0] --178 \le 178
         \rightarrow [simplify]
         [63.1.2.2] true
         Proof of rule precondition 4:
         [63.1.3.0] - 2 < 0
         \rightarrow [simplify]
         [63.1.3.1] true
[63.2] ! (0 == (-\$heap_{funcstart\_724,1}.p3 + \$heap_{funcstart\_724,1}.p3))
\rightarrow [simplify]
[63.5] false
Proof of verification condition: Assertion valid
Condition generated at: C:\Escher\Customers\prang\prang.c (57,26)
To prove: !(0 == asType < integer > (div3.rem)) || !(0 == asType < integer >
asType<integer>(div3.quot))
Given:
heap_{init}.LIMIT == (int)80
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
\theta
\theta
heap_{init}.M2 == asType < short int > ((int)30307)
\theta
```

```
\theta_{init}.a2 == asType<short int>((int)176)
\theta
\theta sheap<sub>init</sub>.M3 == asType<short int>((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
heap_{init}.b3 == asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
invariant
1<br/>( \mathbf{heapIs}\ \$ \mathbf{heap}_{funcstart\_724,1})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \ \operatorname{\$heap}_{funcstart\_724,1},
\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(asType<int>(asType<int>($heap_{tuncstart\_724.1}.p1)) /
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}))) = =
asType<integer>(div1.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) ==
asType<integer>(div1.rem))
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) /
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))) ==
asType<integer>(div2.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
```

```
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a2})) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}) ==
asType<integer>(div2.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a2}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p2)) => !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
asType < int > (\$heap_{funcstart_{-724,1}}.a3))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(asType<int>(sheap<sub>funcstart_724,1.</sub>p3)) %
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a3}))) = =
asType<integer>(div3.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a3) \le
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})) => !(0 ==
asType<integer>(div3.quot))
Proof:
[Take given term]
[5.0] invariant1(heapIs heap_{funcstart_{-724,1}}
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
[5.1] (((((0 < asType<integer>(sheap_{funcstart\_724,1}.p1)) &&
(asType<integer>($heap_funcstart_724.1.p1) <
as
Type<integer>(\rho_{funcstart\_724,1}.M1))) & (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}))) \ \&\& \\
(asType<integer>($heap_funcstart_724,1.p3) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [simplify]
[5.3] (((((0 < $heap_{funcstart_{724,1}}.p1) && ($heap_{funcstart_{724,1}}.p1 < 
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 < function for the start of the start
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asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M2}))) \ \&\& \ (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType<integer>($heap_funcstart_724,1.M3))
\rightarrow [const static or extern object]
[5.4] (((((0 < \theta_{funcstart\_724,1.p1}) && (\theta_{funcstart\_724,1.p1})
asType<integer>(heap_{init}.M1))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
\mathbf{asType} \small{<} \mathbf{integer} \small{>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M2}))) \ \&\& \ (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < $heap_{funcstart\_724,1}.p1) && ($heap_{funcstart\_724,1}.p1 < ])
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) <
as
Type<integer>($heap_{funcstart\_724,1}.M2))) && (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
(asType < integer > (\$heap_{funcstart_{-724.1}}.p3) < 
asType < integer > (\$heap_{funcstart_{-724.1}}.M3))
\rightarrow [simplify]
[5.16] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \; \land \; (0 < \$heap_{funcstart\_724,1}.p1) \; \land 
(0 < \mathrm{\$heap}_{funcstart\_724,1}.\mathrm{p2})) && (\mathrm{\$heap}_{funcstart\_724,1}.\mathrm{p2} <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 < 1)
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M3}))
\rightarrow [const static or extern object]
\label{eq:final_start_724,1.p1} [(((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$he
(0 < \text{\$heap}_{funcstart_{724,1},p2})) \&\& (\text{\$heap}_{funcstart_{724,1},p2} <
asType < integer > (\$heap_{init}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
```

```
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.30] ((-30307 < -$heap<sub>funcstart_724,1</sub>.p2) \wedge (-30269 <
-\text{\$heap}_{funcstart\_724,1}.\text{p1}) \land (0 < \text{\$heap}_{funcstart\_724,1}.\text{p1}) \land (0 <
\text{Sheap}_{funcstart_{724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{724,1}.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.p3 < asType < integer > (\text{\$heap}_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -$heap<sub>funcstart_724.1.</sub>p2) \wedge (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.p2) \land (0 < \text{Sheap}_{funcstart\_724,1}.p3)) \&\&
(\$heap_{funcstart\_724,1}.p3 < \textbf{asType} < \textbf{integer} > (\$heap_{init}.M3))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1.p2}) \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\text{sheap}_{funcstart\_724,1}.\text{p3} < \text{asType} < \text{integer} > (\text{asType} < \text{short})
int > ((int)30323)))
\rightarrow [simplify]
[5.40] (-30323 < -$heap<sub>funcstart_724,1.</sub>p3) \land (-30307 <
-\$heap_{funcstart\_724,1}.p2) \land (-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 <
\text{Sheap}_{funcstart\_724,1}.\text{p1}) \land (0 < \text{Sheap}_{funcstart\_724,1}.\text{p2}) \land (0 <
heap_{funcstart_{-724,1}.p3}
[Work on sub-term 6 of conjunction in term 5.40]
[10.0] 0 < $\text{heap}_{funcstart_724,1}.p3
[Take given term]
[43.0] div3 == div(heapIs $heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
\rightarrow [simplify]
[43.1] \ \mathrm{div3} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3},
asType < int > (\$heap_{funcstart\_724,1}.a3))
\rightarrow [const static or extern object]
[43.2] \ \mathrm{div3} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3},
asType < int > (\$heap_{init}.a3))
\rightarrow [expand definition of constant 'a3' at prang.c (26,20)]
```

```
[43.3] div3 == div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p3,
asType<int>(asType<short int>((int)178)))
\rightarrow [simplify]
[43.6] \text{ div3} == \text{div}(\mathbf{heapIs} \$ \mathbf{heap}_{funcstart\_724,1}, \$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}, 178)
[Take goal term]
[1.0]!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
\rightarrow [from term 43.6, div3 is equal to div(heapIs $heap_{tuncstart\_724.1},
heap_{funcstart_{-724,1}}.p3, 178
[1.1] !(0 == asType<integer>(div(heapIs heapIs heap_{funcstart\_724,1},
\theta_{funcstart\_724,1.p3}, 178).rem)) || !(0 == asType<integer>(div3.quot))
\rightarrow [simplify]
[1.2] ! (0 == \operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p3}, \ 178).\operatorname{rem})
||!(0 == asType < integer > (div3.quot))|
\rightarrow [from term 43.6, div3 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p3, 178
[1.3] ! (0 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem)
||!(0 == asType < integer) / (div(heapIs $heap_{funcstart\_724,1}, 
heap_{funcstart_{-724,1}.p3, 178}, quot)
\rightarrow [simplify]
\textit{[1.5] !} (0 == \operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p3},
178).quot) \vee!(0 == div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p3,
178).rem)
\rightarrow [negate goal and search for contradiction]
[1.6] \ (0 == \operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p3}, \ 178).\operatorname{quot})
\wedge (0 == div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p3, 178).rem)
\rightarrow [separate conjunction and work on first sub-term]
[1.7] 0 == div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).quot
[Work on sub-term 2 of conjunction in term 1.6]
[58.0] 0 == div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem
[Take given term]
{\it [56.0]}~({\bf asType}{<}{\bf integer}{>}({\it \$heap}_{funcstart\_724,1}.p3)<
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}) ==
asType<integer>(div3.rem))
\rightarrow [simplify]
```

```
[56.1] (\text{$heap}_{funcstart\_724,1}.p3 < asType < integer > (\\\text{$heap}_{funcstart\_724,1}.a3))
=> (asType<integer>($heap_{funcstart\_724,1}.p3) ==
asType<integer>(div3.rem))
\rightarrow [const static or extern object]
[56.2] ($heap<sub>funcstart_724,1</sub>.p3 < asType<integer>($heap<sub>init</sub>.a3)) =>
(asType < integer > (\$heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
\rightarrow [expand definition of constant 'a3' at prang.c (26,20)]
[56.3] ($heap_tuncstart_724,1.p3 < asType<integer>(asType<short
\mathbf{int}{>}((\mathbf{int})178))) => (\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}) ==
asType<integer>(div3.rem))
\rightarrow [simplify]
[56.10] (-178 < -$heap<sub>funcstart_724,1.p3</sub>) => ($heap<sub>funcstart_724,1.p3</sub> ==
asType<integer>(div3.rem))
\rightarrow [from term 43.6, div3 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p3, 178
[56.11] (-178 < -$heap<sub>funcstart_724,1.p3</sub>) => ($heap<sub>funcstart_724,1.p3</sub>) ==
\mathbf{asType} < \mathbf{integer} > (\mathbf{div}(\mathbf{heapIs} \ \$ \mathbf{heap}_{funcstart\_724,1}, \ \$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3},
178).rem))
\rightarrow [simplify]
[56.17] (0 == (-\$heap<sub>funcstart_724,1</sub>.p3 + div(heapIs \$heap<sub>funcstart_724,1</sub>,
\text{Sheap}_{funcstart\_724,1.p3}, 178).rem)) \lor (177 < \text{Sheap}_{funcstart\_724,1.p3})
\rightarrow [from\ term\ 58.0,\ div(\textbf{heapIs}\ \$heap_{funcstart\_724,1},\ \$heap_{funcstart\_724,1}.p3,
178).rem is equal to 0
[56.18] (0 == (-\$heap_{funcstart\_724,1}.p3 + 0)) \lor (177 < \$heap_{funcstart\_724,1}.p3)
\rightarrow [simplify]
[56.19] (0 == -\$heap_{funcstart\_724,1}.p3) \lor (177 < \$heap_{funcstart\_724,1}.p3)
\rightarrow [from term 10.0, -$heap<sub>funcstart_724,1</sub>.p3 == literala is false whenever -1 <
(0 + literala)
    Proof of rule precondition:
    [56.19.0] -1 < (0 + 0)
    \rightarrow [simplify]
    [56.19.2] true
[56.20] false \vee (177 < \text{$heap}_{funcstart\_724,1}.p3)
\rightarrow [simplify]
|56.21| \; 177 < \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}
```

```
[Take given term]
[57.0] (asType<integer>($heap_{funcstart\_724,1}.a3) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
\rightarrow [const static or extern object]
[57.1] (asType<integer>($heap_{init}.a3) \le
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})) => !(0 ==
asType<integer>(div3.quot))
\rightarrow [expand definition of constant 'a3' at prang.c (26,20)]
[57.2] (asType<integer>(asType<short int>((int)178)) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
\rightarrow [simplify]
[57.8] (177 < \text{heap}_{funcstart\_724,1}.p3) => !(0 ==
asType<integer>(div3.quot))
\rightarrow [from term 43.6, div3 is equal to div(heapIs $heap_{funcstart\_724,1},
$heap_{funcstart\_724,1}.p3, 178)]
[57.9] (177 < \text{$heap}_{funcstart\_724,1}.p3) => !(0 ==
asType<integer>(div(heapIs $heap_{tuncstart\_724.1}, $heap_{tuncstart\_724.1}.p3,
178).quot))
\rightarrow [simplify]
[57.13] ! (0 == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p3},
178).quot) \vee (-178 < -\$heap_{funcstart\_724,1}.p3)
\rightarrow [from term 56.21, literala < -$heap<sub>funcstart_724,1.</sub>p3 is false whenever -2 <
(177 + literala)
   Proof of rule precondition:
   [57.13.0] - 2 < (-178 + 177)
   \rightarrow [simplify]
   [57.13.2] true
[57.14] false \vee!(0 == div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p3,
178).quot)
\rightarrow [from term 1.7, div(heapIs $heap_{funcstart\_724,1}$, $heap_{funcstart\_724,1}.p3,
178).quot is equal to 0
[57.15] false \vee !(0 == 0)
\rightarrow [simplify]
[57.18] false
```

```
conversion from 'int' to 'short int'
Condition generated at: C:\Escher\Customers\prang\prang.c (61,15)
Condition defined at:
To prove: minof(short int) \le div1.rem
Given:
heap_{init}.LIMIT == (int)80
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
\theta sheap<sub>init</sub>.a1 == asType<short int>((int)177)
\theta
heap_{init}.M2 == asType < short int > ((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
\theta
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta
\rho = asType < short int > ((int)2)
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart_{-724,1}})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ / \\
asType < integer > (asType < int > (\$heap_{funcstart\_724.1}.a1))) = =
asType<integer>(div1.quot)
(\mathbf{asType} {<} \mathbf{int} {>} (\mathbf{asType} {<} \mathbf{int} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}))) = =
asType<integer>(div1.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(asType < integer > (\$heap_{funcstart\_724.1}.p1) = =
```

Proof of verification condition: Type constraint satisfied in explicit

```
asType<integer>(div1.rem))
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
\label{eq:div2} \text{div2} == \text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
(asType<int>(asType<int>($heap_{tuncstart\_724.1}.p2)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724.1}.a2))) = =
asType<integer>(div2.quot)
(asType<int>(asType<int>($heap_{funcstart\_724,1}.p2)) %
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p2) <
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a2})) = >
(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p2) ==
asType<integer>(div2.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a2}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
\label{eq:div3} \text{div3} == \text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1},
\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}),
asType < int > (\$heap_{funcstart\_724.1}.a3))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))) ==
asType<integer>(div3.rem)
(asType<integer>($heap_{tuncstart\_724,1.p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) ==
asType<integer>(div3.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a3}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
```

```
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
Proof:
[Take given term]
[5.0] invariant1(heapIs $heap_{funcstart\_724,1})
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
[5.1] ((((((0 < asType < integer > ($heap_{funcstart\_724,1}.p1)) &&
(asType < integer > ($heap_{funcstart\_724,1}.p1) < 
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2})))\ \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > ($heap_{funcstart\_724,1}.p3))) &&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [simplify]
[5.3] (((((0 < \theta_{funcstart\_724,1.p1) && (\theta_{funcstart\_724,1.p1)
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 < function for the start of the start 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}) <
as
Type<integer>(\rho_{funcstart\_724,1}.M2))) & (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [const static or extern object]
[5.4] (((((0 < $heap_{funcstart_{724,1}}.p1) && ($heap_{funcstart_{724,1}}.p1 < 
asType < integer > (\$heap_{init}.M1))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p2) <
asType<integer>(\theta_{tuncstart\_724,1}.M2))) && (0 <
asType < integer > (\$heap_{funcstart_{-724,1}}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < $heap_{funcstart_{724,1}}.p1) && ($heap_{funcstart_{724,1}}.p1 < 
asType < integer > (asType < short int > ((int)30269)))) && (0 < integer) && (0 < integer
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
as
Type<integer>(\rho_{funcstart\_724,1}.M2))) & (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) <
```

```
asType < integer > (\$heap_{funcstart_{-724,1}}.M3))
\rightarrow [simplify]
[5.16] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.17] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \; \land \; (0 < \$heap_{funcstart\_724,1}.p1) \; \land 
(0 < \text{$heap}_{funcstart_{-724,1}.p2})) \&\& (\text{$heap}_{funcstart_{-724,1}.p2} <
asType < integer > (\$heap_{init}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M3}))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType < integer > (asType < short int > ((int)30307)))) && (0 < footnote{integer})
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [simplify]
[5.30] ((-30307 < -$heap_{funcstart\_724,1}.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{724,1}.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.\text{p3} < \text{asType} < \text{integer} > (\text{\$heap}_{funcstart\_724,1}.\text{M3}))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \land (-30269 <
 -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.p2) \land (0 < \text{Sheap}_{funcstart\_724,1}.p3)) \&\&
(\text{\$heap}_{funcstart\_724,1}.\text{p3} < \text{asType} < \text{integer} > (\text{\$heap}_{init}.\text{M3}))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap_{tuncstart_724,1}.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{724,1}.p3})) \&\&
(\$heap_{funcstart\_724,1}.p3 < \mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{short}
int > ((int)30323)))
\rightarrow [simplify]
[5.40] (-30323 < -$heap_funcstart_724,1.p3) \land (-30307 <
```

```
-\$heap_{funcstart\_724,1}.p2) \land (-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < -\$heap_{funcstart\_724,1}.p1)
\theta_{funcstart\_724,1}.p1) \land (0 < \theta_{funcstart\_724,1}.p2) \land (0 < \theta_{funcstart\_724,1}.p2) \land (0 < \theta_{funcstart\_724,1}.p2)
heap_{funcstart_{-724,1}.p3}
[Work on sub-term 4 of conjunction in term 5.40]
[8.0] 0 < $heap_{funcstart_724,1}.p1
[Take given term]
[11.0] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724.1}.p1),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
\rightarrow [simplify]
[11.1] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType < int > (\$heap_{funcstart\_724.1}.a1))
\rightarrow [const static or extern object]
[11.2] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
asType < int > (\$heap_{init}.a1))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
[11.3] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType<int>(asType<short int>((int)177)))
\rightarrow [simplify]
[11.6] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}, \ 177)
[Assume known post-assertion, class invariant or type constraint for term 11.6]
[15.0] (asType<integer>(sheap_{funcstart\_724,1}.p1) %
asType<integer>(177)) == asType<integer>(div(heapIs
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1},p1, 177}.rem
\rightarrow [simplify]
[15.2] (\theta_{ran} = asType < integer > (div(heapIs))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).rem
→ [expand definition of operator '.%' in class 'int' at built in declaration]
[15.3] ([asType<integer>(sheap_{funcstart\_724,1.p1}) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177), []:
asType < integer > (\$heap_{funcstart_{-724,1}}.p1) \% 177) = =
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).rem)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[15.4] ([asType<integer>(heap_{funcstart\_724,1}.p1) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 0)]:
```

```
asType < integer > (\$heap_{funcstart-724,1}.p1) \% 177) ==
\mathbf{asType} {<} \mathbf{integer} {>} ( \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}, \\
177).\text{rem}
\rightarrow [simplify]
[15.7] ([0 < -$heap<sub>funcstart_724,1</sub>.p1]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177) ==
asType<integer>(div(heapIs $heap_{tuncstart_724,1}, $heap_{tuncstart_724,1}.p1,
177).rem)
\rightarrow [from term 8.0, literala < -$heap<sub>funcstart_724,1</sub>.p1 is false whenever -2 < (0
+ literala)]
    Proof of rule precondition:
    [15.7.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [15.7.2] true
[15.8] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177),
[!(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177) ==
\mathbf{asType} {<} \mathbf{integer} {>} ( \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}, \\
177).rem)
\rightarrow [simplify]
[15.11] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177), [!(0
<-$heap<sub>funcstart_724.1.p1</sub>)]: asType<integer>($heap<sub>funcstart_724.1.p1</sub>) %
177) == asType<integer>(div(heapIs heap_{funcstart\_724.1}),
heap_{funcstart_{-724,1}.p1, 177}.rem
\rightarrow [from term 8.0, literala < -$heap<sub>funcstart_724,1.</sub>p1 is false whenever -2 < (0
+ literala)]
    Proof of rule precondition:
    [15.11.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [15.11.2] true
[15.12] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177),
[!false]: asType<integer>(sheap_{funcstart_{-724,1}}.p1) % 177) ==
asType<integer>(div(heapIs $heap_{tuncstart\_724.1}, $heap_{tuncstart\_724.1}.p1,
177).rem)
\rightarrow [simplify]
 [15.17] \ 0 == (-\text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
```

```
177).rem + (\text{$heap}_{funcstart\_724,1}.p1 \% 177))
[Assume known post-assertion, class invariant or type constraint for term
15.17
[22.0] \ \mathbf{minof(int)} \leq \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
177).rem
\rightarrow [simplify]
\label{eq:condition} \textit{[22.3] -32769} < \text{div}(\textbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).rem
[Take goal term]
[1.0] minof(short int) \leq div1.rem
\rightarrow [simplify]
[1.1] - 32768 \le \text{div} 1.\text{rem}
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177)
\label{eq:constart_724,1} \text{-}32768 \leq \operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1},
177).rem
\rightarrow [simplify]
[1.4] -32769 < \text{div}(\text{heapIs } \text{\$heap}_{funcstart\_724,1}, \text{\$heap}_{funcstart\_724,1}.\text{p1},
177).rem
\rightarrow [from term 22.3, literala < div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1}.p1, 177}.rem is true whenever (-1 + literala) < -32769
    Proof of rule precondition:
    [1.4.0](-32769 + -1) < -32769
    \rightarrow [simplify]
    [1.4.2] true
[1.5] true
Proof of verification condition: Type constraint satisfied in explicit
conversion from 'int' to 'short int'
Condition generated at: C:\Escher\Customers\prang\prang.c (61,15)
Condition defined at:
To prove: div1.rem \le maxof(short int)
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
```

```
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta = asType < short int > ((int)2)
heap_{init}.M2 == asType < short int > ((int)30307)
\theta_{init}.r2 == asType<short int>((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs $heap_{tuncstart_724.1})
div1 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1})) \ / \\
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(\mathbf{asType} {<} \mathbf{integer} {>} (\mathbf{asType} {<} \mathbf{int} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1})) =>
(asType < integer > (\$heap_{funcstart\_724.1}.p1) = =
asType<integer>(div1.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathtt{a1}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p1)) => !(0 ==
asType < integer > (div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
```

```
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}))\ /
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.quot)
(asType<int>(asType<int>($heap_{funcstart\_724,1}.p2)) %
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p2) = =
asType<integer>(div2.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a2) \le
asType < integer > (\$heap_{funcstart\_724,1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart_{-724.1}},
\mathbf{asType} < \mathbf{int} > (\$ heap_{funcstart\_724,1}.p3),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3})) \ / \\
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(asType<integer>(asType<int>($heap_{tuncstart\_724.1}.p3)) %
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a3}))) = =
asType<integer>(div3.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a3})) = >
(asType < integer > ($heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a3}) \leq
\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
Proof:
[Take given term]
[5.0] invariant
1(heapIs \rho_{funcstart\_724,1}
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
 \texttt{[5.1]} \; (((((0 < \mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p1)) \; \&\& \\
(asType < integer > (\$heap_{funcstart\_724,1}.p1) <
```

```
asType<integer>(heap_{funcstart\_724,1}.M1))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType<integer>($heap_{tuncstart\_724,1}.p3) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.3] (((((0 < \theta_{funcstart\_724,1.p1) && (\theta_{funcstart\_724,1.p1)
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2})))\ \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}) <
asType<integer>(heap_{funcstart\_724,1}.M2))) && (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.4] (((((0 < \text{heap}_{funcstart\_724,1}.p1) && (\text{heap}_{funcstart\_724,1}.p1 <
asType<integer>($heap<sub>init</sub>.M1))) && (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart_{-724,1}}.p3))) \&\&
(asType<integer>($heap_{tuncstart_724.1}.p3) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < $heap_{funcstart_{724,1}}.p1) && ($heap_{funcstart_{724,1}}.p1 <
asType < integer > (asType < short int > ((int)30269)))) && (0 < integer) && (0 < integer
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
as
Type<integer>(\rho_{funcstart\_724,1}.M2))) & (0 <
asType < integer > (\$heap_{funcstart_{-724,1}}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart_{-724.1}}.M3))
\rightarrow [simplify]
[5.16] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \; \land \; (0 < \$heap_{funcstart\_724,1}.p1) \; \land 
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 < 1)
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})))\ \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [const static or extern object]
```

```
[5.17] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{init}.\mathrm{M2})))~\&\&~(0<
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType<integer>($heap_funcstart_724,1.M3))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < \text{$heap}_{funcstart\_724,1}.p2)) \&\& (\text{$heap}_{funcstart\_724,1}.p2 <
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.30] ((-30307 < -$heap_{tuncstart_724,1}.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1.p2}) \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.\text{p3} < \text{asType} < \text{integer} > (\text{\$heap}_{funcstart\_724,1}.\text{M3}))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \wedge (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{-724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{-724,1}.p3})) \&\&
(\$heap_{funcstart\_724,1}.p3 < \mathbf{asType} < \mathbf{integer} > (\$heap_{init}.M3))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap_{funcstart\_724,1}.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.p2) \land (0 < \text{Sheap}_{funcstart\_724,1}.p3)) \&\&
(\text{sheap}_{funcstart\_724,1}.p3 < asType < integer > (asType < short)
int > ((int)30323))
\rightarrow [simplify]
[5.40] (-30323 < -\$heap_{funcstart\_724,1}.p3) \land (-30307 < -30307)
 -\$heap_{funcstart\_724,1}.p2) \wedge (-30269 < -\$heap_{funcstart\_724,1}.p1) \wedge (0 <
\text{Sheap}_{funcstart\_724,1}.\text{p1}) \land (0 < \text{Sheap}_{funcstart\_724,1}.\text{p2}) \land (0 <
heap_{funcstart_{-724,1}.p3}
[Work on sub-term 4 of conjunction in term 5.40]
[8.0]~0 < \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}
[Take given term]
[11.0] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
```

```
\rightarrow [simplify]
[11.1] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
asType < int > (\$heap_{funcstart\_724,1}.a1))
\rightarrow [const static or extern object]
[11.2] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{init}.\mathtt{a1}))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
[11.3] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
asType<int>(asType<short int>((int)177)))
\rightarrow [simplify]
[11.6] div1 == div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p1, 177)
[Assume known post-assertion, class invariant or type constraint for term 11.6]
[15.0] (as
Type<integer>($heap_{funcstart\_724,1}.p1) \%
asType < integer > (177)) == asType < integer > (div(heapIs))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}
\rightarrow [simplify]
[15.2] (\theta_{tuncstart} = 15.2] (\theta_{tuncstart} = 15.2] (\theta_{tuncstart} = 15.2] (\theta_{tuncstart} = 15.2) (\theta_{tuncstart} = 15.2)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}
→ [expand definition of operator '.%' in class 'int' at built in declaration]
[15.3] ([asType<integer>(heap_{funcstart\_724,1}.p1) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177), []:
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1})~\%~177) ==
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).rem)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[15.4] ([asType<integer>(sheap_{funcstart\_724,1}.p1) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177) ==
asType<integer>(div(heapIs $heap_{tuncstart_724.1}, $heap_{tuncstart_724.1}.p1,
177).rem)
\rightarrow [simplify]
/15.7] ([0 < -$heap_{funcstart\_724,1}.p1]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177) ==
\mathbf{asType} < \mathbf{integer} > (\mathbf{div}(\mathbf{heapIs} \ \$ \mathbf{heap}_{funcstart\_724,1}, \ \$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}, \\
177).rem)
```

```
\rightarrow [from term 8.0, literala < -$heap<sub>funcstart_724,1</sub>.p1 is false whenever -2 < (0
+ literala)]
   Proof of rule precondition:
   [15.7.0] - 2 < (0 + 0)
   \rightarrow [simplify]
   [15.7.2] true
[15.8] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) \; \% \; 177),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177) = =
\mathbf{asType} {<} \mathbf{integer} {>} ( \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}, \\
177).rem)
\rightarrow [simplify]
[15.11] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177), [!(0
<-$heap<sub>funcstart_724,1.</sub>p1)]: asType<integer>($heap<sub>funcstart_724,1.</sub>p1) %
177) == asType<integer>(div(heapIs heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p1, 177}.rem
\rightarrow [from term 8.0, literala < -$heap_{uncstart\_724,1}.p1 is false whenever -2 < (0
+ literala)]
   Proof of rule precondition:
   [15.11.0] - 2 < (0 + 0)
   \rightarrow [simplify]
   [15.11.2] true
[15.12] ([false]: -(-asType < integer > (\$heap_{funcstart\_724.1}.p1) \% 177),
[!false]: asType<integer>(sheap_{funcstart\_724,1.p1}) \% 177 ==
asType < integer > (div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1,
177).rem)
\rightarrow [simplify]
[15.17] 0 == (-\operatorname{div}(\mathbf{heapIs} \ \hat{\mathbf{s}}_{funcstart\_724,1}, \ \hat{\mathbf{s}}_{funcstart\_724,1}.p1,
177).rem + (\text{$heap}_{funcstart\_724,1}.p1 \% 177))
[Assume known post-assertion, class invariant or type constraint for term
15.17
[23.0] div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1, 177).rem \leq
maxof(int)
\rightarrow [simplify]
177).rem
[Take goal term]
```

```
[1.0] div1.rem \leq maxof(short int)
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177)
[1.1] div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1, 177).rem \leq
maxof(short int)
\rightarrow [simplify]
[1.10] -32768 < -\text{div}(\text{heapIs } \text{$heap}_{funcstart\_724,1}, \text{$heap}_{funcstart\_724,1}.\text{p1},
177).rem
\rightarrow [from term 23.9, literala < -div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).rem is true whenever (-1 + literala) < -32768
   Proof of rule precondition:
   [1.10.0](-32768 + -1) < -32768
   \rightarrow [simplify]
   [1.10.2] true
[1.11] true
Proof of verification condition: Type constraint satisfied in implicit
conversion from 'short int' to 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (61,15)
Condition defined at:
To prove: minof(int) \le asType < short int > (div1.rem)
Given:
heap_{init}.LIMIT == (int)80
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
\theta
\theta
\theta
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
\theta = asType < short int > ((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
```

```
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
heap_{init}.p3 == asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart\_724,1})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(asType < int > (asType < int > (\$heap_{funcstart\_724,1}.p1)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}))\ \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))) = =
asType<integer>(div1.rem)
(asType<integer>($heap_{tuncstart\_724.1}.p1) <
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a1})) = >
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) = =
asType<integer>(div1.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a1) \le
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.quot)
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2})) \ \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2})) =>
(asType < integer > (\$heap_{funcstart\_724,1}.p2) = =
asType<integer>(div2.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a2}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
```

```
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
\label{eq:div3} \text{div3} == \text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}),
asType < int > (\$heap_{funcstart\_724.1}.a3))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))) ==
asType<integer>(div3.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3})) =>
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) ==
asType<integer>(div3.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a3) \le
asType < integer > (\$heap_{funcstart\_724.1}.p3)) = > !(0 ==
asType < integer > (div3.quot))
!(0 == \mathbf{asType} < \mathbf{integer} > (\mathbf{div} 3.\mathbf{rem})) \mid\mid !(0 ==
asType<integer>(div3.quot))
Proof:
[Take given term]
[5.0] invariant1(heapIs heap_{funcstart\_724,1})
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
[5.1] ((((((0 < asType < integer > ($heap_{funcstart\_724,1}.p1)) &&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) <
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart_{-724.1}}.M3))
\rightarrow [simplify]
[5.3] (((((0 < $heap_{funcstart\_724,1}.p1) && ($heap_{funcstart\_724,1}.p1 < 
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 < funcstart\_724,1)
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2})))\ \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})))\ \&\&
```

```
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.4] \ (((((0 < \text{\$heap}_{funcstart\_724,1}.\text{p1}) \&\& \ (\text{\$heap}_{funcstart\_724,1}.\text{p1} <
asType<integer>(heap_{init}.M1))) && (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2})))\ \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) <
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M3}))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < $heap_{funcstart_{724,1}}.p1) && ($heap_{funcstart_{724,1}}.p1 < 
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 < funcstart\_724,1)
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
(asType < integer > (\$heap_{funcstart_{-724,1}}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.16] ((((-30269 < -$heap_{funcstart\_724,1}.p1) \lambda (0 < $heap_{funcstart\_724,1}.p1) \lambda
(0 < \$ heap_{funcstart\_724,1}.p2)) && (\$ heap_{funcstart\_724,1}.p2 <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.17] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \; \land \; (0 < \$heap_{funcstart\_724,1}.p1) \; \land 
(0 < \text{$heap}_{funcstart\_724,1}.p2)) \&\& (\text{$heap}_{funcstart\_724,1}.p2 <
asType < integer > (\$heap_{init}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M3}))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > (\$heap_{funcstart\_724.1}.p3) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
```

```
\rightarrow [simplify]
[5.30] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \wedge (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1.p2} \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\$heap_{funcstart\_724,1}.p3 < \mathbf{asType} < \mathbf{integer} > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -$heap_{funcstart\_724,1}.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.p2) \land (0 < \text{Sheap}_{funcstart\_724,1}.p3)) \&\&
(\text{\$heap}_{funcstart\_724,1}.p3 < asType < integer > (\text{\$heap}_{init}.M3))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1.p2} \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\$heap_{funcstart\_724,1}.p3 < \textbf{asType} < \textbf{integer} > (\textbf{asType} < \textbf{short}
int > ((int)30323)))
\rightarrow [simplify]
[5.40] (-30323 < -$heap<sub>funcstart_724,1.</sub>p3) \land (-30307 <
-\$heap_{funcstart\_724,1}.p2) \wedge (-30269 < -\$heap_{funcstart\_724,1}.p1) \wedge (0 <
\text{Sheap}_{funcstart\_724,1}.\text{p1}) \land (0 < \text{Sheap}_{funcstart\_724,1}.\text{p2}) \land (0 <
heap_{funcstart_{724,1}.p3}
[Work on sub-term 4 of conjunction in term 5.40]
[8.0] 0 < $heap_{funcstart_724,1}.p1
[Take given term]
[11.0] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \ \hat{\mathbf{s}}_{heap}) + \operatorname{div1}_{funcstart} = \mathbf{f}_{funcstart}
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}),
asType < int > (\$heap_{funcstart\_724,1}.a1))
\rightarrow [simplify]
[11.1] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
asType < int > (\$heap_{funcstart\_724,1}.a1))
\rightarrow [const static or extern object]
[11.2] div1 == div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}.p1,
asType < int > (\$heap_{init}.a1))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
[11.3] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType<int>(asType<short int>((int)177)))
\rightarrow [simplify]
[11.6] div1 == div(heapIs $heap_{funcstart\_724,1}$, $heap_{funcstart\_724,1}.p1, 177)
```

```
[Assume known post-assertion, class invariant or type constraint for term 11.6]
[15.0] (asType<integer>(peq_{funcstart\_724,1}.p1) %
asType<integer>(177)) == asType<integer>(div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}
\rightarrow [simplify]
[15.2] (\theta_{tuncstart\_724,1.p1} \% 177) == asType<integer>(div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}
→ [expand definition of operator '.%' in class 'int' at built in declaration]
[15.3] \; ([\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) < 0] :
-(-asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177), []:
asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177) ==
\mathbf{asType} {<} \mathbf{integer} {>} ( \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}, \\
177).rem)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[15.4] ([asType<integer>($heap_{funcstart\_724,1}.p1) < 0]:
-(-\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) \% \ 177),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177) ==
\mathbf{asType} {<} \mathbf{integer} {>} ( \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}, \\
177).rem)
\rightarrow [simplify]
[15.7] ([0 < -\$heap_{funcstart\_724,1}.p1]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 0)]:
asType < integer > (\$heap_{funcstart-724,1}.p1) \% 177) ==
asType<integer>(div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1,
177).rem)
\rightarrow [from term 8.0, literala < -$heap<sub>funcstart_724.1</sub>.p1 is false whenever -2 < (0
+ literala)
    Proof of rule precondition:
    [15.7.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [15.7.2] true
[15.8] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) \; \% \; 177),
[!(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177) = =
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).rem)
\rightarrow [simplify]
```

```
[15.11] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p1) \; \% \; 177), \; [!(0.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; ((1.15.11)] \; 
<-$heap<sub>funcstart_724,1</sub>.p1)]: asType<integer>($heap<sub>funcstart_724,1</sub>.p1) %
177) == asType<integer>(div(heapIs heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p1, 177}.rem
\rightarrow [from term 8.0, literala < -$heap<sub>funcstart_724,1.</sub>p1 is false whenever -2 < (0
+ literala)]
        Proof of rule precondition:
        [15.11.0] - 2 < (0 + 0)
        \rightarrow [simplify]
        [15.11.2] true
[15.12] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177),
[!false]: asType<integer>(p_{funcstart\_724,1}.p_1) \% 177) ==
asType<integer>(div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1,
177).rem)
\rightarrow [simplify]
[15.17] \ 0 == (-\text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).rem + (\text{$heap}_{funcstart\_724,1}.p1 \% 177))
[Assume known post-assertion, class invariant or type constraint for term
15.17
[22.0] \operatorname{minof(int)} \leq \operatorname{div}(\operatorname{heapIs} \operatorname{\$heap}_{funcstart\_724,1}, \operatorname{\$heap}_{funcstart\_724,1}.p1,
177).rem
\rightarrow [simplify]
[22.3] -32769 < div(heapIs $heap_{tuncstart\_724.1}, $heap_{tuncstart\_724.1}.p1,
177).rem
[Take goal term]
[1.0] minof(int) \leq asType<short int>(div1.rem)
\rightarrow [simplify]
[1.1] -32768 \leq asType<short int>(div1.rem)
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177
[1.2] -32768 \leq asType<short int>(div(heapIs $heap<sub>funcstart_724,1</sub>,
heap_{funcstart_{-724,1}.p1, 177}.rem
\rightarrow [simplify]
[1.5] -32769 < div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1,
177).rem
\rightarrow [from term 22.3, literala < div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177).rem is true whenever (-1 + literala) < -32769
```

```
Proof of rule precondition:
   [1.5.0] (-32769 + -1) < -32769
   \rightarrow [simplify]
   [1.5.2] true
[1.6] true
Proof of verification condition: Type constraint satisfied in implicit
conversion from 'short int' to 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (61,15)
Condition defined at:
To prove: asType<short int>(div1.rem) \leq maxof(int)
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
\theta
\theta = asType < short int > ((int)2)
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\rho_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart_{-724,1}})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
```

 $\begin{aligned} &(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{funcstart_724,1}.\mathrm{p1})) \ / \\ &\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{funcstart_724,1}.\mathrm{a1}))) \ == \end{aligned}$

```
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heap_{tuncstart\_724,1}.p1)) %
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))) = =
asType<integer>(div1.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1})) =>
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) ==
asType<integer>(div1.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathtt{a1}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
\label{eq:div2} \text{div2} == \text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}),
asType < int > (\$heap_{funcstart\_724.1}.a2))
(asType<int>(asType<int>($heap_{tuncstart\_724.1}.p2)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p2) = =
asType<integer>(div2.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.a2) \leq
asType < integer > (\$heap_{funcstart\_724.1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724.1}.p3),
asType < int > (\$heap_{funcstart\_724.1}.a3))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p3})) \ / \\
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.rem)
```

```
(asType < integer > (\$heap_{funcstart\_724,1}.p3) <
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) ==
asType<integer>(div3.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a3) \le
asType < integer > (\$heap_{funcstart\_724,1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
Proof:
[Take given term]
[5.0] invariant1(heapIs heap_{funcstart_{-724,1}})
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
[5.1] ((((((0 < asType < integer > ($heap_{funcstart\_724,1}.p1)) &&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) <
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p2) < 
\mathbf{asType} \small{<} \mathbf{integer} \small{>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M2}))) \ \&\& \ (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.3] (((((0 < $heap_{funcstart_{724,1}}.p1) && ($heap_{funcstart_{724,1}}.p1 < ])
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(asType<integer>($heap_funcstart_724.1.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.4] (((((0 < $heap_{funcstart_{724,1}}.p1) && ($heap_{funcstart_{724,1}}.p1 < ]
asType < integer > (\$heap_{init}.M1))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})))\ \&\&
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart_{-724.1}}.M3))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
```

```
[5.5] (((((0 < $heap_{funcstart_{724,1}}.p1) && ($heap_{funcstart_{724,1}}.p1 < 
asType<integer>(asType<short int>((int)30269)))) && (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2})))\ \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p2) < 
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{tuncstart_{-724,1}}.M3))
\rightarrow [simplify]
[5.16] ((((-30269 < -$heap_{funcstart\_724,1}.p1) \lambda (0 < $heap_{funcstart\_724,1}.p1) \lambda
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M2})))~\&\&~(0<
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.17] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \; \land \; (0 < \$heap_{funcstart\_724,1}.p1) \; \land 
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType < integer > (\$heap_{init}.M2))) \&\& (0 <
asType < integer > ($heap_{funcstart\_724,1}.p3))) &&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -$heap<sub>funcstart_724,1.</sub>p1) \land (0 < $heap<sub>funcstart_724,1.</sub>p1) \land
(0 < \text{$heap}_{funcstart\_724,1}.p2)) \&\& (\text{$heap}_{funcstart\_724,1}.p2 <
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.30] ((-30307 < -$heap_funcstart_724,1.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1.p2} \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\$heap_{funcstart\_724,1}.p3 < \mathbf{asType} < \mathbf{integer} > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -$heap<sub>funcstart_724,1</sub>.p2) \wedge (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1.p2}) \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.\text{p3} < \text{asType} < \text{integer} > (\text{\$heap}_{init}.\text{M3}))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \wedge (-30269 <
```

```
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.p2) \land (0 < \text{Sheap}_{funcstart\_724,1}.p3)) \&\&
(\$heap_{funcstart\_724,1}.p3 < \mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{short}
int > ((int)30323)))
\rightarrow [simplify]
[5.40] (-30323 < -$heap_funcstart_724,1.p3) \land (-30307 <
-\$heap_{funcstart\_724,1}.p2) \land (-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < -\$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.\text{p1}) \land (0 < \text{Sheap}_{funcstart\_724,1}.\text{p2}) \land (0 <
heap_{funcstart_{-724,1}.p3}
[Work on sub-term 4 of conjunction in term 5.40]
[8.0] 0 < $\text{heap}_{funcstart_724.1}.p1
[Take given term]
[11.0] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \ \text{$heap}_{funcstart\_724.1},
asType < int > (\$heap_{funcstart\_724.1}.p1),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
\rightarrow [simplify]
[11.1] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
\rightarrow [const static or extern object]
[11.2] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
asType < int > (\$heap_{init}.a1))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
[11.3] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType<int>(asType<short int>((int)177)))
\rightarrow [simplify]
[11.6] \text{ div1} == \text{div}(\text{heapIs } \text{$heap}_{funcstart\_724,1}, \text{$heap}_{funcstart\_724,1}.\text{p1}, 177)
[Assume known post-assertion, class invariant or type constraint for term 11.6]
[15.0] (as
Type<integer>($heap_{funcstart\_724,1}.p1) \%
asType<integer>(177)) == asType<integer>(div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}
\rightarrow [simplify]
[15.2] ($heap_{funcstart\_724,1}.p1 % 177) == asType<integer>(div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}
→ [expand definition of operator '.%' in class 'int' at built in declaration]
[15.3] ([asType<integer>($heap_{funcstart\_724,1}.p1) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177), []:
asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177) ==
```

```
\mathbf{asType} {<} \mathbf{integer} {>} ( \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}, \\
177).rem)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
 [15.4] \; ([\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) < 0] : 
-(-asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177) ==
asType<integer>(div(heapIs $heap_{tuncstart\_724.1}, $heap_{tuncstart\_724.1}.p1,
177).rem)
\rightarrow [simplify]
[15.7] ([0 < -$heap<sub>funcstart_724,1.</sub>p1]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177),
[!(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177) ==
asType<integer>(div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1,
177).rem)
\rightarrow [from term 8.0, literala < -$heap<sub>funcstart_724.1</sub>.p1 is false whenever -2 < (0
+ literala)]
    Proof of rule precondition:
    [15.7.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [15.7.2] true
[15.8] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177),
[!(asType < integer > (\$heap_{funcstart\_724.1}.p1) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177) ==
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).rem)
\rightarrow [simplify]
[15.11] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177), [!(0
<-$heap<sub>funcstart_724,1.</sub>p1)]: asType<integer>($heap<sub>funcstart_724,1.</sub>p1) %
177) == asType < integer > (div(heapIs \$heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p1, 177}.rem
\rightarrow [from term 8.0, literala < -$heap<sub>funcstart_724,1</sub>.p1 is false whenever -2 < (0
+ literala)]
    Proof of rule precondition:
    [15.11.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [15.11.2] true
```

```
[15.12] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177),
[!false]: asType<integer>(p_{funcstart\_724,1}.p1) % 177) ==
\mathbf{asType} < \mathbf{integer} > (\mathbf{div}(\mathbf{heapIs} \$ \mathbf{heap}_{funcstart\_724,1}, \$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1},
177).\text{rem}
\rightarrow [simplify]
\textit{[15.17] 0} == (-\text{div}(\textbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).rem + (\text{$heap}_{funcstart\_724,1}.p1 \% 177))
[Assume known post-assertion, class invariant or type constraint for term
15.17
[23.0] div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1, 177).rem \leq
maxof(int)
\rightarrow [simplify]
[23.9] -32768 < -\text{div}(\text{heapIs } \text{$heap}_{funcstart\_724,1}, \text{$heap}_{funcstart\_724,1}.\text{p1},
177).rem
[Take goal term]
[1.0] asType<short int>(div1.rem) \leq maxof(int)
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177
[1.1] asType<short int>(div(heapIs $heap_{funcstart\_724,1},)
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} \leq \text{maxof(int)}
\rightarrow [simplify]
[1.11] -32768 < -\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).rem
\rightarrow [from term 23.9, literala < -\text{div}(\text{heapIs }\$\text{heap}_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177.rem is true whenever (-1 + literala) < -32768
    Proof of rule precondition:
    [1.11.0](-32768 + -1) < -32768
    \rightarrow [simplify]
    [1.11.2] true
[1.12] true
Proof of verification condition: Type constraint satisfied in implicit
conversion from 'short int const' to 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (61,10)
```

Condition defined at:

To prove: $minof(int) \leq \$heap_{funcstart_724,1}.r1$

Given:

```
heap_{init}.LIMIT == (int)80
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta = asType < short int > ((int)2)
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\rho_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
\theta sheap<sub>init</sub>.M3 == asType<short int>((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
invariant
1(heap<br/>Is heap_{funcstart\_724,1})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \ \operatorname{\$heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) /
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}))) = =
asType<integer>(div1.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))) = =
asType<integer>(div1.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1})) =>
(asType < integer > (\$heap_{funcstart\_724,1}.p1) = =
asType<integer>(div1.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathtt{a1}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
```

```
div2 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
(asType<integer>(asType<int>($heap_{tuncstart\_724.1}.p2)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.quot)
(\mathbf{asType} {<} \mathbf{integer} {>} (\mathbf{asType} {<} \mathbf{int} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2})) \ \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724.1}.a2)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p2) = =
asType<integer>(div2.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.a2) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
asType < int > (\$heap_{funcstart\ 724.1}.a3))
(asType<int>(asType<int>($heap_{tuncstart\_724.1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(asType<int>(asType<int>($heap_{funcstart\_724,1}.p3)) %
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathtt{a3}))) ==
asType<integer>(div3.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}) ==
asType<integer>(div3.rem))
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a3}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
Proof:
[Take goal term]
[1.0] minof(int) \leq $heap<sub>funcstart_724.1</sub>.r1
```

```
\rightarrow [simplify]
[1.1] -32768 \leq $heap<sub>funcstart_724,1</sub>.r1
\rightarrow [const static or extern object]
[1.2] -32768 \le \text{$heap}_{init}.r1
\rightarrow [expand definition of constant 'r1' at prang.c (15,20)]
[1.3] - 32768 \le asType < short int > ((int)171)
\rightarrow [simplify]
[1.6] true
Proof of verification condition: Type constraint satisfied in implicit
conversion from 'short int const' to 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (61,10)
Condition defined at:
To prove: \text{$heap}_{funcstart\_724,1}.r1 \leq \max(\text{int})
Given:
heap_{init}.LIMIT == (int)80
\theta
\theta_{init}.r1 == asType < short int > ((int)171)
\theta
\theta
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\rho_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
\theta = asType < short int > ((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
\theta == asType<short int>((int)178)
\theta = asType < short int > ((int)63)
\theta
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart_{-724,1}})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
```

```
asType < int > (\$heap_{funcstart\_724,1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ / \\
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}))) = =
asType<integer>(div1.quot)
(asType < int > (asType < int > (\$heap_{funcstart\_724,1}.p1)) \%
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}))) = =
asType<integer>(div1.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p1) = =
asType<integer>(div1.rem))
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}) \leq
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1})) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.quot)
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}))~\%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a2})) =>
(asType < integer > (\$heap_{funcstart\_724,1}.p2) = =
asType<integer>(div2.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a2) \le
asType < integer > (\$heap_{funcstart\_724,1}.p2)) => !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > ($heap_{funcstart\_724,1}.p3),
asType < int > (\$heap_{funcstart\_724,1}.a3))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724.1}.a3))) = =
```

```
asType<integer>(div3.quot)
(asType<integer>(asType<int>($heap_{tuncstart_724,1}.p3)) %
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.rem)
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a3})) = {>}
(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a3}) \leq
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3})) = > !(0 = =
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
Proof:
[Take goal term]
[1.0] $\text{heap}_{funcstart_724,1}.\text{r1} \leq \text{maxof(int)}
\rightarrow [const static or extern object]
[1.1] $heap<sub>init</sub>.r1 \leq maxof(int)
\rightarrow [expand definition of constant 'r1' at prang.c (15,20)]
[1.2] asType<short int>((int)171) \le maxof(int)
\rightarrow [simplify]
[1.6] true
Proof of verification condition: Arithmetic result of operator '*' is within
limit of type 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (61,13)
Condition defined at:
To prove: minof(int) \le (asType < int > (asType < short int > (div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1))
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
heap_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
```

```
\rho_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta
heap_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart\_724,1})
div1 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(asType<int>(asType<int>($heap_{funcstart\_724,1}.p1)) %
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) ==
asType<integer>(div1.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a1) \le
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1})) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}))\ /
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))) ==
asType<integer>(div2.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724.1}.p2)) \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.rem)
```

```
(asType < integer > (\$heap_{funcstart\_724,1}.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) ==
asType<integer>(div2.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a2) \le
asType < integer > (\$heap_{funcstart\_724,1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
asType < int > (\$heap_{funcstart\_724.1}.a3))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p3})) \ / \\
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a3}))) = =
asType<integer>(div3.quot)
(asType<int>(asType<int>($heap_{funcstart\_724,1}.p3)) %
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.rem)
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(asType < integer > (\$heap_{funcstart\ 724,1}.p3) = =
asType<integer>(div3.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a3) \le
asType < integer > (\$heap_{funcstart\_724,1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
Proof:
[Take given term]
[5.0] invariant
1(heapIs heap_{funcstart\_724,1})
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
 [5.1] \ (((((0 < \mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p1)) \ \&\& \\
(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
as
Type<integer>(\rho_{funcstart\_724,1}.M2))) & (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
```

```
\rightarrow [simplify]
[5.3] (((((0 < \text{heap}_{funcstart\_724,1}.p1) && (\text{heap}_{funcstart\_724,1}.p1 <
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}))) \ \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p2) < 
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [const static or extern object]
[5.4] \ (((((0 < \text{\$heap}_{funcstart\_724,1}.\text{p1}) \&\& \ (\text{\$heap}_{funcstart\_724,1}.\text{p1} <
asType < integer > (\$heap_{init}.M1))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(asType<integer>($heap_funcstart_724.1.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) <
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M3}))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < $heap_{funcstart_724,1}.p1) && ($heap_{funcstart_724,1}.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > ($heap_{funcstart\_724,1}.p3))) &&
(asType<integer>($heap_{tuncstart\_724,1}.p3) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.16] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < \text{\$heap}_{funcstart\_724,1}.\text{p2})) && (\text{\$heap}_{funcstart\_724,1}.\text{p2} <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.17] \left( \left( \left( \left( -30269 < -\$ \text{heap}_{funcstart\_724,1}.\text{p1} \right) \right. \wedge \left. \left( 0 < \$ \text{heap}_{funcstart\_724,1}.\text{p1} \right) \right. \wedge \right. \right) \\
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType<integer>(heap_{init}.M2))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType<integer>($heap_funcstart_724,1.M3))
```

```
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < $heap_{funcstart\_724,1}.p2)) && ($heap_{funcstart\_724,1}.p2 <
asType < integer > (asType < short int > ((int)30307)))) && (0 < integer) && (0 < integer
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.30] ((-30307 < -$heap<sub>funcstart_724,1</sub>.p2) \wedge (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{724,1}.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.\text{p3} < \text{asType} < \text{integer} > (\text{\$heap}_{funcstart\_724,1}.\text{M3}))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -$heap<sub>funcstart_724,1</sub>.p2) \wedge (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{heap}_{funcstart\_724,1.p2} \land (0 < \text{heap}_{funcstart\_724,1.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.p3 < asType < integer > (\text{\$heap}_{init}.M3))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap_funcstart_724,1.p2) \land (-30269 <
 -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{724,1}.p3})) \&\&
(\text{sheap}_{funcstart\_724.1}.\text{p3} < \text{asType} < \text{integer} > (\text{asType} < \text{short})
int > ((int)30323))
\rightarrow [simplify]
[5.40] (-30323 < -$heap<sub>funcstart_724,1</sub>.p3) \land (-30307 <
-\$heap_{funcstart\_724,1}.p2) \land (-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < -\$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724.1.p1} \land (0 < \text{Sheap}_{funcstart\_724.1.p2}) \land (0 <
heap_{funcstart_{724,1}.p3}
[Work on sub-term 4 of conjunction in term 5.40]
\textit{[8.0]} \ 0 < \$ heap_{funcstart\_724,1}.p1
[Take given term]
[11.0] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}),
asType < int > (\$heap_{funcstart\_724,1}.a1))
\rightarrow [simplify]
[11.1] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
\rightarrow [const static or extern object]
```

```
[11.2] div1 == div(heapIs \theta_{funcstart_{-724,1}}, \theta_{funcstart_{-724,1}}, p1,
asType < int > (\$heap_{init}.a1))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
\textit{[11.3]} \ \text{div1} == \text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
asType < int > (asType < short int > ((int)177)))
\rightarrow [simplify]
[11.6] div1 == div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1, 177)
[Take goal term]
[1.0] minof(int) \le (asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724.1}.r1))
\rightarrow [simplify]
[1.1] -32768 \leq (asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177)
[1.2] -32768 \leq (asType<int>(asType<short int>(div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).rem)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{r1}))
\rightarrow [simplify]
 \label{eq:constant_724,1} \text{-}32768 \leq (\text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).rem * asType < int > (\$heap_{funcstart\_724,1}.r1))
\rightarrow [const static or extern object]
\textit{[1.5] -32768} \leq (\text{div}(\textbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).rem * asType < int > (\$heap_{init}.r1))
\rightarrow [expand definition of constant 'r1' at prang.c (15,20)]
[1.6] -32768 \leq (\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1},
177).rem * asType<int>(asType<short int>((int)171)))
\rightarrow [simplify]
 \label{eq:loss_loss} \mbox{$[1.11]$ -32769} < (171 * \mbox{div}(\mathbf{heapIs} \; \$\mbox{$heap}_{funcstart\_724,1}, \; \$\mbox{$heap}_{funcstart\_724,1}.p1, 
177).rem)
\rightarrow [literal comparison of product]
[1.12] ([171 < 0]: (-32769 / -171) < -\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p1, 177}.rem, [0 < 171]: (-32769 / 171) < div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}, [0 == 171]: -32769 < 0)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[1.13] ([171 < 0]: (-32769 / -171) < -\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1},
```

```
\rho_{uncstart_{-724,1}.p1,\ 177).rem,\ [(0<171)\land !(171<0)]:\ (-32769\ /\ 171)<171
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p1, \ 177).rem, \ [(0 == 171)]
\land !(0 < 171) \land !(171 < 0)]: -32769 < 0)
\rightarrow [simplify]
[1.21] -192 < div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}.p1, 177).rem
\rightarrow [negate goal and search for contradiction]
[1.22] !(-192 < div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}.p1,
177).rem)
\rightarrow [simplify]
[1.24] 191 < -\text{div}(\text{heapIs }\text{\$heap}_{funcstart\_724,1}, \text{\$heap}_{funcstart\_724,1}.\text{p1},
177).rem
[Assume known post-assertion, class invariant or type constraint for term 11.6]
[15.0] (as
Type<integer>($heap_{funcstart\_724,1}.p1) \%
asType<integer>(177)) == asType<integer>(div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}
\rightarrow [simplify]
[15.2] (heap_{funcstart\_724,1}.p1 \% 177) == asType<integer>(div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}
→ [expand definition of operator '.%' in class 'int' at built in declaration]
[15.3] ([asType<integer>($heap_{funcstart\_724,1}.p1) < 0]:
-(-\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) \% 177), \ []:
asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177) ==
asType<integer>(div(heapIs $heap_{funcstart\_724.1}, $heap_{funcstart\_724.1}.p1,
177).rem)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[15.4] ([asType<integer>(heap_{funcstart\_724,1}.p1) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724.1}.p1) \% 177),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177) ==
asType<integer>(div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
177).rem)
\rightarrow [simplify]
[15.7] ([0 < -$heap<sub>funcstart_724,1</sub>.p1]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177) ==
asType<integer>(div(heapIs $heap_{tuncstart_724.1}, $heap_{tuncstart_724.1}.p1,
177).rem)
```

```
\rightarrow [from term 8.0, literala < -$heap<sub>funcstart_724,1</sub>.p1 is false whenever -2 < (0
+ literala)]
    Proof of rule precondition:
    [15.7.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [15.7.2] true
[15.8] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177) = =
\mathbf{asType} {<} \mathbf{integer} {>} ( \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}, \\
177).rem)
\rightarrow [simplify]
[15.11] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177), [!(0
<-$heap<sub>funcstart_724,1.</sub>p1)]: asType<integer>($heap<sub>funcstart_724,1.</sub>p1) %
177) == asType<integer>(div(heapIs heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p1, 177}.rem
\rightarrow [from term 8.0, literala < -$heap_{uncstart\_724,1}.p1 is false whenever -2 < (0
+ literala)]
    Proof of rule precondition:
    [15.11.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [15.11.2] true
[15.12] ([false]: -(-asType < integer > (\$heap_{funcstart\_724.1}.p1) \% 177),
[!false]: asType<integer>(sheap_{funcstart\_724,1.p1}) \% 177 ==
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).rem)
\rightarrow [simplify]
[15.17] 0 == (-\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem + (\text{$heap}_{funcstart\_724,1}.p1 \% 177))
[Create new term from terms 1.24, 15.17 using rule: transitivity 15]
[69.0] (0 + 191) < -(\text{$heap}_{funcstart\_724.1}.p1 \% 177)
\rightarrow [simplify]
[69.2] false
```

Proof of verification condition: Arithmetic result of operator '*' is within limit of type 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (61,13)

Condition defined at:

```
To prove: (asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) \le maxof(int)
Given:
heap_{init}.LIMIT == (int)80
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
\theta
\theta
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\rho_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
\theta = asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
heap_{init}.p3 == asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart\_724,1})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
(asType<integer>(asType<int>($heap_{tuncstart\_724.1}.p1)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) ==
asType<integer>(div1.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathtt{a1}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p1)) => !(0 ==
```

```
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724.1}.a2))
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2})) \ / \ 
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.quot)
(asType<int>(asType<int>($heap_{funcstart\_724.1}.p2)) %
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) = =
asType<integer>(div2.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a2) \le
asType < integer > (\$heap_{funcstart\_724,1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a3}))
(\mathbf{asType} {<} \mathbf{integer} {>} (\mathbf{asType} {<} \mathbf{int} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3})) \ / \\
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a3})) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a3) \le
asType < integer > (\$heap_{funcstart\_724,1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
Proof:
```

```
[Take given term]
[5.0] invariant1(heapIs heap_{funcstart\_724,1})
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
[5.1] ((((((0 < asType < integer > ($heap_{funcstart\_724,1}.p1)) &&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) <
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
\mathbf{asType} \small{<} \mathbf{integer} \small{>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M2}))) \ \&\& \ (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.3] (((((0 < $heap_{funcstart_724,1}.p1) && ($heap_{funcstart_724,1}.p1 < function for the content of the 
asType<integer>(sheap_{funcstart\_724,1}.M1))) && (0 <
asType < integer > (\$heap_{funcstart_{-724,1}}.p2))) \&\&
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 < 1)
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})))\ \&\&
(asType < integer > (\$heap_{funcstart\_724.1}.p3) < 
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M3}))
\rightarrow [const static or extern object]
[5.4] (((((0 < $heap_{funcstart_{724,1}}.p1) && ($heap_{funcstart_{724,1}}.p1 < 
asType < integer > (\$heap_{init}.M1))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})))\ \&\&
(asType<integer>($heap_funcstart_724.1.p3) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < $heap_{funcstart_{724,1}}.p1) && ($heap_{funcstart_{724,1}}.p1 < 
asType<integer>(asType<short int>((int)30269)))) && (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2})))\ \&\&
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.16] ((((-30269 < -$heap<sub>funcstart_724,1.</sub>p1) \land (0 < $heap<sub>funcstart_724,1.</sub>p1) \land
```

```
(0 < \text{\$heap}_{funcstart_{-724,1}.p2})) \&\& (\text{\$heap}_{funcstart_{-724,1}.p2} <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p3) < 
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M3}))
\rightarrow [const static or extern object]
[5.17] ((((-30269 < -$heap_{funcstart\_724,1}.p1) \lambda (0 < $heap_{funcstart\_724,1}.p1) \lambda
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType<integer>(heap_{init}.M2))) && (0 <
asType<integer>($heap_tuncstart_724.1.p3))) &&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \; \land \; (0 < \$heap_{funcstart\_724,1}.p1) \; \land 
(0 < \text{Sheap}_{funcstart_{724,1},p2})) \&\& (\text{Sheap}_{funcstart_{724,1},p2} < 0
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{tuncstart_{-724,1}}.M3))
\rightarrow [simplify]
[5.30] ((-30307 < -$heap_funcstart_724,1.p2) \land (-30269 <
-$heap_{funcstart\_724,1}.p1) \land (0 < $heap_{funcstart\_724,1}.p1) \land (0 <
\text{Sheap}_{funcstart\_724,1.p2} \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.p3 < asType < integer > (\text{\$heap}_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -$heap<sub>funcstart_724,1</sub>.p2) \wedge (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1.p2}) \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.\text{p3} < \mathbf{asType} < \mathbf{integer} > (\text{\$heap}_{init}.\text{M3}))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap_funcstart_724,1.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{-724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{-724,1}.p3})) \&\&
(\text{sheap}_{funcstart\_724,1}.\text{p3} < \text{asType} < \text{integer} > (\text{asType} < \text{short})
int > ((int)30323)))
\rightarrow [simplify]
[5.40] (-30323 < -\$heap_{funcstart\_724,1}.p3) \land (-30307 < -30307)
-\$heap_{funcstart\_724,1}.p2) \land (-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < -\$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.\text{p1}) \land (0 < \text{Sheap}_{funcstart\_724,1}.\text{p2}) \land (0 <
heap_{funcstart_{-724,1}.p3}
```

```
[Work on sub-term 4 of conjunction in term 5.40]
\textit{[8.0]} \ 0 < \$ heap_{funcstart\_724,1}.p1
[Take given term]
[11.0] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
\rightarrow [simplify]
[11.1] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
\rightarrow [const static or extern object]
[11.2] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType < int > (\$heap_{init}.a1))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
[11.3] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
asType < int > (asType < short int > ((int)177)))
\rightarrow [simplify]
[11.6] div1 == div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1, 177)
[Take goal term]
[1.0] (asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) \le maxof(int)
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177)
[1.1] (asType<int>(asType<short int>(div(heapIs $heap_{tuncstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}) * asType < int > (\text{Sheap}_{funcstart\_724,1}.\text{r1})) \le
maxof(int)
\rightarrow [simplify]
[1.3] (div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1, 177).rem *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{r1})) \leq \mathbf{maxof}(\mathbf{int})
\rightarrow [const static or extern object]
[1.4] (div(heap
Is \rho_{tuncstart\_724,1} , \rho_{tuncstart\_724,1} , 177).
rem *
asType < int > (\$heap_{init}.r1)) \le maxof(int)
\rightarrow [expand definition of constant 'r1' at prang.c (15,20)]
[1.5] (div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}, 177).rem *
asType < int > (asType < short int > ((int)171))) \le maxof(int)
\rightarrow [simplify]
[1.18] -32768 < (-171 * div(heapIs $heap<sub>funcstart_724,1</sub>,
```

```
heap_{funcstart_{-724,1}}.p1, 177).rem
\rightarrow [literal comparison of product]
[1.19] ([-171 < 0]: (-32768 / 171) < -\text{div}(\mathbf{heapIs} \ \$ heap_{funcstart\_724.1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}, [0 < -171]: (-32768 / -171) < \text{div}(\textbf{heapIs})
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[1.20] ([-171 < 0]: (-32768 / 171) < -{\rm div}(\mathbf{heapIs}\ \$ \mathrm{heap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p1, 177}.rem, [(0 < -171) \land !(-171 < 0)]: (-32768 / -171) < 0
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).rem, \ [(-171 ==
0) \wedge !(-171 < 0) \wedge !(0 < -171)]: -32768 < 0)
\rightarrow [simplify]
[1.24] -192 < -\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).rem
\rightarrow [negate goal and search for contradiction]
[1.25]!(-192 < -\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).rem)
\rightarrow [simplify]
[1.28] 191 < div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1, 177).rem
[Assume known post-assertion, class invariant or type constraint for term 11.6]
[15.0] (asType<integer>(sheap_{funcstart\_724,1}.p1) %
asType<integer>(177)) == asType<integer>(div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}
\rightarrow [simplify]
[15.2] (\text{heap}_{funcstart\_724,1}.p1 % 177) == asType<integer>(div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).rem
\rightarrow [expand definition of operator '.%' in class 'int' at built in declaration]
[15.3] ([asType<integer>(peqtention = 15.3) ([asType<integer>(peqtention = 15.3) ([asType<integer) (peqtention = 15.3) 
-(-asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177), []:
asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177) = =
asType<integer>(div(heapIs p_{funcstart\_724,1}, p_{funcstart\_724,1}),
177).\text{rem}
\rightarrow [explicitly assert falsehood of skipped guards in subsequent guards]
[15.4] ([asType<integer>($heap_{funcstart\_724,1}.p1) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724.1}.p1) \% 177),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177) ==
\mathbf{asType} {<} \mathbf{integer} {>} ( \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}. \mathrm{p1}, \\
```

```
177).rem)
\rightarrow [simplify]
[15.7] ([0 < -$heap<sub>funcstart_724,1</sub>.p1]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 0)]:
asType < integer > (\$heap_{funcstart-724,1}.p1) \% 177) ==
asType<integer>(div(heapIs $heap_{tuncstart\_724.1}, $heap_{tuncstart\_724.1}.p1,
177).rem)
\rightarrow [from term 8.0, literala < -$heap<sub>funcstart_724,1.</sub>p1 is false whenever -2 < (0
+ literala)]
    Proof of rule precondition:
    [15.7.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [15.7.2] true
[15.8] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177) ==
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).rem)
\rightarrow [simplify]
[15.11] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177), [!(0
<-$heap<sub>funcstart_724,1.</sub>p1)]: asType<integer>($heap<sub>funcstart_724,1.</sub>p1) %
177) == asType < integer > (div(heapIs \$heap_{funcstart\_724.1},
heap_{funcstart_{-724,1}}.p1, 177).rem
\rightarrow [from term 8.0, literala < -$heap<sub>funcstart_724,1</sub>.p1 is false whenever -2 < (0
+ literala)]
    Proof of rule precondition:
    [15.11.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [15.11.2] true
\textit{[15.12]} \; ([\mathbf{false}]: \; -(\mathbf{-asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) \; \% \; 177),
[!false]: asType<integer>($heap_{funcstart\_724,1}.p1) % 177) ==
\mathbf{asType} < \mathbf{integer} > (\mathbf{div}(\mathbf{heapIs} \ \$ \mathbf{heap}_{funcstart\_724,1}, \ \$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}, \\
177).rem)
\rightarrow [simplify]
[15.17] \ 0 == (-\text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).rem + (\text{$heap}_{funcstart\_724,1}.p1 \% 177))
\rightarrow [remainder is less than divisor]
```

```
Proof of rule precondition:
```

```
[15.17.0] (177 + -\text{div}(\textbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}) \leq 0
\rightarrow [\text{simplify}]
[15.17.11] 176 < \text{div}(\textbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}
\rightarrow [\text{from term } 1.28, \text{literala} < \text{div}(\textbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem is true whenever } (-1 + \text{literala}) < 191]
\textbf{Proof of rule precondition:}
[15.17.11.0] (-1 + 176) < 191
\rightarrow [\text{simplify}]
[15.17.11.2] \textbf{true}
[15.17.12] \textbf{true}
[15.18] \textbf{false}
```

Proof of verification condition: Type constraint satisfied in explicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (61,40)

Condition defined at:

To prove: $minof(short int) \le div1.quot$

Given:

```
\begin{array}{lll} \$ heap_{init}.LIMIT == (int)80 \\ \$ heap_{init}.M1 == asType < short int > ((int)30269) \\ \$ heap_{init}.r1 == asType < short int > ((int)171) \\ \$ heap_{init}.a1 == asType < short int > ((int)177) \\ \$ heap_{init}.b1 == asType < short int > ((int)2) \\ \$ heap_{init}.M2 == asType < short int > ((int)30307) \\ \$ heap_{init}.r2 == asType < short int > ((int)172) \\ \$ heap_{init}.a2 == asType < short int > ((int)176) \\ \$ heap_{init}.b2 == asType < short int > ((int)35) \\ \$ heap_{init}.M3 == asType < short int > ((int)30323) \\ \$ heap_{init}.r3 == asType < short int > ((int)170) \\ \$ heap_{init}.a3 == asType < short int > ((int)178) \\ \$ heap_{init}.b3 == asType < short int > ((int)63) \\ \end{cases}
```

```
\theta
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs $heap_{tuncstart_{724.1}})
div1 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ / \\
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}))) = =
asType<integer>(div1.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p1) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1})) =>
(asType < integer > (\$heap_{funcstart\_724,1}.p1) = =
asType<integer>(div1.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a1) \le
asType < integer > (\$heap_{funcstart\_724,1}.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart\_724.1},
asType < int > (\$heap_{funcstart\_724.1}.p2),
asType < int > (\$heap_{funcstart\_724.1}.a2))
(asType<integer>(asType<int>($heap_{funcstart\_724,1}.p2)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p2) = =
asType<integer>(div2.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a2) \le
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})) => !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
```

```
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a3}))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(\mathbf{asType} {<} \mathbf{integer} {>} (\mathbf{asType} {<} \mathbf{int} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3})) \ \%
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a3}))) = =
asType<integer>(div3.rem)
(asType<integer>($heap_{tuncstart\_724.1}.p3) <
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}) ==
asType<integer>(div3.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a3}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
Proof:
[Take given term]
[5.0] invariant1(heapIs $heap_{funcstart_724,1})
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
 \texttt{[5.1]} \; (((((0 < \mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p1)) \; \&\& \\
(asType < integer > ($heap_{funcstart\_724,1}.p1) < 
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}))) \ \&\& \\
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M3}))
\rightarrow [simplify]
[5.3] \ (((((0 < \$heap_{funcstart\_724,1}.p1) \&\& \ (\$heap_{funcstart\_724,1}.p1 < 
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
as
Type<integer>(\rho_{funcstart\_724,1}.M2))) & (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
```

```
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
 \rightarrow [const static or extern object]
 [5.4] (((((0 < \text{heap}_{funcstart\_724,1}.p1) && (\text{heap}_{funcstart\_724,1}.p1 <
asType<integer>(heap_{init}.M1))) && (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2})))\ \&\&
 (asType < integer > (\$heap_{funcstart\_724,1}.p2) <
 asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
 (\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
 \rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
 [5.5] (((((0 < $heap_{funcstart_{-724,1}}.p1) && ($heap_{funcstart_{-724,1}}.p1 < 
asType<integer>(asType<short int>((int)30269)))) && (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
 (\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 < function for the start of the start 
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
 (\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{tuncstart_{-724.1}}.M3))
 \rightarrow [simplify]
 [5.16] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
\mathbf{asType} \small{<} \mathbf{integer} \small{>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M2}))) \ \&\& \ (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
 (asType < integer > ($heap_{funcstart\_724,1}.p3) < 
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M3}))
 \rightarrow [const static or extern object]
 [5.17] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \; \land \; (0 < \$heap_{funcstart\_724,1}.p1) \; \land 
 (0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType < integer > (\$heap_{init}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
 (asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M3}))
 \rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
 [5.18] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
 (0 < \text{$heap}_{funcstart\_724,1}.p2)) \&\& (\text{$heap}_{funcstart\_724,1}.p2 <
asType < integer > (asType < short int > ((int)30307)))) && (0 < integer) && (0 < integer
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
 (\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart_{-724.1}}.M3))
 \rightarrow [simplify]
```

```
[5.30] ((-30307 < -$heap_funcstart_724,1.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.p2) \land (0 < \text{Sheap}_{funcstart\_724,1}.p3)) \&\&
(\text{\$heap}_{funcstart\_724,1}.p3 < asType < integer > (\text{\$heap}_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -$heap<sub>funcstart_724,1</sub>.p2) \wedge (-30269 <
-\text{\$heap}_{funcstart\_724,1}.\text{p1}) \land (0 < \text{\$heap}_{funcstart\_724,1}.\text{p1}) \land (0 <
\text{Sheap}_{funcstart\_724,1.p2} \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.\text{p3} < \mathbf{asType} < \mathbf{integer} > (\text{\$heap}_{init}.\text{M3}))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap<sub>funcstart_724,1</sub>.p2) \wedge (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\theta_{funcstart\_724,1}.p2) \land (0 < \theta_{funcstart\_724,1}.p3)) \&\&
(\$heap_{funcstart\_724,1}.p3 < \mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{short}
int > ((int)30323)))
\rightarrow [simplify]
[5.40] (-30323 < -\text{$heap_{funcstart\_724,1.p3}$}) \land (-30307 <
-\$heap_{funcstart\_724,1}.p2) \land (-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < -\$heap_{funcstart\_724,1}.p2)
\text{Sheap}_{funcstart\_724,1}.\text{p1}) \land (0 < \text{Sheap}_{funcstart\_724,1}.\text{p2}) \land (0 <
heap_{funcstart_{724,1}.p3}
[Work on sub-term 4 of conjunction in term 5.40]
[8.0] 0 < $heap_{funcstart_724,1}.p1
[Take given term]
[11.0] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
\rightarrow [simplify]
[11.1] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
\rightarrow [const static or extern object]
[11.2] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType < int > (\$heap_{init}.a1))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
[11.3] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType<int>(asType<short int>((int)177)))
\rightarrow [simplify]
[11.6] div1 == div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177)
[Assume known post-assertion, class invariant or type constraint for term 11.6]
```

```
[14.0] (asType<integer>(\theta_{funcstart\_724,1}.p1) /
asType<integer>(177)) == asType<integer>(div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).quot
\rightarrow [simplify]
[14.2] ($heap<sub>funcstart_724,1</sub>.p1 / 177) == asType<integer>(div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).quot)
→ [expand definition of operator './' in class 'int' at built in declaration]
[14.3] ([asType<integer>($heap_{funcstart\_724,1}.p1) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177), []:
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1})~/~177) ==
asType<integer>(div(heapIs $heap_{tuncstart\_724.1}, $heap_{tuncstart\_724.1}.p1,
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[14.4] ([asType<integer>(heap_{funcstart\_724,1}.p1) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177),
[!(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})<0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177) ==
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).quot)
\rightarrow [simplify]
[14.7] ([0 < -$heap<sub>funcstart_724,1.</sub>p1]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177) ==
\mathbf{asType} \small{<} \mathbf{integer} \small{>} ( \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}, \\
177).quot)
\rightarrow [from term 8.0, literala < -$heap<sub>funcstart_724.1</sub>.p1 is false whenever -2 < (0
+ literala)]
    Proof of rule precondition:
    [14.7.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [14.7.2] true
[14.8] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) \; / \; 177),
[!(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) < 0)]:
asType < integer > (\$heap_{funcstart\_724.1}.p1) / 177) = =
asType<integer>(div(heapIs $heap_{tuncstart_724.1}, $heap_{tuncstart_724.1.p1},
177).quot)
\rightarrow [simplify]
[14.11] \; ([{\bf false}]: \; -({\bf -asType}{<} {\bf integer}{>} (\$ {\rm heap}_{funcstart\_724,1}.{\rm p1}) \; / \; 177), \; [!(0 <
```

```
-$heap<sub>funcstart_724,1.</sub>p1)]: asType<integer>($heap<sub>funcstart_724,1.</sub>p1) / 177)
== asType<integer>(div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p1, 177}.quot)
\rightarrow [from term 8.0, literala < -$heap<sub>funcstart_724,1.</sub>p1 is false whenever -2 < (0
+ literala)]
    Proof of rule precondition:
    [14.11.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [14.11.2] true
[14.12] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) \; / \; 177),
[!false]: asType<integer>(\theta_{funcstart\_724,1}.p1) / 177) ==
\mathbf{asType} < \mathbf{integer} > (\mathbf{div}(\mathbf{heapIs} \ \$ \mathbf{heap}_{funcstart\_724,1}, \ \$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1},
177).quot)
\rightarrow [simplify]
[14.17] 0 == (-div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p1,
177).quot + ({\rm \$heap}_{funcstart\_724,1}.{\rm p1} \ / \ 177))
[Assume known post-assertion, class invariant or type constraint for term
14.17
\label{eq:constant_724,1} \textit{[20.0]} \ \mathbf{minof(int)} \leq \text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).quot
\rightarrow [simplify]
\label{eq:condition} \mbox{[20.3] -32769} < \mbox{div}(\mathbf{heapIs} \ \$\mbox{heap}_{funcstart\_724,1}, \ \$\mbox{heap}_{funcstart\_724,1}.\mbox{p1},
177).quot
[Take goal term]
[1.0] minof(short int) \leq div1.quot
\rightarrow [simplify]
[1.1] - 32768 \le \text{div} 1.\text{quot}
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177)
[1.2] -32768 \le \text{div}(\text{heapIs } \text{\$heap}_{funcstart\_724,1}, \text{\$heap}_{funcstart\_724,1}.\text{p1},
177).quot
\rightarrow [simplify]
[1.4] -32769 < div(heapIs $heap_{funcstart_724,1}$, $heap_{funcstart_724,1}.p1,
177).quot
\rightarrow [from term 20.3, literala < div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177).quot is true whenever (-1 + literala) < -32769
```

```
Proof of rule precondition:
   [1.4.0](-32769 + -1) < -32769
   \rightarrow [simplify]
   [1.4.2] true
[1.5] true
Proof of verification condition: Type constraint satisfied in explicit
conversion from 'int' to 'short int'
Condition generated at: C:\Escher\Customers\prang\prang.c (61,40)
Condition defined at:
To prove: div1.quot \leq maxof(short int)
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
\theta
\theta = asType < short int > ((int)2)
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\theta
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
heap_{init}.a3 == asType<short int>((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart_{-724,1}})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) /
```

 $\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart_724,1}.\mathbf{a1}))) = =$

```
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heap_{tuncstart\_724.1}.p1)) %
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1})) =>
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) ==
asType<integer>(div1.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathtt{a1}) \leq
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) = > !(0 = =
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
\label{eq:div2} \text{div2} == \text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}),
asType < int > (\$heap_{funcstart\_724.1}.a2))
(asType<int>(asType<int>($heap_{tuncstart\_724.1}.p2)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p2) = =
asType<integer>(div2.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a2) \le
asType < integer > (\$heap_{funcstart\_724.1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724.1}.p3),
asType < int > (\$heap_{funcstart\_724.1}.a3))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p3})) \ / \\
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.rem)
```

```
(asType < integer > (\$heap_{funcstart\_724,1}.p3) <
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) ==
asType<integer>(div3.rem))
(asType < integer > (\$heap_{funcstart_{-724,1}}.a3) \le
asType < integer > (\$heap_{funcstart\_724,1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
Proof:
[Take given term]
[5.0] invariant1(heapIs heap_{funcstart_{-724,1}})
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
[5.1] ((((((0 < asType < integer > ($heap_{funcstart\_724,1}.p1)) &&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) <
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p2) < 
\mathbf{asType} \small{<} \mathbf{integer} \small{>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M2}))) \ \&\& \ (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.3] (((((0 < $heap_{funcstart_{724,1}}.p1) && ($heap_{funcstart_{724,1}}.p1 < ])
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(asType<integer>($heap_funcstart_724.1.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.4] (((((0 < $heap_{funcstart_724.1}.p1) && ($heap_{funcstart_724.1}.p1 < function for the content of the 
asType < integer > (\$heap_{init}.M1))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})))\ \&\&
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
```

```
[5.5] (((((0 < $heap_{funcstart_{-724,1}}.p1) && ($heap_{funcstart_{-724,1}}.p1 < 
asType<integer>(asType<short int>((int)30269)))) && (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2})))\ \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p2) < 
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{tuncstart_{-724,1}}.M3))
\rightarrow [simplify]
[5.16] ((((-30269 < -$heap_{funcstart\_724,1}.p1) \lambda (0 < $heap_{funcstart\_724,1}.p1) \lambda
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M2})))~\&\&~(0<
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.17] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \; \land \; (0 < \$heap_{funcstart\_724,1}.p1) \; \land 
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType < integer > (\$heap_{init}.M2))) \&\& (0 <
asType < integer > ($heap_{funcstart\_724,1}.p3))) &&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < \text{$heap}_{funcstart\_724,1}.p2)) \&\& (\text{$heap}_{funcstart\_724,1}.p2 <
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.30] ((-30307 < -$heap_funcstart_724,1.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1.p2} \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\$heap_{funcstart\_724,1}.p3 < \mathbf{asType} < \mathbf{integer} > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -$heap<sub>funcstart_724,1</sub>.p2) \wedge (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1.p2} \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.\text{p3} < \text{asType} < \text{integer} > (\text{\$heap}_{init}.\text{M3}))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \wedge (-30269 <
```

```
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.p2) \land (0 < \text{Sheap}_{funcstart\_724,1}.p3)) \&\&
(\text{\$heap}_{funcstart\_724,1}.p3 < asType < integer > (asType < short)
int > ((int)30323)))
\rightarrow [simplify]
[5.40] (-30323 < -$heap<sub>funcstart_724,1.</sub>p3) \wedge (-30307 <
-\$heap_{funcstart\_724,1}.p2) \land (-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < -\$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.\text{p1}) \land (0 < \text{Sheap}_{funcstart\_724,1}.\text{p2}) \land (0 <
heap_{funcstart_{-724,1}.p3}
[Work on sub-term 4 of conjunction in term 5.40]
[8.0] 0 < $\text{heap}_{funcstart_724.1}.p1
[Take given term]
[11.0] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \ \text{$heap}_{funcstart\_724.1},
asType < int > (\$heap_{funcstart\_724.1}.p1),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
\rightarrow [simplify]
[11.1] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
\rightarrow [const static or extern object]
[11.2] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
asType < int > (\$heap_{init}.a1))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
[11.3] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType<int>(asType<short int>((int)177)))
\rightarrow [simplify]
[11.6] \text{ div1} == \text{div}(\text{heapIs } \text{$heap}_{funcstart\_724,1}, \text{$heap}_{funcstart\_724,1}.\text{p1}, 177)
[Assume known post-assertion, class invariant or type constraint for term 11.6]
[14.0] \; (\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) \; / \;
asType<integer>(177)) == asType<integer>(div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).quot
\rightarrow [simplify]
[14.2] ($heap<sub>funcstart_724,1</sub>.p1 / 177) == asType<integer>(div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).quot
→ [expand definition of operator './' in class 'int' at built in declaration]
[14.3] ([asType<integer>(heap_{funcstart\_724,1}.p1) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177), []:
asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177) ==
```

```
\mathbf{asType} {<} \mathbf{integer} {>} ( \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}, \\
177).quot)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
\textit{[14.4]} \; ([\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177) ==
asType<integer>(div(heapIs $heap_{tuncstart\_724.1}, $heap_{tuncstart\_724.1}.p1,
177).quot)
\rightarrow [simplify]
[14.7] ([0 < -$heap<sub>funcstart_724.1</sub>.p1]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177),
[!(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) < 0)]:
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1})~/~177) ==
asType<integer>(div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1,
177).quot)
\rightarrow [from term 8.0, literala < -$heap<sub>funcstart_724.1</sub>.p1 is false whenever -2 < (0
+ literala)]
    Proof of rule precondition:
    [14.7.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [14.7.2] true
[14.8] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) \; / \; 177),
[!(asType < integer > (\$heap_{funcstart\_724.1}.p1) < 0)]:
asType < integer > (\$heap_{funcstart\_724.1}.p1) / 177) = =
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).quot)
\rightarrow [simplify]
[14.11] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177), [!(0 < integer > (\$heap_{funcstart\_724,1}.p1) / 177)]
-\$heap_{funcstart\_724,1}.p1)]: asType<integer>(\$heap_{funcstart\_724,1}.p1) / 177)
== asType < integer > (div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p1, 177}.quot)
\rightarrow [from term 8.0, literala < -$heap<sub>funcstart_724,1</sub>.p1 is false whenever -2 < (0
+ literala)
    Proof of rule precondition:
    [14.11.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [14.11.2] true
```

```
[14.12] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177),
[!false]: asType<integer>(\theta_{funcstart\_724,1}.p1) / 177) ==
\mathbf{asType} \small{<} \mathbf{integer} \small{>} ( \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}, \\
177).quot)
\rightarrow [simplify]
 [14.17] \ 0 == (-\text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).quot + (\text{$heap}_{funcstart\_724,1}.p1 / 177))
[Assume known post-assertion, class invariant or type constraint for term
14.17
[21.0] div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1, 177).quot \leq
maxof(int)
\rightarrow [simplify]
\label{eq:continuous} \mbox{$[21.9]$ -32768} < -{\rm div}(\mathbf{heapIs} \ \$ {\rm heap}_{funcstart\_724,1}, \ \$ {\rm heap}_{funcstart\_724,1}.{\rm p1},
177).quot
[Take goal term]
[1.0] div1.quot \leq maxof(short int)
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177)
[1.1] div(heapIs \theta_{funcstart_724,1}, \theta_{funcstart_724,1}, \theta_{funcstart_724,1}, \theta_{funcstart_724,1}).quot
maxof(short int)
\rightarrow [simplify]
\label{eq:continuous} \mbox{[1.10] -32768} < -\mbox{div}(\mbox{\bf heapIs $\$heap}_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1,
177).quot
\rightarrow [from term 21.9, literala < -\text{div}(\text{heapIs }\$\text{heap}_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot is true whenever (-1 + literala) < -32768
    Proof of rule precondition:
    [1.10.0](-32768 + -1) < -32768
    \rightarrow [simplify]
    [1.10.2] true
[1.11] true
```

Proof of verification condition: Type constraint satisfied in implicit conversion from 'short int' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (61,40)

Condition defined at:

To prove: $minof(int) \le asType < short int > (div1.quot)$

Given:

```
heap_{init}.LIMIT == (int)80
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta = asType < short int > ((int)2)
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\rho_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
\theta sheap<sub>init</sub>.M3 == asType<short int>((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
heap_{init}.a3 == asType<short int>((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
invariant
1(heapIs heap_{funcstart_{-724,1}})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \ \operatorname{\$heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) /
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}))) = =
asType<integer>(div1.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))) = =
asType<integer>(div1.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1})) =>
(asType < integer > (\$heap_{funcstart\_724,1}.p1) = =
asType<integer>(div1.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathtt{a1}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
```

```
div2 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
(asType<integer>(asType<int>($heap_{tuncstart\_724.1}.p2)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.quot)
(\mathbf{asType} {<} \mathbf{integer} {>} (\mathbf{asType} {<} \mathbf{int} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2})) \ \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724.1}.a2)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p2) = =
asType<integer>(div2.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.a2) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
asType < int > (\$heap_{funcstart\ 724.1}.a3))
(asType<int>(asType<int>($heap_{tuncstart\_724.1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(asType<int>(asType<int>($heap_{funcstart\_724,1}.p3)) %
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathtt{a3}))) ==
asType<integer>(div3.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}) ==
asType<integer>(div3.rem))
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a3}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
Proof:
[Take given term]
[5.0] invariant1(heapIs heap_{funcstart=724.1})
```

```
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
[5.1] ((((((0 < asType < integer > ($heap_{funcstart\_724,1}.p1)) &&
(asType < integer > (\$heap_{funcstart\_724,1}.p1) <
as
Type<integer>(\rho_{funcstart\_724,1}.M1))) & (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
(asType < integer > (\$heap_{funcstart\_724.1}.p3) < 
asType<integer>($heap_funcstart_724,1.M3))
\rightarrow [simplify]
[5.3] \ (((((0 < \$heap_{funcstart\_724,1}.p1) \&\& \ (\$heap_{funcstart\_724,1}.p1 < (
as
Type<integer>(\rho_{funcstart\_724,1}.M1))) & (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 < funcstart\_724,1.M2))
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})))\ \&\&
(asType<integer>($heap_funcstart_724.1.p3) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.4] (((((0 < $heap_{funcstart_{724,1}}.p1) && ($heap_{funcstart_{724,1}}.p1 < 
asType < integer > (\$heap_{init}.M1))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < \text{heap}_{funcstart\_724,1}.p1) && (\text{heap}_{funcstart\_724,1}.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2})))\ \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p2) < 
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{tuncstart_{-724,1}}.M3))
\rightarrow [simplify]
|5.16| \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \; \land \; (0 < \$heap_{funcstart\_724,1}.p1) \; \land 
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M2})))~\&\&~(0<
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
```

```
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.17] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \; \land \; (0 < \$heap_{funcstart\_724,1}.p1) \; \land 
(0 < \text{\$heap}_{funcstart\_724,1}.\text{p2})) && (\text{\$heap}_{funcstart\_724,1}.\text{p2} <
asType < integer > ($heap_{init}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})))\ \&\&
(asType<integer>($heap_{tuncstart\_724,1}.p3) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -\$heap_{tuncstart\_724.1}.p1) \land (0 < \$heap_{tuncstart\_724.1}.p1) 
(0 < \mathrm{\$heap}_{funcstart\_724,1}.\mathrm{p2})) && (\mathrm{\$heap}_{funcstart\_724,1}.\mathrm{p2} <
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.30] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{724,1}.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.p3 < asType < integer > (\text{\$heap}_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\theta_{funcstart\_724,1}.p2) \land (0 < \theta_{funcstart\_724,1}.p3)) \&\&
(\text{\$heap}_{funcstart\_724,1}.\text{p3} < \text{asType} < \text{integer} > (\text{\$heap}_{init}.\text{M3}))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \wedge (-30269 <
 -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1.p2}) \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\$heap_{funcstart\_724,1}.p3 < \mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{short}
int > ((int)30323))
\rightarrow [simplify]
[5.40] (-30323 < -\$heap_{funcstart\_724,1.p3}) \land (-30307 <
-\$heap_{funcstart\_724,1}.p2) \wedge (-30269 < -\$heap_{funcstart\_724,1}.p1) \wedge (0 <
\text{Sheap}_{funcstart\_724,1}.\text{p1}) \land (0 < \text{Sheap}_{funcstart\_724,1}.\text{p2}) \land (0 <
heap_{funcstart_{724,1}.p3}
[Work on sub-term 4 of conjunction in term 5.40]
[8.0] 0 < \text{$heap}_{funcstart\_724,1}.p1
```

```
[Take given term]
[11.0] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
\rightarrow [simplify]
[11.1] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
\rightarrow [const static or extern object]
[11.2] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{init}.\mathrm{a1}))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
[11.3] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType<int>(asType<short int>((int)177)))
\rightarrow [simplify]
[11.6] \text{ div1} == \text{div}(\text{heapIs } \text{$heap}_{funcstart\_724,1}, \text{$heap}_{funcstart\_724,1}.\text{p1}, 177)
[Assume known post-assertion, class invariant or type constraint for term 11.6]
[14.0] (asType<integer>($heap_{tuncstart\_724.1}.p1) /
asType<integer>(177)) == asType<integer>(div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).quot
\rightarrow [simplify]
[14.2] ($heap_{funcstart\_724,1}.p1 / 177) == asType < integer > (div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).quot
→ [expand definition of operator './' in class 'int' at built in declaration]
[14.3] ([asType<integer>(heap_{funcstart\_724,1}.p1) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724.1}.p1) / 177), []:
asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177) ==
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).quot)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[14.4] ([asType<integer>($heap_{funcstart\_724,1}.p1) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177),
[!(\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177) ==
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).quot)
\rightarrow [simplify]
[14.7] ([0 < -\$heap_{funcstart\_724,1}.p1]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177),
```

```
[!(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})<0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177) ==
\mathbf{asType} \small{<} \mathbf{integer} \small{>} ( \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}, \\
177).quot)
\rightarrow [from term 8.0, literala < -$heap<sub>funcstart_724.1</sub>.p1 is false whenever -2 < (0
+ literala)]
        Proof of rule precondition:
        [14.7.0] - 2 < (0 + 0)
        \rightarrow [simplify]
        [14.7.2] true
[14.8] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177),
[!(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) < 0)]:
asType < integer > (\$heap_{funcstart\_724.1}.p1) / 177) = =
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).quot)
\rightarrow [simplify]
[14.11] \; ([{\bf false}]: \; -({\bf -asType}{<} {\bf integer}{>} (\$ {\rm heap}_{funcstart\_724,1}.{\rm p1}) \; / \; 177), \; [!(0 < {\rm parter})] \; ([{\bf false}]: \; -({\bf -asType}{<} {\bf integer}{>} (\$ {\rm heap}_{funcstart\_724,1}.{\rm p1}) \; / \; 177), \; [!(0 < {\bf -asType}{<} {\bf integer}{>} (\$ {\bf -asType}{<} {\bf
-\$heap_{funcstart\_724,1}.p1): asType<integer>(\$heap_{funcstart\_724,1}.p1) / 177)
== asType < integer > (div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177).quot
\rightarrow [from term 8.0, literala < -$heap<sub>funcstart_724,1</sub>.p1 is false whenever -2 < (0
+ literala)]
        Proof of rule precondition:
        [14.11.0] - 2 < (0 + 0)
        \rightarrow [simplify]
        [14.11.2] true
[14.12] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177),
[!false]: asType<integer>($heap<sub>funcstart_724,1.</sub>p1) / 177) ==
\mathbf{asType} \small{<} \mathbf{integer} \small{>} ( \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}, \\
177).quot)
\rightarrow [simplify]
[14.17] \ 0 == (-\text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).quot + (\text{$heap}_{funcstart\_724,1}.p1 / 177))
[Assume known post-assertion, class invariant or type constraint for term
[20.0] minof(int) \leq div(heapIs \text{heap}_{funcstart\_724,1}, \text{heap}_{funcstart\_724,1}.p1,
177).quot
\rightarrow [simplify]
```

```
177).quot
[Take goal term]
[1.0] minof(int) \leq asType<short int>(div1.quot)
\rightarrow [simplify]
\textit{[1.1] -32768} \leq \mathbf{asType} {<} \mathbf{short \ int} {>} (\mathrm{div1.quot})
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart_{724,1}},
heap_{funcstart_{-724,1}}.p1, 177)
[1.2] -32768 \leq asType<short int>(div(heapIs $heap_{funcstart\_724,1},)
heap_{funcstart_{-724,1}}.p1, 177).quot
\rightarrow [simplify]
[1.5] -32769 < div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1,
177).quot
\rightarrow [from term 20.3, literala < div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot is true whenever (-1 + literala) < -32769
   Proof of rule precondition:
   [1.5.0](-32769 + -1) < -32769
   \rightarrow [simplify]
   [1.5.2] true
[1.6] true
Proof of verification condition: Type constraint satisfied in implicit
conversion from 'short int' to 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (61,40)
Condition defined at:
To prove: asType < short int > (div1.quot) \le maxof(int)
Given:
heap_{init}.LIMIT == (int)80
\theta
\theta
heap_{init}.a1 == asType < short int > ((int)177)
\theta
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\rho_{init}.r2 == asType < short int > ((int)172)
```

[20.3] -32769 < div(heapIs \$heap_{funcstart_{-724,1}}, \$heap_{funcstart_{-724,1}}.p1,

```
\theta_{init}.a2 == asType<short int>((int)176)
\theta
\theta sheap<sub>init</sub>.M3 == asType<short int>((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
heap_{init}.b3 == asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
invariant
1<br/>( \mathbf{heapIs}\ \$ \mathbf{heap}_{funcstart\_724,1})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \ \operatorname{\$heap}_{funcstart\_724,1},
\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(asType<int>(asType<int>($heap_{tuncstart\_724.1}.p1)) /
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}))) = =
asType<integer>(div1.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) ==
asType<integer>(div1.rem))
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) /
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))) ==
asType<integer>(div2.rem)
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) <
```

```
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}) ==
asType<integer>(div2.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a2}) \leq
asType < integer > (\$heap_{funcstart\_724.1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
asType < int > (\$heap_{funcstart\_724,1}.a3))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(asType<int>(sheap<sub>funcstart_724,1.</sub>p3)) %
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))) ==
asType<integer>(div3.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.a3) \leq
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})) => !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
Proof:
[Take given term]
[5.0] invariant1(heapIs heap_{funcstart\_724,1})
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
[5.1] ((((((0 < asType < integer > ($heap_{funcstart\_724,1}.p1)) &&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M1})))~\&\&~(0<
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p2) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M2})))~\&\&~(0<
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
```

```
[5.3] (((((0 < $heap_{funcstart_{724,1}}.p1) && ($heap_{funcstart_{724,1}}.p1 < ])
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 < funcstart\_724,1)
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}))) \ \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.4] (((((0 < \text{\$heap}_{funcstart\_724,1}.p1) \&\& (\text{\$heap}_{funcstart\_724,1}.p1 <
asType<integer>(heap_{init}.M1))) && (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2})))\ \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p2) < 
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < $heap_{funcstart_{724,1}}.p1) && ($heap_{funcstart_{724,1}}.p1 < 
asType<integer>(asType<short int>((int)30269)))) && (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))~\&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 < 1)
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})))\ \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M3}))
\rightarrow [simplify]
[5.16] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1
(0 < \text{$heap_{funcstart\_724,1}.p2})) \&\& (\text{$heap_{funcstart\_724,1}.p2} <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [const static or extern object]
[5.17] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \; \land \; (0 < \$heap_{funcstart\_724,1}.p1) \; \land 
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType < integer > (\$heap_{init}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M3}))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
```

```
[5.18] ((((-30269 < -$heap<sub>funcstart_724,1.</sub>p1) \land (0 < $heap<sub>funcstart_724,1.</sub>p1) \land
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType<integer>($heap_funcstart_724,1.M3))
\rightarrow [simplify]
[5.30] ((-30307 < -$heap_{funcstart\_724,1}.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{724,1}.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.p3 < asType < integer > (\text{\$heap}_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -$heap_{funcstart\_724,1}.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{724,1}.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.\text{p3} < \mathbf{asType} < \mathbf{integer} > (\text{\$heap}_{init}.\text{M3}))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{724,1}.p3})) \&\&
($heap_funcstart_724.1.p3 < asType<integer>(asType<short
int > ((int)30323)))
\rightarrow [simplify]
[5.40] (-30323 < -$heap_{funcstart\_724,1}.p3) \land (-30307 <
-\$heap_{funcstart\_724,1}.p2) \land (-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < -\$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.\text{p1}) \land (0 < \text{Sheap}_{funcstart\_724,1}.\text{p2}) \land (0 <
heap_{funcstart\_724,1}.p3
[Work on sub-term 4 of conjunction in term 5.40]
[8.0] 0 < $heap_{funcstart_724,1}.p1
[Take given term]
[11.0] div1 == div(heapIs heap_{funcstart_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
asType < int > (\$heap_{funcstart\_724.1}.a1))
\rightarrow [simplify]
[11.1] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \operatorname{\$heap}_{funcstart\_724,1}, \operatorname{\$heap}_{funcstart\_724,1}.p1,
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
\rightarrow [const static or extern object]
[11.2] div1 == div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1},
asType < int > (\$heap_{init}.a1))
```

```
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
[11.3] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType<int>(asType<short int>((int)177)))
\rightarrow [simplify]
[11.6] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}, \ 177)
[Assume known post-assertion, class invariant or type constraint for term 11.6]
[14.0] \; (\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) \; / \\
asType<integer>(177)) == asType<integer>(div(heapIs
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, 177).quot
\rightarrow [simplify]
[14.2] ($heap_{funcstart\_724,1}.p1 / 177) == asType < integer > (div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).quot)
→ [expand definition of operator './' in class 'int' at built in declaration]
[14.3] ([asType<integer>(sheap_{funcstart\_724,1}.p1) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177), []:
asType < integer > (\$heap_{funcstart-724.1}.p1) / 177) = =
\mathbf{asType} {<} \mathbf{integer} {>} ( \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}, \\
177).quot)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
 [14.4] \; ([\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) < 0] : 
-(-asType < integer > (\$heap_{funcstart\_724.1}.p1) / 177),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 0)]:
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1})~/~177) ==
\mathbf{asType} {<} \mathbf{integer} {>} ( \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}, \\
177).quot)
\rightarrow [simplify]
[14.7] ([0 < -$heap<sub>funcstart_724,1.</sub>p1]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177) ==
asType<integer>(div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1,
177).quot)
\rightarrow [from term 8.0, literala < -$heap<sub>funcstart_724,1.</sub>p1 is false whenever -2 < (0
+ literala)]
    Proof of rule precondition:
    [14.7.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [14.7.2] true
```

```
[14.8] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) \; / \; 177),
[!(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p1) < 0)]:
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1})~/~177) ==
\mathbf{asType} < \mathbf{integer} > (\mathbf{div}(\mathbf{heapIs} \ \$ \mathbf{heap}_{funcstart\_724,1}, \ \$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}, \\
177).quot)
\rightarrow [simplify]
[14.11] \; ([{\bf false}]: \; -({\bf -asType}{<} {\bf integer}{>} (\$ {\rm heap}_{funcstart\_724,1}.{\rm p1}) \; / \; 177), \; [!(0 < 
-\$heap_{funcstart\_724,1}.p1): asType<integer>(\$heap_{funcstart\_724,1}.p1) / 177)
== asType < integer > (div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177).quot
\rightarrow [from term 8.0, literala < -$heap<sub>funcstart_724,1.</sub>p1 is false whenever -2 < (0
+ literala)]
    Proof of rule precondition:
    [14.11.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [14.11.2] true
[14.12] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177),
[!false]: asType<integer>(\theta_{tal}) (\theta_{tal}) | 177) ==
asType < integer > (div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1,
177).quot)
\rightarrow [simplify]
 [14.17] \ 0 == (-\mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
177).quot + (\text{$heap}_{funcstart\_724,1}.p1 / 177))
[Assume known post-assertion, class invariant or type constraint for term
14.17
[21.0] div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1, 177).quot \leq
maxof(int)
\rightarrow [simplify]
\label{eq:constant_724,1} \mbox{$1.9$] -32768} < -\mbox{div}(\mbox{$\mathbf{heapIs}$ \$heap}_{funcstart\_724,1}, \$heap}_{funcstart\_724,1}.p1,
177).quot
[Take goal term]
[1.0] asType<short int>(div1.quot) \leq maxof(int)
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177
[1.1] asType<short int>(div(heapIs heap_{funcstart\_724,1},
\text{$heap}_{funcstart\_724,1.p1, 177).quot} \leq \text{maxof(int)}
\rightarrow [simplify]
```

```
[1.11] -32768 < -\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).quot
\rightarrow [from term 21.9, literala < -div(heapIs $heap_{funcstart\_724,1},
$heap_{funcstart\_724,1}.p1, 177).quot is true whenever (-1 + literala) < -32768]
   Proof of rule precondition:
   [1.11.0](-32768 + -1) < -32768
   \rightarrow [simplify]
   [1.11.2] true
[1.12] true
Proof of verification condition: Type constraint satisfied in implicit
conversion from 'short int const' to 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (61,35)
Condition defined at:
To prove: minof(int) \leq \$heap_{funcstart\_724,1}.b1
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\theta_{init}.r2 == asType<short int>((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
\theta sheap<sub>init</sub>.M3 == asType<short int>((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart_{-724.1}})
```

```
div1 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}))~\%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))) = =
asType<integer>(div1.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}) <
asType < integer > (\$heap_{funcstart\_724.1}.a1)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p1) ==
asType<integer>(div1.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathtt{a1}) \leq
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1})) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\ 724.1}.a2))
(asType<int>(asType<int>($heap_{tuncstart\_724.1}.p2)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.quot)
(asType<int>(asType<int>($heap_{funcstart\_724,1}.p2)) %
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))) ==
asType<integer>(div2.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2})) =>
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) ==
asType<integer>(div2.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a2) \le
asType < integer > (\$heap_{funcstart\_724,1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
asType < int > (\$heap_{funcstart\_724,1}.a3))
(asType<integer>(asType<int>($heap_{tuncstart\_724.1}.p3)) /
```

```
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}))~\%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a3}))) = =
asType<integer>(div3.rem)
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a3) \le
asType < integer > (\$heap_{funcstart\_724,1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
Proof:
[Take goal term]
[1.0] minof(int) \leq $heap<sub>funcstart_724,1</sub>.b1
\rightarrow [simplify]
[1.1] -32768 \leq $heap<sub>funcstart_724,1</sub>.b1
\rightarrow [const static or extern object]
[1.2] -32768 \le \text{$heap}_{init}.b1
\rightarrow [expand definition of constant 'b1' at prang.c (17,20)]
[1.3] -32768 \leq asType<short int>((int)2)
\rightarrow [simplify]
[1.6] true
Proof of verification condition: Type constraint satisfied in implicit
conversion from 'short int const' to 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (61,35)
Condition defined at:
To prove: \text{$heap}_{funcstart\_724,1}.b1 \leq \max(\text{int})
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
\theta
```

```
heap_{init}.M2 == asType < short int > ((int)30307)
\theta_{init}.r2 == asType<short int>((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
heap_{init}.b2 == asType < short int > ((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
heap_{init}.a3 == asType<short int>((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\rho = asType < short int > ((int)2)
\theta = asType < short int > ((int)3)
invariant1(heapIs $heap_{tuncstart_724.1})
div1 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1})) =>
(asType < integer > (\$heap_{funcstart\_724,1}.p1) = =
asType<integer>(div1.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathtt{a1}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) /
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.quot)
```

```
(asType<integer>(asType<int>($heap_{funcstart\_724.1}.p2)) %
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}) ==
asType<integer>(div2.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a2) \le
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})) => !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
\label{eq:div3} \text{div3} == \text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}),
asType < int > (\$heap_{funcstart\_724,1}.a3))
(asType<integer>(asType<int>($heap_{tuncstart\_724.1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))) = =
asType<integer>(div3.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a3) \le
asType < integer > (\$heap_{funcstart\_724,1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
Proof:
[Take goal term]
[1.0] $heap<sub>funcstart_724,1</sub>.b1 \leq maxof(int)
\rightarrow [const static or extern object]
[1.1] $heap<sub>init</sub>.b1 \leq maxof(int)
\rightarrow [expand definition of constant 'b1' at prang.c (17,20)]
[1.2] asType<short int>((int)2) \le maxof(int)
\rightarrow [simplify]
```

[1.6] true

```
Proof of verification condition: Arithmetic result of operator '*' is within
limit of type 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (61,38)
Condition defined at:
To prove: minof(int) \le (asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724.1}.b1))
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta = asType < short int > ((int)2)
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
\theta sheap<sub>init</sub>.a2 == asType<short int>((int)176)
\theta = asType < short int > ((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType<short int>((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart_{724,1}})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ / \\
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
```

```
(asType < integer > (\$heap_{funcstart\_724,1}.p1) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) = =
asType<integer>(div1.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a1) \le
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType < integer > (div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p2})) \ / \\
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.quot)
(asType<int>(asType<int>($heap_{funcstart\_724,1}.p2)) %
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType < integer > (div2.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p2) = =
asType<integer>(div2.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a2) \le
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})) => !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart_{-724.1}},
asType < int > (\$heap_{funcstart\_724,1}.p3),
asType < int > (\$heap_{funcstart\_724,1}.a3))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p3})) \ / \\
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}))~\%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a3}))) = =
asType<integer>(div3.rem)
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}) ==
asType<integer>(div3.rem))
```

```
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.a3) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
Proof:
[Take given term]
[5.0] invariant1(heapIs heap_{funcstart\_724,1})
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
[5.1] ((((((0 < asType < integer > (heap_{funcstart_{-724,1}}.p1)) &&
(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 
as
Type<integer>(\rho_{funcstart\_724,1}.M1))) & (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(asType<integer>($heap_funcstart_724.1.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
asType<integer>(sheap_{funcstart_{-724,1}}.M1))) && (0 <
asType < integer > (\$heap_{funcstart_{-724,1}}.p2))) \&\&
(asType<integer>($heap_funcstart_724,1.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 < function 0)
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.4] (((((0 < $heap_{funcstart_{724,1}}.p1) && ($heap_{funcstart_{724,1}}.p1 < ]
asType < integer > (\$heap_{init}.M1))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(asType<integer>($heap_funcstart_724,1.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}))) \ \&\& \\
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < \text{\$heap}_{funcstart\_724,1}.p1) \&\& (\text{\$heap}_{funcstart\_724,1}.p1 <
\mathbf{asType} \small{<} \mathbf{integer} \small{>} (\mathbf{asType} \small{<} \mathbf{short} \ \mathbf{int} \small{>} ((\mathbf{int})30269)))) \ \&\& \ (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p2) <
```

```
asType<integer>(heap_{funcstart\_724,1}.M2))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.16] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p3) < 
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M3}))
\rightarrow [const static or extern object]
[5.17] ((((-30269 < -$heap_{funcstart\_724,1}.p1) \lambda (0 < $heap_{funcstart\_724,1}.p1) \lambda
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType < integer > (\$heap_{init}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M3}))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < \text{$heap}_{funcstart\_724,1}.p2)) \&\& (\text{$heap}_{funcstart\_724,1}.p2 <
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.30] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\$heap_{funcstart\_724,1}.p2) \land (0 < \$heap_{funcstart\_724,1}.p3)) \&\&
(\text{\$heap}_{funcstart\_724,1}.p3 < asType < integer > (\text{\$heap}_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -$heap_funcstart_724,1.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1.p2} \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.\text{p3} < \text{asType} < \text{integer} > (\text{\$heap}_{init}.\text{M3}))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \wedge (-30269 <
 -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.p2) \land (0 < \text{Sheap}_{funcstart\_724,1}.p3)) \&\&
(\text{sheap}_{funcstart\_724,1}.\text{p3} < \text{asType} < \text{integer} > (\text{asType} < \text{short})
int > ((int)30323)))
```

```
\rightarrow [simplify]
[5.40] (-30323 < -\text{$heap}_{funcstart\_724,1}.p3) \land (-30307 < -\text{$partstart}_{funcstart}]
-\$heap_{funcstart\_724,1}.p2) \wedge (-30269 < -\$heap_{funcstart\_724,1}.p1) \wedge (0 <
\text{Sheap}_{funcstart\_724,1}.\text{p1}) \land (0 < \text{Sheap}_{funcstart\_724,1}.\text{p2}) \land (0 <
heap_{funcstart_{-724,1}.p3}
[Work on sub-term 4 of conjunction in term 5.40]
\textit{[8.0]} \ 0 < \$ heap_{funcstart\_724,1}.p1
[Take given term]
[11.0] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
\rightarrow [simplify]
[11.1]~{\rm div1} == {\rm div}(\mathbf{heapIs}~\$ \mathrm{heap}_{funcstart\_724,1},\,\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType < int > (\$heap_{funcstart\_724,1}.a1))
\rightarrow [const static or extern object]
[11.2] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType < int > ($heap_{init}.a1))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
\textit{[11.3]} \ \text{div1} == \text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
asType<int>(asType<short int>((int)177)))
\rightarrow [simplify]
[11.6] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}, \ 177)
[Take goal term]
[1.0] minof(int) \le (asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724,1}.b1))
\rightarrow [simplify]
[1.1] -32768 \leq (asType\leqint>(asType\leqshort int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724,1}.b1))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177
[1.2] -32768 \leq (asType<int>(asType<short int>(div(heapIs
\text{Sheap}_{funcstart_{-724,1}}, \text{Sheap}_{funcstart_{-724,1}}, p_1, 177).quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))
\rightarrow [simplify]
[1.4] - 32768 \leq (\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1},
177).quot * asType < int > (\$heap_{funcstart\_724,1}.b1))
```

```
\rightarrow [const static or extern object]
[1.5] - 32768 \le (\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1},
177).quot * asType < int > (\$heap_{init}.b1))
\rightarrow [expand definition of constant 'b1' at prang.c (17,20)]
[1.6] -32768 \le (\text{div}(\text{heapIs } \text{$heap}_{funcstart\_724,1}, \text{$heap}_{funcstart\_724,1}.\text{p1},
177).quot * asType<int>(asType<short int>((int)2)))
[1.11] -32769 < (2 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1,
177).quot)
\rightarrow [literal comparison of product]
[1.12] ([2 < 0]: (-32769 / -2) < -\text{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1},
\rho_{funcstart_{-724,1},p1, 177}, quot, [0 < 2]: (-32769 / 2) < \text{div}(\mathbf{heapIs})
\$ heap_{funcstart\_724,1}, \, \$ heap_{funcstart\_724,1}.p1, \, 177).quot, \, [0 == 2]: \, -32769 < 0)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[1.13] ([2 < 0]: (-32769 / -2) < -\text{div}(\text{heapIs } \text{$heap}_{funcstart\_724,1},
\theta_{1} = \frac{1}{12} \left( \frac{1}{12} - 
div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).quot, [(0 == 2)]
\land !(0 < 2) \land !(2 < 0)]: -32769 < 0
\rightarrow [simplify]
[1.21] \ -16385 < {\rm div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
177).quot
\rightarrow [negate goal and search for contradiction]
[1.22]!(-16385 < \text{div}(\text{heapIs } \text{$heap}_{funcstart\_724,1}, \text{$heap}_{funcstart\_724,1}.\text{p1},
177).quot)
\rightarrow [simplify]
[1.24] 16384 < -\text{div}(\text{heapIs } \text{\$heap}_{funcstart\_724,1}, \text{\$heap}_{funcstart\_724,1}.\text{p1},
177).quot
[Assume known post-assertion, class invariant or type constraint for term 11.6]
[14.0] \; (\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) \; / \;
asType < integer > (177)) == asType < integer > (div(heapIs))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).quot)
\rightarrow [simplify]
[14.2] ($heap<sub>funcstart_724,1.</sub>p1 / 177) == asType<integer>(div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).quot
→ [expand definition of operator './' in class 'int' at built in declaration]
[14.3] ([asType<integer>(sheap_{funcstart\_724,1}.p1) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177), []:
```

```
asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177) ==
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).quot)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[14.4] ([asType<integer>(heap_{funcstart\_724,1}.p1) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177) ==
\mathbf{asType} {<} \mathbf{integer} {>} ( \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}. \mathrm{p1}, \\
177).quot)
\rightarrow [simplify]
[14.7] ([0 < -$heap<sub>funcstart_724,1.</sub>p1]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177),
[!(\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177) ==
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).quot)
\rightarrow [from term 8.0, literala < -$heap<sub>funcstart_724.1</sub>.p1 is false whenever -2 < (0
+ literala)]
    Proof of rule precondition:
    [14.7.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [14.7.2] true
[14.8] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177) ==
\mathbf{asType} < \mathbf{integer} > (\mathbf{div}(\mathbf{heapIs} \ \$ \mathbf{heap}_{funcstart\_724,1}, \ \$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}, \\
177).quot)
\rightarrow [simplify]
[14.11] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177), [!(0 <
-\$heap_{funcstart\_724,1}.p1)]: \ \mathbf{asType} < \mathbf{integer} > (\$heap_{funcstart\_724,1}.p1) \ / \ 177)
== asType < integer > (div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177).quot
\rightarrow [from term 8.0, literala < -$heap<sub>funcstart_724,1</sub>.p1 is false whenever -2 < (0
+ literala)
    Proof of rule precondition:
    [14.11.0] - 2 < (0 + 0)
    \rightarrow [simplify]
```

```
[14.11.2] true
[14.12] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177),
[!false]: asType<integer>($heap<sub>funcstart_724,1.</sub>p1) / 177) ==
\mathbf{asType} < \mathbf{integer} > (\mathbf{div}(\mathbf{heapIs} \ \$ \mathbf{heap}_{funcstart\_724,1}, \ \$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}, \\
177).quot)
\rightarrow [simplify]
[14.17] \ 0 == (-\text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).quot + (\text{$heap}_{funcstart\_724,1}.p1 / 177))
[Create new term from terms 1.24, 14.17 using rule: transitivity 15]
\textit{[67.0]} \; (0 + 16384) < -(\$ heap_{funcstart\_724,1}.p1 \; / \; 177)
\rightarrow [simplify]
[67.7]~2899968 < -\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}
\rightarrow [from term 8.0, literala < -$heap<sub>funcstart_724,1</sub>.p1 is false whenever -2 < (0
+ literala)]
   Proof of rule precondition:
   [67.7.0] - 2 < (0 + 2899968)
   \rightarrow [simplify]
   [67.7.2] true
[67.8] false
Proof of verification condition: Arithmetic result of operator '*' is within
limit of type 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (61,38)
Condition defined at:
To prove: (asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724,1}.b1)) \le maxof(int)
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta
heap_{init}.M2 == asType < short int > ((int)30307)
\rho_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
```

```
\theta sheap<sub>init</sub>.b2 == asType<short int>((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
heap_{init}.b3 == asType < short int > ((int)63)
\theta
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart\_724,1})
div1 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(\mathbf{asType} {<} \mathbf{integer} {>} (\mathbf{asType} {<} \mathbf{int} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ / \\
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))) = =
asType<integer>(div1.quot)
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(asType < integer > ($heap_{funcstart\_724,1}.p1) < 
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) ==
asType<integer>(div1.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathtt{a1}) \leq
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1})) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p2})) \ / \\
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))) ==
asType<integer>(div2.quot)
(asType < integer > (asType < int > (\$heap_{tuncstart\_724.1}.p2)) \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
```

```
(asType < integer > (\$heap_{funcstart_{-724,1}}.p2) = =
asType<integer>(div2.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a2}) \leq
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})) => !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
(asType<int>(asType<int>($heap_{tuncstart\_724.1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart_{-724,1}}.a3))) = =
asType<integer>(div3.quot)
(\mathbf{asType} {<} \mathbf{integer} {>} (\mathbf{asType} {<} \mathbf{int} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3})) \ \%
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a3}))) = =
asType<integer>(div3.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3})) =>
(asType < integer > ($heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a3) \le
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})) => !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
Proof:
[Take given term]
[5.0] invariant1(heapIs heap_{funcstart\_724,1})
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
[5.1] ((((((0 < asType < integer > ($heap_{funcstart\_724,1}.p1)) &&
(asType < integer > ($heap_{funcstart\_724,1}.p1) < 
\mathbf{asType} \small{<} \mathbf{integer} \small{>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M1}))) \ \&\& \ (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p2) < 
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
```

```
[5.3] (((((0 < $heap_{funcstart_{724,1}}.p1) && ($heap_{funcstart_{724,1}}.p1 < ])
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 < funcstart\_724,1)
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}))) \ \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.4] (((((0 < \text{\$heap}_{funcstart\_724,1}.p1) \&\& (\text{\$heap}_{funcstart\_724,1}.p1 <
asType<integer>(heap_{init}.M1))) && (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2})))\ \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p2) < 
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < $heap_{funcstart_{724,1}}.p1) && ($heap_{funcstart_{724,1}}.p1 < 
asType<integer>(asType<short int>((int)30269)))) && (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))~\&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 < 1)
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})))\ \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M3}))
\rightarrow [simplify]
[5.16] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [const static or extern object]
[5.17] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \; \land \; (0 < \$heap_{funcstart\_724,1}.p1) \; \land 
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType < integer > (\$heap_{init}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M3}))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
```

```
[5.18] ((((-30269 < -$heap<sub>funcstart_724,1.</sub>p1) \land (0 < $heap<sub>funcstart_724,1.</sub>p1) \land
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType<integer>($heap_funcstart_724,1.M3))
\rightarrow [simplify]
[5.30] ((-30307 < -$heap_funcstart_724,1.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{724,1}.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.p3 < asType < integer > (\text{\$heap}_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -$heap_{funcstart\_724,1}.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.\text{p2}) \wedge (0 < \text{Sheap}_{funcstart\_724,1}.\text{p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.\text{p3} < \mathbf{asType} < \mathbf{integer} > (\text{\$heap}_{init}.\text{M3}))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{724,1}.p3})) \&\&
($heap_funcstart_724.1.p3 < asType<integer>(asType<short
int > ((int)30323)))
\rightarrow [simplify]
[5.40] (-30323 < -$heap_{funcstart\_724,1}.p3) \land (-30307 <
-\$heap_{funcstart\_724,1}.p2) \land (-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < -\$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.\text{p1}) \land (0 < \text{Sheap}_{funcstart\_724,1}.\text{p2}) \land (0 <
heap_{funcstart\_724,1}.p3
[Work on sub-term 3 of conjunction in term 5.40]
[7.0] -30269 < -\$heap_{funcstart\_724,1}.p1
[Work on sub-term 4 of conjunction in term 5.40]
\textit{[8.0]} \ 0 < \$ heap_{funcstart\_724,1}.p1
[Take given term]
[11.0] div1 == div(heapIs heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
asType < int > (\$heap_{funcstart\_724.1}.a1))
\rightarrow [simplify]
[11.1] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType < int > (\$heap_{funcstart\_724.1}.a1))
```

```
\rightarrow [const static or extern object]
[11.2] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
asType < int > (\$heap_{init}.a1))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
\textit{[11.3]} \ \text{div1} == \text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
asType<int>(asType<short int>((int)177)))
\rightarrow [simplify]
[11.6] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, 177)
[Take goal term]
[1.0] (asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724,1}.b1)) \le maxof(int)
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177
[1.1] (asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},))
\theta_{funcstart_{724,1},p1,177,quot} ** asType<int>($\text{heap}_{funcstart_{724,1},b1}$)
\leq \max of(int)
\rightarrow [simplify]
[1.3] (div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1, 177).quot *
asType < int > (\$heap_{funcstart\_724,1}.b1)) \le maxof(int)
\rightarrow [const static or extern object]
[1.4] (div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1, 177).quot *
asType < int > (\$heap_{init}.b1)) \le maxof(int)
\rightarrow [expand definition of constant 'b1' at prang.c (17,20)]
[1.5] (div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1, 177).quot *
asType < int > (asType < short int > ((int)2))) \le maxof(int)
 \label{eq:continuous} \mbox{[1.18] -32768} < \mbox{(-2 * div($\mathbf{heapIs}$ $\mathbb{sheap}_{funcstart\_724,1}, $\mathbb{sheap}_{funcstart\_724,1}.p1, } 
177).quot)
\rightarrow [literal comparison of product]
[1.19] ([-2 < 0]: (-32768 / 2) < -\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1},
\rho_{tuncstart_{-724,1},p1,177}, quot, [0 < -2]: (-32768 / -2) < \text{div}(\rho_{tuncstart_{-724,1},p1})
\$ heap_{funcstart\_724,1}, \$ heap_{funcstart\_724,1}.p1, 177).quot, [-2 == 0]: -32768 < 0)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[1.20] ([-2 < 0]: (-32768 / 2) < -\text{div}(\text{heapIs } \text{$heap}_{tuncstart 724.1},
\text{Sheap}_{funcstart\_724,1.p1}, 177).\text{quot}, [(0 < -2) \land !(-2 < 0)]: (-32768 / -2) < 0
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}, \ [(-2 == 0)]
\land !(-2 < 0) \land !(0 < -2)]: -32768 < 0)
```

```
\rightarrow [simplify]
[1.24] -16384 < -\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).quot
\rightarrow [negate goal and search for contradiction]
[1.25]!(-16384 < -\text{div}(\text{heapIs }\text{\$heap}_{funcstart\_724,1}, \text{\$heap}_{funcstart\_724,1}.p1,
177).quot)
\rightarrow [simplify]
[1.28] 16383 < \text{div}(\text{heapIs } \text{$heap}_{funcstart\_724,1}, \text{$heap}_{funcstart\_724,1}.\text{p1},
177).quot
[Assume known post-assertion, class invariant or type constraint for term 11.6]
[14.0] (asType<integer>($heap<sub>funcstart_724,1.</sub>p1) /
asType<integer>(177)) == asType<integer>(div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).quot
\rightarrow [simplify]
[14.2] ($heap<sub>funcstart_724,1.</sub>p1 / 177) == asType<integer>(div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).quot
→ [expand definition of operator './' in class 'int' at built in declaration]
[14.3] ([asType<integer>(heap_{funcstart\_724,1}.p1) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177), []:
asType < integer > ($heap_{funcstart\_724,1}.p1) / 177) ==
asType<integer>(div(heapIs $heap_{tuncstart_724.1}, $heap_{tuncstart_724.1.p1},
177).quot)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
\textit{[14.4]} \; ([\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177) ==
asType<integer>(div(heapIs p_{funcstart\_724,1}, p_{funcstart\_724,1}),
177).quot)
\rightarrow [simplify]
[14.7] ([0 < -\$heap_{funcstart\_724,1}.p1]:
-(-asType < integer > (\$heap_{funcstart\_724.1}.p1) / 177),
[!(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p1) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177) ==
\mathbf{asType} \small{<} \mathbf{integer} \small{>} ( \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}, \\
177).quot)
\rightarrow [from term 8.0, literala < -$heap<sub>funcstart_724.1</sub>.p1 is false whenever -2 < (0
+ literala)]
```

```
Proof of rule precondition: [14.7.0] -2 < (0+0)
```

$$\rightarrow$$
 [simplify]

[14.7.2] **true**

```
[14.8] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177), [!(asType < integer > (\$heap_{funcstart\_724,1}.p1) / 0)]: asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177) ==
```

asType<integer>(div(heapIs $heap_{funcstart_724,1.p1})$) 177) == asType<integer>(div(heapIs $heap_{funcstart_724,1.p1}$, $heap_{funcstart_724,1.p1}$, 177).quot)

 \rightarrow [simplify]

$$\begin{array}{l} [14.11] \; ([{\bf false}]: \; -(-{\bf asType} < {\bf integer} > (\${\bf heap}_{funcstart_724,1}.{\bf p1}) \; / \; 177), \; [!(0 < -\${\bf heap}_{funcstart_724,1}.{\bf p1})]: \; {\bf asType} < {\bf integer} > (\${\bf heap}_{funcstart_724,1}.{\bf p1}) \; / \; 177) \\ == {\bf asType} < {\bf integer} > ({\bf div}({\bf heapIs} \; \${\bf heap}_{funcstart_724,1}, \${\bf heap}_{funcstart_724,1}.{\bf p1}, \; 177).{\bf quot}) \\ \end{array}$$

 \rightarrow [from term 8.0, literala < -\$heap_{funcstart_724,1}.p1 is false whenever -2 < (0 + literala)]

Proof of rule precondition:

$$[14.11.0] - 2 < (0 + 0)$$

 \rightarrow [simplify]

[14.11.2] **true**

$$[14.12] \; ([\mathbf{false}] \colon -(-\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart_724,1}.\mathrm{p1}) \; / \; 177),$$

[!false]: asType<integer>(\$heap_{funcstart_724,1.}p1) / 177) ==

asType<integer>(div(heapIs $heap_{funcstart_724,1}$, $heap_{funcstart_724,1}$.p1, 177).quot)

 \rightarrow [simplify]

[14.17] 0 == (-div(heapIs
$$heap_{funcstart_724,1}$$
, $heap_{funcstart_724,1}$.p1, 177).quot + ($heap_{funcstart_724,1}$.p1 / 177))

[Create new term from terms 1.28, 14.17 using rule: transitivity 16]

$$[67.0] (0 + 16383) < (\text{$heap}_{funcstart_724,1}.p1 / 177)$$

 \rightarrow [simplify]

[67.8] 2899967 < \$heap_{tuncstart_{-724,1}}.p1

 \rightarrow [from term 7.0, literala < \$heap_{funcstart_724,1}.p1 is false whenever -2 < (-30269 + literala)]

Proof of rule precondition:

$$[67.8.0] - 2 < (-30269 + 2899967)$$

 $\rightarrow [simplify]$

```
[67.9] false
Proof of verification condition: Type constraint satisfied in implicit
conversion from 'int' to 'short int'
Condition generated at: C:\Escher\Customers\prang\prang.c (61,33)
Condition defined at:
To prove: minof(short\ int) \le ((asType < int > (asType < short\ int))
int>(div1.rem) * asType<int>($heap_{funcstart\_724,1}.r1)) -
(asType<int>(asType<short int>(div1.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1})))
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
\theta
\theta
\theta
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\rho_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta sheap<sub>init</sub>.b2 == asType<short int>((int)35)
\theta = asType < short int > ((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
heap_{init}.b3 == asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
heap_{init}.p3 == asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart\_724,1})
div1 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
```

[67.8.2] true

```
(asType < int > (asType < int > (\$heap_{funcstart\_724,1}.p1)) \%
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}))) = =
asType<integer>(div1.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(asType < integer > (\$heap_{funcstart\_724.1}.p1) = =
asType<integer>(div1.rem))
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}),
asType < int > (\$heap_{funcstart\_724,1}.a2))
(asType<integer>(asType<int>($heap_{tuncstart\_724.1}.p2)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.quot)
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{sheap}_{funcstart\_724,1}.\mathbf{p2}))~\%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))) ==
asType<integer>(div2.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p2) = =
asType<integer>(div2.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a2) \le
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})) => !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
asType < int > (\$heap_{funcstart\_724,1}.a3))
(\mathbf{asType} {<} \mathbf{integer} {>} (\mathbf{asType} {<} \mathbf{int} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3})) \ / \\
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(\mathbf{asType} < \mathbf{int} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3})) \ \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
```

```
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) ==
asType<integer>(div3.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a3}) \leq
asType < integer > (\$heap_{funcstart\_724.1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
Proof:
[Take given term]
[5.0] invariant1(heapIs $heap_{funcstart_724,1})
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
 \texttt{[5.1]} \; (((((0 < \mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p1)) \; \&\& \\
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) <
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})))\ \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [simplify]
[5.3] (((((0 < $heap_{funcstart_{724,1}}.p1) && ($heap_{funcstart_{724,1}}.p1 < ]
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2})))\ \&\&
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) <
asType < integer > (\$heap_{funcstart_{-724,1}}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})))\ \&\&
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.4] \ (((((0 < \$heap_{funcstart\_724,1}.p1) \&\& \ (\$heap_{funcstart\_724,1}.p1 < 
asType < integer > (\$heap_{init}.M1))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) <
as
Type<integer>(\rho_{funcstart\_724,1}.M2))) & (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType<integer>($heap_{tuncstart\_724.1}.p3) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M3}))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
```

```
[5.5] (((((0 < $heap_{funcstart_{724,1}}.p1) && ($heap_{funcstart_{724,1}}.p1 < 
asType<integer>(asType<short int>((int)30269)))) && (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2})))\ \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p2) < 
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{tuncstart_{-724,1}}.M3))
\rightarrow [simplify]
[5.16] ((((-30269 < -$heap_{funcstart\_724,1}.p1) \lambda (0 < $heap_{funcstart\_724,1}.p1) \lambda
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
\mathbf{asType} \small{<} \mathbf{integer} \small{>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M2}))) \ \&\& \ (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.17] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \; \land \; (0 < \$heap_{funcstart\_724,1}.p1) \; \land 
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType < integer > (\$heap_{init}.M2))) \&\& (0 <
asType < integer > ($heap_{funcstart\_724,1}.p3))) &&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < \text{$heap}_{funcstart\_724,1}.p2)) \&\& (\text{$heap}_{funcstart\_724,1}.p2 <
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.30] ((-30307 < -$heap_funcstart_724,1.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1.p2} \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\$heap_{funcstart\_724,1}.p3 < \mathbf{asType} < \mathbf{integer} > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -$heap<sub>funcstart_724,1</sub>.p2) \wedge (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1.p2} \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.\text{p3} < \text{asType} < \text{integer} > (\text{\$heap}_{init}.\text{M3}))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \wedge (-30269 <
```

```
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.p2) \land (0 < \text{Sheap}_{funcstart\_724,1}.p3)) \&\&
(\$heap_{funcstart\_724,1}.p3 < \mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{short}
int > ((int)30323)))
\rightarrow [simplify]
[5.40] (-30323 < -$heap<sub>funcstart_724,1.</sub>p3) \wedge (-30307 <
-\$heap_{funcstart\_724,1}.p2) \land (-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < -\$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.\text{p1}) \land (0 < \text{Sheap}_{funcstart\_724,1}.\text{p2}) \land (0 <
heap_{funcstart_{-724,1}.p3}
[Work on sub-term 3 of conjunction in term 5.40]
[7.0] -30269 < -\$heap_{funcstart\_724.1}.p1
[Work on sub-term 4 of conjunction in term 5.40]
[8.0] 0 < $heap_{funcstart_724,1}.p1
[Take given term]
[11.0] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1},
\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}),
asType < int > (\$heap_{funcstart\_724,1}.a1))
\rightarrow [simplify]
[11.1] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType < int > (\$heap_{funcstart\_724,1}.a1))
\rightarrow [const static or extern object]
[11.2] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType < int > (\$heap_{init}.a1))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
[11.3] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType<int>(asType<short int>((int)177)))
\rightarrow [simplify]
[11.6] \text{ div1} == \text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177)
[Take goal term]
[1.0] minof(short int) \le ((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{tuncstart\_724.1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1)))
\rightarrow [simplify]
[1.1] -32768 \leq ((asType\leqint>(asType\leqshort int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType < int>($heap_{funcstart\_724,1}.b1)))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart_{724,1}},
```

```
heap_{funcstart_{-724,1}}.p1, 177)
[1.2] -32768 \leq ((asType<int>(asType<short int>(div(heapIs))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724.1}.b1)))
\rightarrow [simplify]
 [1.4] - 32768 \leq ((\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{pl}, \\
177).rem * asType < int > (\$heap_{funcstart\_724,1}.r1)) -
(asType<int>(asType<short int>(div1.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1})))
\rightarrow [const static or extern object]
 [1.5] -32768 \leq ((\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, \\
177).rem * asType < int > (\$heap_{init}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1}.\mathbf{quot})) \ * \ \mathbf{asType}{<} \mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1})))
\rightarrow [expand definition of constant 'r1' at prang.c (15,20)]
[1.6] -32768 \leq ((div(heapIs $heap_{funcstart\_724.1}, $heap_{funcstart\_724.1}.p1,
177).rem * asType<int>(asType<short int>((int)171))) -
(asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724,1}.b1)))
\rightarrow [simplify]
[1.9] -32768 \leq ((\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1},
177).rem * 171) - (asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724,1}.b1)))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p1, 177}
[1.10] -32768 \leq ((171 * div(heapIs $heap_{funcstart\_724,1},
\theta_{funcstart\_724,1.p1, 177}.rem - (asType < int > (asType < short)
int>(div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).quot)) *
asType < int > (\$heap_{funcstart\_724,1}.b1)))
\rightarrow [simplify]
[1.12] -32768 \leq ((171 * div(heapIs $heap_{funcstart\_724,1},
\rho_{funcstart\_724,1.p1, 177}.rem – (div(heapIs \rho_{funcstart\_724,1, p1, 177}.rem)
\theta_{funcstart\_724,1}.p1, 177).quot * asType < int > (\theta_{funcstart\_724,1}.b1))
\rightarrow [const static or extern object]
[1.13] -32768 \leq ((171 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}) - (div(heapIs \text{Sheap}_{funcstart\_724,1},
\theta_{funcstart\_724,1.pl}, 177).quot * asType < int > (\theta_{init}.bl))
\rightarrow [expand definition of constant 'b1' at prang.c (17,20)]
```

```
\textit{[1.14] -32768} \leq ((171 * \text{div}(\textbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).rem) – (div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).quot * asType<int>(asType<short int>((int)2))))
\rightarrow [simplify]
[1.21] -32769 < ((-2 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1,
177).quot) + (171 * div(heapIs heapIs = f_{uncstart-724,1}, heap_{funcstart-724,1}.p1,
177).rem))
\rightarrow [negate goal and search for contradiction]
[1.22]!(-32769 < ((-2 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724.1.p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724.1},
heap_{funcstart_{-724,1}.p1, 177).rem}
\rightarrow [simplify]
[1.27] 32768 < ((2 * div(\mathbf{heapIs} \$heap_{funcstart\_724.1}, \$heap_{funcstart\_724.1}, p1,
177).quot) + (-171 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).rem))
[Assume known post-assertion, class invariant or type constraint for term 11.6]
[14.0] (asType<integer>(heap_{funcstart\_724,1}.p1) /
asType<integer>(177)) == asType<integer>(div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).quot)
\rightarrow [simplify]
[14.2] ($heap<sub>funcstart_724,1.</sub>p1 / 177) == asType<integer>(div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).quot
→ [expand definition of operator './' in class 'int' at built in declaration]
[14.3] ([asType<integer>(peqtention = 14.3] ([asType<integer)(peqtention = 14.3]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177), []:
asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177) = =
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).quot)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[14.4] ([asType<integer>(heap_{funcstart_{-724,1}}.p1) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177) ==
asType<integer>(div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1,
177).quot)
\rightarrow [simplify]
[14.7] ([0 < -$heap<sub>funcstart_724,1</sub>.p1]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177),
[!(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) < 0)]:
```

```
asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177) ==
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).quot)
\rightarrow [from term 8.0, literala < -$heap<sub>funcstart_724,1.</sub>p1 is false whenever -2 < (0
+ literala)]
        Proof of rule precondition:
        [14.7.0] - 2 < (0 + 0)
        \rightarrow [simplify]
        [14.7.2] true
[14.8] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 0)]:
\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) \ / \ 177) = =
\mathbf{asType} < \mathbf{integer} > (\mathbf{div}(\mathbf{heapIs} \ \$ \mathbf{heap}_{funcstart\_724,1}, \ \$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}, \\
177).quot)
\rightarrow [simplify]
[14.11] \; ([{\bf false}]: \; -({\bf -asType}{<} {\bf integer}{>} (\$ {\rm heap}_{funcstart\_724,1}.{\rm p1}) \; / \; 177), \; [!(0 < {\rm parter})] \; ([{\bf false}]: \; -({\bf -asType}{<} {\bf integer}{>} (\$ {\rm heap}_{funcstart\_724,1}.{\rm p1}) \; / \; 177), \; [!(0 < {\bf -asType}{<} {\bf integer}{>} (\$ {\bf -asType}{<} {\bf
-\$heap_{funcstart\_724,1}.p1)]: \ \mathbf{asType} < \mathbf{integer} > (\$heap_{funcstart\_724,1}.p1) \ / \ 177)
== asType < integer > (div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot
\rightarrow [from term 8.0, literala < -$heap<sub>funcstart_724,1</sub>.p1 is false whenever -2 < (0
+ literala)
        Proof of rule precondition:
        [14.11.0] - 2 < (0 + 0)
        \rightarrow [simplify]
        [14.11.2] true
[14.12] ([\mathbf{false}]: -(-\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) \ / \ 177),
[!false]: asType<integer>($heap<sub>funcstart_724,1.</sub>p1) / 177) ==
\mathbf{asType} {<} \mathbf{integer} {>} ( \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}, \\
177).quot)
\rightarrow [simplify]
[14.17] \ 0 == (-\text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).quot + (\text{$heap}_{funcstart\_724,1}.p1 / 177))
[Assume known post-assertion, class invariant or type constraint for term 11.6]
[15.0] (asType<integer>(heap_{funcstart\_724,1}.p1) %
asType<integer>(177)) == asType<integer>(div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}
\rightarrow [simplify]
```

```
[15.2] (\text{sheap}_{tuncstart-724.1}.p1 % 177) == asType<integer>(div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}
→ [expand definition of operator '.%' in class 'int' at built in declaration]
[15.3] ([asType<integer>(sheap_{funcstart\_724,1}.p1) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177), []:
asType < integer > (\$heap_{funcstart\_724.1}.p1) \% 177) ==
asType<integer>(div(heapIs $heap_{tuncstart\_724,1}, $heap_{tuncstart\_724,1}.p1,
177).rem)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[15.4] ([asType<integer>($heap_{funcstart\_724,1}.p1) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724.1}.p1) \% 177),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177) ==
asType<integer>(div(heapIs p_{funcstart\_724,1}, p_{funcstart\_724,1}),
177).\text{rem}
\rightarrow [simplify]
[15.7] ([0 < -$heap<sub>funcstart_724,1.</sub>p1]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 0)]:
asType<integer>($heap_{funcstart\_724,1}.p1) \% 177) ==
asType<integer>(div(heapIs p_{funcstart\_724,1}, p_{funcstart\_724,1}),
177).rem)
\rightarrow [from term 8.0, literala < -$heap<sub>funcstart_724,1</sub>.p1 is false whenever -2 < (0
+ literala)]
   Proof of rule precondition:
   [15.7.0] - 2 < (0 + 0)
   \rightarrow [simplify]
   [15.7.2] true
[15.8] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177),
[!(asType < integer > (\$heap_{funcstart\_724.1}.p1) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177) ==
asType<integer>(div(heapIs $heap_{funcstart_724,1}, $heap_{funcstart_724,1}.p1,
177).rem)
\rightarrow [simplify]
[15.11] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177), [!(0
< -$heap<sub>funcstart_724.1</sub>.p1)]: asType<integer>($heap<sub>funcstart_724.1</sub>.p1) %
177) == asType<integer>(div(heapIs heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p1, 177}.rem
\rightarrow [from term 8.0, literala < -$heap<sub>funcstart_724,1</sub>.p1 is false whenever -2 < (0
```

```
+ literala)]
    Proof of rule precondition:
    [15.11.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [15.11.2] true
[15.12] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177),
[!false]: asType<integer>(sheap_{funcstart_724,1}.p1) \% 177 ==
asType<integer>(div(heapIs $heap_{tuncstart\_724.1}, $heap_{tuncstart\_724.1}.p1,
177).rem)
\rightarrow [simplify]
[15.17] \ 0 == (-\text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).rem + (\text{$heap}_{funcstart\_724,1}.p1 \% 177))
[Copy term 1.27]
[77.0] 32768 < ((-171 * div(heapIs heap_{funcstart_{-724,1}},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177).quot)
\rightarrow [from\ term\ 15.17,\ div(\textbf{heapIs}\ \$heap_{funcstart\_724,1},\ \$heap_{funcstart\_724,1}.p1,
177).rem is equal to heap_{funcstart\_724,1}.p1 \% 177
[77.1] 32768 < ((-171 * (\$heap_{funcstart\_724,1}.p1 \% 177)) + (2 * div(heapIs))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).quot)
[Create new term from term 14.17 using rule: condition for equality of division]
[81.0] ((177 * (0 + -(-\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}))) < (1 + \text{Sheap}_{funcstart\_724,1}.\text{p1})) \land
(\text{\$heap}_{funcstart\_724,1}.\text{p1} < (177 * (0 + 1 + -(-\text{div}(\text{heapIs}))))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1, 177).quot))))
\rightarrow [simplify]
[81.15] \; (-1 < ((-177 * \mathrm{div}(\mathbf{heapIs} \; \$ \mathrm{heap}_{funcstart\_724,1}, \; \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}, \; \$))))
177).quot) + \text{$heap}_{funcstart\_724,1}.p1)) \land (-177 < (-\text{$heap}_{funcstart\_724,1}.p1 +
(177 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).quot)))
[Work on sub-term 2 of conjunction in term 81.15]
\textit{[82.0] -1} < ((-177 * \text{div}(\textbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).quot) + $heap<sub>funcstart_724.1</sub>.p1)
[Create new term from terms 82.0, 7.0 using rule: transitivity 2]
[117.0] (-30269 + -1 + 1) < (-177 * div(heapIs $heap_{funcstart\_724,1},)
heap_{funcstart_{-724,1}}.p1, 177).quot
\rightarrow [simplify]
[117.1] -30269 < (-177 * div(heapIs $heap_{funcstart\_724,1},
```

```
\rightarrow [literal comparison of product]
[117.2] ([-177 < 0]: (-30269 / 177) < -\text{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1},
\theta_{17} = \theta
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[117.3] ([-177 < 0]: (-30269 / 177) < -\text{div}(\mathbf{heapIs} \ \text{$heap}_{funcstart\_724.1},
\text{Sheap}_{funcstart\_724.1.p1}, 177).\text{quot}, [(0 < -177) \land !(-177 < 0)]: (-30269 / -177)
< \operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot, \ [(-177
==0) \land !(-177 < 0) \land !(0 < -177)]: -30269 < 0)
\rightarrow [simplify]
[117.7] - 172 < -\text{div}(\text{heapIs } \text{$heap}_{funcstart\_724.1}, \text{$heap}_{funcstart\_724.1}.\text{p1},
177).quot
[Create new term from terms 117.7, 77.1 using rule: transitivity 5]
[119.0] 32768 < ((-171 * (\text{$heap}_{funcstart\_724.1}.\text{p1} \% 177)) + (2 * -(-172 + 1)))
\rightarrow [simplify]
[119.5] 32426 < (-171 * ($heap_{funcstart\_724,1}.p1 % 177))
\rightarrow [literal comparison of product]
[119.6] ([-171 < 0]: (32426 / 171) < –($heap_{funcstart\_724,1}.p1 \% 177), [0 <
-171]: (32426 / -171) < (\text{$heap}_{funcstart\_724,1}.\text{p1} \% 177), [-171 == 0]: 32426 <
→ [explicitly assert falsehood of skipped guards in subsequent guards]
-171) \wedge!(-171 < 0)]: (32426 / -171) < ($heap_{funcstart\_724,1}.p1 % 177), [(-171)]
==0) \land !(-171 < 0) \land !(0 < -171)]: 32426 < 0)
\rightarrow [simplify]
[119.12] false
Proof of verification condition: Type constraint satisfied in implicit
conversion from 'int' to 'short int'
Condition generated at: C:\Escher\Customers\prang\prang.c (61,33)
Condition defined at:
```

 $heap_{funcstart_{-724,1}}.p1, 177).quot$

 $\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart_724,1}.\mathbf{r1})) - (\mathbf{asType} < \mathbf{int} > (\mathbf{asType} < \mathbf{short} \\ \mathbf{int} > (\mathbf{div1}.\mathbf{quot})) * \mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart_724,1}.\mathbf{b1}))) \le \mathbf{maxof}(\mathbf{short})$

To prove: ((asType<int>(asType<short int>(div1.rem)) *

int)

Given:

```
heap_{init}.LIMIT == (int)80
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta = asType < short int > ((int)2)
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\rho_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
\theta sheap<sub>init</sub>.M3 == asType<short int>((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
invariant
1(heap<br/>Is heap_{funcstart\_724,1})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \ \operatorname{\$heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) /
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}))) = =
asType<integer>(div1.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))) = =
asType<integer>(div1.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1})) =>
(asType < integer > (\$heap_{funcstart\_724,1}.p1) = =
asType<integer>(div1.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathtt{a1}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
```

```
div2 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
(asType<integer>(asType<int>($heap_{tuncstart\_724.1}.p2)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.quot)
(\mathbf{asType} {<} \mathbf{integer} {>} (\mathbf{asType} {<} \mathbf{int} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2})) \ \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724.1}.a2)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p2) = =
asType<integer>(div2.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.a2) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
asType < int > (\$heap_{funcstart\ 724.1}.a3))
(asType<int>(asType<int>($heap_{tuncstart\_724.1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(asType<int>(asType<int>($heap_{funcstart\_724,1}.p3)) %
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))) ==
asType<integer>(div3.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}) ==
asType<integer>(div3.rem))
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a3}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
Proof:
[Take given term]
[5.0] invariant1(heapIs heap_{funcstart\_724,1})
```

```
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
[5.1] ((((((0 < asType < integer > ($heap_{funcstart\_724,1}.p1)) &&
(asType < integer > (\$heap_{funcstart\_724,1}.p1) <
as
Type<integer>(\rho_{funcstart\_724,1}.M1))) & (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
(asType < integer > (\$heap_{funcstart\_724.1}.p3) < 
asType<integer>($heap_funcstart_724,1.M3))
\rightarrow [simplify]
[5.3] \ (((((0 < \$heap_{funcstart\_724,1}.p1) \&\& \ (\$heap_{funcstart\_724,1}.p1 < (
as
Type<integer>(\rho_{funcstart\_724,1}.M1))) & (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 < funcstart\_724,1)
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})))\ \&\&
(asType<integer>($heap_funcstart_724.1.p3) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.4] (((((0 < $heap_{funcstart_{724,1}}.p1) && ($heap_{funcstart_{724,1}}.p1 < 
asType < integer > (\$heap_{init}.M1))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < \text{\$heap}_{funcstart\_724,1}.p1) \&\& (\text{\$heap}_{funcstart\_724,1}.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2})))\ \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p2) < 
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{tuncstart_{-724.1}}.M3))
\rightarrow [simplify]
|5.16| \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \; \land \; (0 < \$heap_{funcstart\_724,1}.p1) \; \land 
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M2})))~\&\&~(0<
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
```

```
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.17] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \; \land \; (0 < \$heap_{funcstart\_724,1}.p1) \; \land 
(0 < \text{\$heap}_{funcstart\_724,1}.\text{p2})) && (\text{\$heap}_{funcstart\_724,1}.\text{p2} <
asType < integer > ($heap_{init}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})))\ \&\&
(asType<integer>($heap_{tuncstart\_724,1}.p3) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -\$heap_{tuncstart\_724.1}.p1) \land (0 < \$heap_{tuncstart\_724.1}.p1) 
(0 < \$ heap_{funcstart\_724,1}.p2)) && (\$ heap_{funcstart\_724,1}.p2 <
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.30] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{724,1}.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.p3 < asType < integer > (\text{\$heap}_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\theta_{funcstart\_724,1}.p2) \land (0 < \theta_{funcstart\_724,1}.p3)) \&\&
(\text{\$heap}_{funcstart\_724,1}.\text{p3} < \text{asType} < \text{integer} > (\text{\$heap}_{init}.\text{M3}))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \land (-30269 <
 -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1.p2}) \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\$heap_{funcstart\_724,1}.p3 < \mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{short}
int > ((int)30323))
\rightarrow [simplify]
[5.40] (-30323 < -\$heap_{funcstart\_724,1.p3}) \land (-30307 <
-\$heap_{funcstart\_724,1}.p2) \wedge (-30269 < -\$heap_{funcstart\_724,1}.p1) \wedge (0 <
\text{Sheap}_{funcstart\_724,1}.\text{p1}) \land (0 < \text{Sheap}_{funcstart\_724,1}.\text{p2}) \land (0 <
heap_{funcstart_{724,1}.p3}
[Work on sub-term 4 of conjunction in term 5.40]
[8.0] \ 0 < \text{$heap}_{funcstart\_724,1}.p1
```

```
[Take given term]
[11.0] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a1}))
\rightarrow [simplify]
[11.1] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
\rightarrow [const static or extern object]
[11.2] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
asType < int > (\$heap_{init}.a1))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
\label{eq:linear_start_724,1} \text{ div1} == \text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
asType<int>(asType<short int>((int)177)))
\rightarrow [simplify]
[11.6] div1 == div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p1, 177)
[Take goal term]
[1.0] ((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{tuncstart\_724.1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))) \le maxof(short)
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart_{724,1}},
heap_{funcstart_{-724,1}}.p1, 177
[1.1] ((asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},))
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}) * asType<int>(\text{Sheap}_{funcstart\_724,1}.\text{r1})) -
(asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724,1}.b1))) \le maxof(short int)
\rightarrow [simplify]
[1.3] ((div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1, 177).rem *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{tuncstart\_724.1}.b1))) \le maxof(short)
int)
\rightarrow [const static or extern object]
[1.4] ((div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, 177).rem *
asType < int > (\$heap_{init}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))) \le maxof(short)
int)
\rightarrow [expand definition of constant 'r1' at prang.c (15,20)]
[1.5] ((div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, 177).rem *
```

```
asType<int>(asType<short int>((int)171))) -
(asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724.1}.b1))) \le maxof(short int)
\rightarrow [simplify]
[1.8] ((div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, 177).rem * 171)
- (asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724,1}.b1))) \le maxof(short int)
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177)
[1.9] ((171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).rem)
- (asType < int > (asType < short int > (div(heapIs $heap_{funcstart\_724,1}, 
\text{Sheap}_{funcstart=724,1}.\text{p1}, 177).\text{quot}) * asType<int>(\text{Sheap}_{funcstart=724,1}.\text{b1}))
\leq \maxof(short\ int)
\rightarrow [simplify]
[1.11] ((171 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1.p1},
177).rem) – (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).quot * asType<int>($heap<sub>funcstart-724,1</sub>.b1))) \leq maxof(short int)
\rightarrow [const static or extern object]
[1.12] ((171 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).rem) – (div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).quot * asType < int > (\$heap_{init}.b1)) \le maxof(short int)
\rightarrow [expand definition of constant 'b1' at prang.c (17,20)]
\label{eq:loss_loss} \ensuremath{\texttt{[1.13]}}\ ((171\ ^*\ \mathrm{div}(\mathbf{heapIs}\ \$\mathrm{heap}_{funcstart\_724,1},\ \$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
177).rem) - (\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).quot * asType<int>(asType<short int>((int)2)))) < maxof(short
int)
\rightarrow [simplify]
[1.32] -32768 < ((-171 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p1, 177}, quot))
→ [negate goal and search for contradiction]
[1.33]!(-32768 < ((-171 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177).quot)
\rightarrow [simplify]
 [1.38] \ 32767 < ((171 * \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}, \\
177).rem) + (-2 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).quot))
```

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[Assume known post-assertion, class invariant or type constraint for term 11.6]
[14.0] (asType<integer>($heap_{funcstart\_724,1}.p1) /
asType<integer>(177)) == asType<integer>(div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).quot)
\rightarrow [simplify]
[14.2] ($heap<sub>funcstart_724,1.</sub>p1 / 177) == asType<integer>(div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).quot
→ [expand definition of operator './' in class 'int' at built in declaration]
[14.3] \; ([\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) < 0] :
-(-asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177), []:
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) \ / \ 177) = =
\mathbf{asType} < \mathbf{integer} > (\mathbf{div}(\mathbf{heapIs} \ \$ \mathbf{heap}_{funcstart\_724,1}, \ \$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}, \\
177).quot)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[14.4] ([asType<integer>(heap_{funcstart\_724,1}.p1) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 0)]:
\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) \ / \ 177) = =
\mathbf{asType} {<} \mathbf{integer} {>} ( \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}, \\
177).quot)
\rightarrow [simplify]
[14.7] ([0 < -\$heap_{funcstart\_724,1}.p1]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177) ==
asType<integer>(div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1,
177).quot)
\rightarrow [from term 8.0, literala < -$heap<sub>funcstart_724.1</sub>.p1 is false whenever -2 < (0
+ literala)
    Proof of rule precondition:
    [14.7.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [14.7.2] true
[14.8] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) \; / \; 177),
[!(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177) ==
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).quot)
\rightarrow [simplify]
```

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[14.11] \; ([{\bf false}]: \; -({\bf -asType}{<} {\bf integer}{>} (\$ {\rm heap}_{funcstart\_724,1}.{\rm p1}) \; / \; 177), \; [!(0 < {\rm parter})] \; ([{\bf false}]: \; -({\bf -asType}{<} {\bf integer}{>} (\$ {\rm heap}_{funcstart\_724,1}.{\rm p1}) \; / \; 177), \; [!(0 < {\bf -asType}{<} {\bf integer}{>} (\$ {\bf -asType}{<} {\bf
-\$heap_{funcstart\_724,1}.p1)]: asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177)
== asType < integer > (div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177).quot
\rightarrow [from term 8.0, literala < -$heap<sub>funcstart_724.1</sub>.p1 is false whenever -2 < (0
+ literala)]
           Proof of rule precondition:
           [14.11.0] - 2 < (0 + 0)
           \rightarrow [simplify]
           [14.11.2] true
\label{eq:continuous_flat_self_lambda} $$[14.12]$ ([false]: -(-asType<integer>($heap_{funcstart\_724,1}.p1) / 177),
[!false]: asType<integer>(\ensuremath{\text{heap}}_{funcstart\_724,1}.\text{p1}) / 177) ==
asType<integer>(div(heapIs $heap_{tuncstart\_724.1}, $heap_{tuncstart\_724.1}.p1,
177).quot)
\rightarrow [simplify]
[14.17] \ 0 == (-\text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).quot + (\text{$heap}_{funcstart\_724,1}.p1 / 177))
[Assume known post-assertion, class invariant or type constraint for term 11.6]
[15.0] (asType<integer>(heap_{funcstart\_724,1}.p1) %
asType < integer > (177)) == asType < integer > (div(heapIs))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}
\rightarrow [simplify]
[15.2] (\text{heap}_{funcstart\_724,1}.p1 % 177) == asType<integer>(div(heapIs
\$ \mathrm{heap}_{funcstart\_724,1}, \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}, \ 177).\mathrm{rem})
→ [expand definition of operator '.%' in class 'int' at built in declaration]
[15.3] ([asType<integer>(peq_{tanget}) (peq_{tanget}) ([asType<integer)) (peq_{tanget}) ([asType<integer)) (peq_{tanget}) (peq_{tange}) (peq_{tanget}) (peq_{tange}) (peq_{tange}) (peq_{tange}) (peq_{tange}) (peq_{tange}) (peq_{tange}) (peq_{tange}) (peq_{tange}) (peq_{tange}) (pe
-(-asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177), []:
asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177) = =
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).\text{rem}
→ [explicitly assert falsehood of skipped guards in subsequent guards]
\textit{[15.4]} \; ([\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) < 0]:
 -(-asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177) ==
\mathbf{asType} {<} \mathbf{integer} {>} ( \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}, \\
177).rem)
\rightarrow [simplify]
```

```
[15.7] ([0 < -$heap<sub>funcstart_724,1.</sub>p1]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177),
[!(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177) = =
asType < integer > (div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1,
177).rem)
\rightarrow [from term 8.0, literala < –$heap_{uncstart\_724,1}.p1 is false whenever -2 < (0
+ literala)]
    Proof of rule precondition:
    [15.7.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [15.7.2] true
[15.8] ([false]: -(-asType < integer > (\$heap_{tuncstart\_724.1}.p1) \% 177),
[!(asType < integer > (\$heap_{funcstart\_724.1}.p1) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177) ==
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).\text{rem}
\rightarrow [simplify]
[15.11] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177), [!(0
<-$heap<sub>funcstart_724,1</sub>.p1)]: asType<integer>($heap<sub>funcstart_724,1</sub>.p1) %
177) == asType < integer > (div(heapIs \$heap_{funcstart\_724.1},
heap_{funcstart_{-724,1}}.p1, 177).rem
\rightarrow [from term 8.0, literala < -$heap_{funcstart\_724,1}.p1 is false whenever -2 < (0
+ literala)
    Proof of rule precondition:
    [15.11.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [15.11.2] true
\textit{[15.12]} \; ([\mathbf{false}]: \; -(\mathbf{-asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) \; \% \; 177),
[!false]: asType<integer>($heap_{funcstart\_724,1}.p1) % 177) ==
\mathbf{asType} < \mathbf{integer} > (\mathbf{div}(\mathbf{heapIs} \ \$ \mathbf{heap}_{funcstart\_724,1}, \ \$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}, \\
177).\text{rem}
\rightarrow [simplify]
[15.17] \ 0 == (-\text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).rem + (\text{$heap}_{funcstart\_724,1}.p1 \% 177))
[Assume known post-assertion, class invariant or type constraint for term
14.17
[20.0] minof(int) \leq div(heapIs \text{$heap}_{funcstart\_724,1}, \text{$heap}_{funcstart\_724,1}.p1,
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177).quot
\rightarrow [simplify]
\label{eq:constant_724,1} \mbox{$1$} -32769 < \mbox{div}(\mathbf{heapIs} \ \$ \mbox{$heap}_{funcstart\_724,1}, \ \$ \mbox{$heap}_{funcstart\_724,1}. p1,
177).quot
[Take given term]
[24.0] (asType<integer>($heap_{funcstart\_724,1}.p1) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p1) = =
asType<integer>(div1.rem))
\rightarrow [simplify]
[24.1] \; (\$ heap_{funcstart\_724,1}.p1 < \mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.a1))
=> (asType < integer > (\$heap_{funcstart\_724,1}.p1) = =
asType<integer>(div1.rem))
\rightarrow [const static or extern object]
[24.2] ($heap<sub>funcstart_724.1</sub>.p1 < asType<integer>($heap<sub>init</sub>.a1)) =>
(asType < integer > (\$heap_{funcstart\_724,1}.p1) = =
asType<integer>(div1.rem))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
[24.3] \ (\$heap_{funcstart\_724,1}.p1 < \mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{short})
int>((int)177))) => (asType< integer>($heap_{funcstart\_724,1}.p1) ==
asType<integer>(div1.rem))
\rightarrow [simplify]
[24.10] (-177 < -$heap<sub>funcstart_724,1.p1</sub>) => ($heap<sub>funcstart_724,1.p1</sub> ==
asType<integer>(div1.rem))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart_724,1},
heap_{funcstart_{-724,1}.p1, 177}
\label{eq:continuous} \textit{[24.11]} \; (\text{-177} < -\$ \text{heap}_{funcstart\_724,1}.\text{p1}) => (\$ \text{heap}_{funcstart\_724,1}.\text{p1} ==
\mathbf{asType} \small{<} \mathbf{integer} \small{>} ( \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}, \\
177).rem))
\rightarrow [simplify]
[24.17] \; (0 == (-\$ heap_{funcstart\_724,1}.p1 + div(\textbf{heapIs} \; \$ heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p1}, 177).rem)) \lor (176 < \text{Sheap}_{funcstart\_724,1.p1})
[Branch on disjunction or conditional in term 24.17]
[59.0] (0 == (-\$heap_{funcstart\_724,1}.p1 + div(heapIs \$heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem})) \lor (176 < \text{Sheap}_{funcstart\_724,1}.\text{p1}) \lor !(0 ==
(-\text{\$heap}_{funcstart\_724,1}.\text{p1} + \text{div}(\text{\textbf{heapIs}} \, \text{\$heap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177).rem
[Copy term 1.38]
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[60.0] (32767 < ((-2 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1,
177).quot) + (171 * div(heapIs heapI_{funcstart_{724,1}}, heap_{funcstart_{724,1}}.p1,
(-\$heap_{funcstart\_724,1}.p1 + div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p1, 177).rem}
\rightarrow [from\ term\ 59.0,\ div(\textbf{heapIs}\ \$heap_{funcstart\_724,1},\ \$heap_{funcstart\_724,1}.p1,
177).rem is equal to heap_{funcstart\_724,1}.p1
\label{eq:condition} \textit{[60.1]} \ (32767 < ((-2 * \text{div}(\textbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).quot) + (171 * \text{$heap}_{funcstart\_724,1.p1}))) \vee \dots
[Copy term 15.17]
\textit{[61.0]} \ (0 == (-\text{div}(\textbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).rem + (\text{$heap}_{funcstart\_724,1}.p1 \% 177)) \vee (176 < \text{$heap}_{funcstart\_724,1}.p1)
\vee !(0 == (-\$heap_{funcstart\_724,1}.p1 + div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p1, 177).rem}
\rightarrow [from term 59.0, div(heapIs $heap_{funcstart\_724,1}$, $heap_{funcstart\_724,1}$.p1,
177).rem is equal to $heap_funcstart_724.1.p1]
[61.1] (0 == (-$heap_{funcstart_{-724,1}}.p1 + ($heap_{funcstart_{-724,1}}.p1 % 177))) \vee \dots
[Create new term from terms 1.38, 20.3 using rule: transitivity 11r]
[69.0] (1 + 32767 + (-32769 * 2)) < (171 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p1, 177}.rem
\rightarrow [simplify]
[69.2] -32770 < (171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1,
177).rem)
\rightarrow [literal comparison of product]
[69.3] ([171 < 0]: (-32770 / -171) < -\text{div}(\text{heapIs } \text{$heap}_{funcstart\_724.1},
\text{heap}_{funcstart\_724.1}.\text{p1}, 177).\text{rem}, [0 < 171]: (-32770 / 171) < \text{div}(\text{heapIs})
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}, [0 == 171]: -32770 < 0)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[69.4] ([171 < 0]: (-32770 / -171) < -\text{div}(\mathbf{heapIs} \ \$ heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}, [(0 < 171) \land !(171 < 0)]: (-32770 / 171) < 0
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p1, \ 177).rem, \ [(0 == 171)]
\land !(0 < 171) \land !(171 < 0)]: -32770 < 0)
\rightarrow [simplify]
[69.12] -192 < div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1,
177).rem
[Assume known post-assertion, class invariant or type constraint for term 61.1]
[70.0] (\text{$heap_{funcstart\_724,1.p1} < 177}) \lor (176 < \text{$heap_{funcstart\_724,1.p1}) \lor!(0
==(-\text{\$heap}_{funcstart\_724,1}.\text{p1} + \text{div}(\text{heapIs \$heap}_{funcstart\_724,1},
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heap_{funcstart_{-724,1}}.p1, 177).rem
\rightarrow [simplify]
[70.3] (-177 < -\$heap_{funcstart\_724,1}.p1) \vee ...
[Copy term 1.38]
[72.0] 32767 < ((-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1,
177).quot) + (171 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).rem))
\rightarrow [from\ term\ 15.17,\ div(\textbf{heapIs}\ \$heap_{funcstart\_724,1},\ \$heap_{funcstart\_724,1}.p1,
177).rem is equal to heap_{funcstart\_724,1}.p1 \% 177
[72.1] \ 32767 < ((-2 * \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
(177).quot + (171 * (\$heap_{funcstart\_724,1}.p1 \% 177)))
[Copy term 60.1]
\label{eq:condition} \mbox{[73.0] } (32767 < ((-2 * \mbox{div}(\mathbf{heapIs} \; \$ \mbox{$heap}_{funcstart\_724,1}, \; \$ \mbox{$heap}_{funcstart\_724,1}.\mbox{$p1$}, \; \$ \mbox{$p1$}, \; \$ \
(177).\text{quot} + (171 * \text{$heap}_{funcstart\_724,1.}\text{p1}))) \lor (176 <
\$ heap_{funcstart\_724,1}.p1) \lor !(0 == (-\$ heap_{funcstart\_724,1}.p1 + div(\textbf{heapIs})) \land (-\$ heap_{funcstart\_724,1}.p1 + div(\textbf{heapIs})) \land (-\$ heap_{funcstart\_724,1}.p1 + div(\textbf{heapIs}))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).rem)
\rightarrow [from\ term\ 14.17,\ div(\textbf{heapIs}\ \$heap_{funcstart\_724,1},\ \$heap_{funcstart\_724,1}.p1,
177).quot is equal to heap_{funcstart\_724,1}.p1 / 177
[73.1] (32767 < ((-2 * ($heap_{funcstart\_724,1}.p1 / 177)) + (171 *
heap_{funcstart_{724,1}.p1})) \vee ...
\rightarrow [division by larger divisor]
         Proof of rule precondition 1:
         \label{eq:continuous} \mbox{\it [73.1.0.0] literald} < -\$ heap_{funcstart\_724,1}.p1
         \rightarrow [unify with term 70.3]
         [73.1.0.1] true
         Proof of rule precondition 2:
         \label{eq:continuous} \textit{[73.1.1.0]} \ literalc < \$heap_{funcstart\_724,1}.p1
         \rightarrow [unify with term 8.0]
         [73.1.1.1] true
         Proof of rule precondition 3:
         [73.1.2.0] --177 \le 177
         \rightarrow [simplify]
         [73.1.2.2] true
         Proof of rule precondition 4:
         [73.1.3.0] - 2 < 0
```

```
\rightarrow [simplify]
         [73.1.3.1] true
[73.2] (32767 < ((-2 * heap_{funcstart\_724,1}.p1) + (171 *
heap_{funcstart_{-724,1}.p1)} \vee \dots
\rightarrow [simplify]
[73.4] (32767 < (169 * \text{$heap}_{funcstart\_724,1}.\text{p1})) \lor \dots
\rightarrow [literal comparison of product]
[73.5] ([169 < 0]: (32767 / -169) < -\$heap_{funcstart\_724,1}.p1, [0 < 169]: (32767)
/ 169) < $heap<sub>funcstart_724,1.</sub>p1, [0 == 169]: 32767 < 0) \vee ...
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[73.6] ([169 < 0]: (32767 / -169) < -$heap<sub>funcstart_724,1.</sub>p1, [(0 < 169) \wedge!(169)
< 0)]: (32767 / 169) < $heap<sub>funcstart_724,1</sub>.p1, [(0 == 169) \land !(0 < 169) \land 
!(169 < 0)]: 32767 < 0) \lor ...
\rightarrow [simplify]
[73.13] (true \land (193 < $heap_{funcstart\_724,1}.p1)) \lor ...
\rightarrow [from term 70.3, literala < $heap<sub>funcstart_724,1</sub>.p1 is false whenever -2 <
(-177 + literala)
         Proof of rule precondition:
         [73.13.0] - 2 < (-177 + 193)
         \rightarrow [simplify]
         [73.13.2] true
[73.14] (true \wedge false) \vee \dots
\rightarrow [simplify]
[73.15] false \vee ...
[Remove 'false' term 73.15 and fetch new term from containing clause]
[74.0] 176 < $heap_{funcstart_724,1}.p1
[Remove 'false' term 73.15 and fetch new term from containing clause]
[75.0] !(0 == (-\$heap_{funcstart\_724,1}.p1 + div(heapIs \$heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p1, 177).rem}
[Create new term from term 14.17 using rule: condition for equality of division]
[79.0] ((177 * (0 + -(-\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1},
\text{Sheap}_{funcstart_{-724,1},p1, 177}.\text{quot}))) < (1 + \text{Sheap}_{funcstart_{-724,1},p1})) \land
($heap<sub>funcstart_724,1</sub>.p1 < (177 * (0 + 1 + -(-\text{div}(\mathbf{heapIs})))
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 177).quot))))
\rightarrow [simplify]
```

```
[79.15] (-1 < ((-177 * div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, p_1, f_1)
177).quot) + $\text{heap}_{funcstart\_724,1.p1})) \wedge (-177 < (-\text{$heap}_{funcstart\_724,1.p1} + \text{$p$})
(177 * \text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot})))
\rightarrow [separate conjunction and work on first sub-term]
[79.16] -177 < (-\$heap_{funcstart\_724,1}.p1 + (177 * div(heapIs))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).quot)
[Create new term from term 75.0 using rule: not-equal implies greater-than or
less-than]
[81.0] (0 < (-$heap<sub>funcstart_724,1</sub>.p1 + div(heapIs $heap<sub>funcstart_724,1</sub>,
\theta_{funcstart\_724,1}.p1, 177).rem \lor ((-\theta_{funcstart\_724,1}.p1 + div(\mathbf{heapIs}))
\text{Sheap}_{funcstart_{-724,1}}, \text{Sheap}_{funcstart_{-724,1},p1, 177}.\text{rem}) < 0
\rightarrow [simplify]
[81.5] (0 < (-$heap_{funcstart_{724.1}}.p1 + div(heapIs $heap_{funcstart_{724.1}}))
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem})) \lor (0 < (-\text{div}(\textbf{heapIs} \text{Sheap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + \text{Sheap}_{funcstart\_724,1}.\text{p1})
[Branch on disjunction or conditional in term 81.5]
[82.0] (0 < (-\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).rem + \text{$heap}_{funcstart\_724,1}.p1) \(\times (0 < (-\$heap_{funcstart\_724,1}.p1 +
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).rem)) \lor !(0 <
(-\text{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.\text{p1}, \ 177).\text{rem} +
heap_{funcstart_{724,1}.p1}
[Create new term from terms 82.0, 79.16 using rule: transitivity 1]
[83.0] ((-177 + 0 + 1) < (-div(heapIs $heap_{tuncstart\_724.1},
\text{Sheap}_{funcstart_{-724,1},p1, 177}.rem + (177 * div(heapIs \text{Sheap}_{funcstart_{-724,1},p1, 177}).rem + (177 * div(heapIs \text{Sheap}_{funcstart_{-724,1},p
\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},\ 177).\mathrm{quot}))) \ \lor \ (0 < (-\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1} \ + \\
\operatorname{div}(\mathbf{heapIs} \ \text{$heap}_{funcstart\_724,1}, \ \text{$heap}_{funcstart\_724,1}.p1, \ 177).rem)) \lor !(0 <
(-\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} +
heap_{funcstart_{-724,1}.p1}
\rightarrow [simplify]
[83.1] (-176 < (-div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).rem + (177 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).quot))) \vee \dots
[Create new term from terms 83.1, 69.12 using rule: transitivity 2]
[85.0] ((-192 + -176 + 1) < (177 * div(heap
Is $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot})) \lor (0 < (-\text{Sheap}_{funcstart\_724,1}.\text{p1} +
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1, 177).rem)) \vee !(0 <
(-\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} +
```

 $heap_{funcstart_{-724,1}.p1}$

 \rightarrow [simplify]

```
[85.1] (-367 < (177 * div(heapIs p_{funcstart_{-724,1}}, p_{funcstart_{-724,1}}, p_{funcstart_{-724,1}}
177).quot)) ∨ ...
\rightarrow [literal comparison of product]
[85.2] ([177 < 0]: (-367 / -177) < -\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}, [0 < 177]: (-367 / 177) < \text{div}(\text{heapIs})
\text{Sheap}_{funcstart-724,1}, \text{Sheap}_{funcstart-724,1}.p1, 177).quot, [0 == 177]: -367 < 0)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[85.3] ([177 < 0]: (-367 / -177) < -\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1},
\theta_{177} = \theta_{1
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724.1}, \ \$ \operatorname{heap}_{funcstart\_724.1}. p1, \ 177). \operatorname{quot}, \ [(0 ==
177) \land !(0 < 177) \land !(177 < 0)]: -367 < 0) \lor \dots
\rightarrow [simplify]
[85.11] (-3 < div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1,
177).quot) \vee \dots
[Create new term from terms 85.11, 72.1 using rule: transitivity 11]
[90.0] ((1 + 32767 + (-3 * 2)) < (171 * ($heap_{funcstart\_724,1}.p1 % 177))) \vee (0
< (-$heap<sub>funcstart_724,1</sub>.p1 + div(heapIs $heap<sub>funcstart_724,1</sub>,
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem})) \vee !(0 < (-\text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p1, 177}.rem + heap_{funcstart_{-724,1}.p1}
\rightarrow [simplify]
[90.2] (32762 < (171 * (\$heap_{funcstart\_724,1}.p1 \% 177))) \lor ...
\rightarrow [literal comparison of product]
[90.3] \; ([171<0] \colon (32762 \; / \; \text{-}171) < -(\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1} \; \% \; 177), \, [0<171] \colon
(32762 / 171) < (\text{\$heap}_{funcstart\_724,1}.\text{p1} \% 177), [0 == 171]: 32762 < 0) \lor \dots
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[90.4] ([171 < 0]: (32762 / -171) < -(\text{$heap_{funcstart\_724.1}.p1 \% 177}), [(0 <
171) \land !(171 < 0)]: (32762 / 171) < (\$heap_{funcstart\_724,1}.p1 \% 177), [(0 ==
171) \land !(0 < 171) \land !(171 < 0)]: 32762 < 0) \lor \dots
\rightarrow [simplify]
[90.13] false \vee ...
[Remove 'false' term 90.13 and fetch new term from containing clause]
[91.0] 0 < (-\text{\$heap}_{funcstart\_724,1}.\text{p1} + \text{div}(\text{heapIs }\text{\$heap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p1, 177}.rem
[Create new term from terms 91.0, 74.0 using rule: transitivity 2]
[93.0] (0 + 1 + 176) < \text{div}(\text{heapIs } \text{$heap}_{funcstart\_724,1}, \text{$heap}_{funcstart\_724,1}.\text{p1},
```

177).rem

```
\rightarrow [simplify]
[93.1] 177 < \text{div}(\text{heapIs } \text{$heap}_{funcstart\_724,1}, \text{$heap}_{funcstart\_724,1}.\text{p1}, 177).rem
[Create new term from terms 93.1, 15.17 using rule: transitivity 16]
[94.0] (0 + 177) < ($heap_{funcstart_724,1}.p1 % 177)
\rightarrow [simplify]
[94.2] false
Proof of verification condition: Assertion valid
Condition generated at: C:\Escher\Customers\prang\prang.c (62,31)
To prove: asType<integer>(\theta) (\theta) (\theta
asType<integer>($heap<sub>724.1:745.8</sub>.M1)
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
\theta_{init}.a1 == asType<short int>((int)177)
\theta = asType < short int > ((int)2)
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\theta
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
heap_{init}.a3 == asType<short int>((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart_{-724,1}})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) /
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}))) = =
```

```
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heap_{tuncstart\_724,1}.p1)) %
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))) = =
asType<integer>(div1.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1})) =>
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) ==
asType<integer>(div1.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathtt{a1}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
\label{eq:div2} \text{div2} == \text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}),
asType < int > (\$heap_{funcstart\_724.1}.a2))
(asType<int>(asType<int>($heap_{tuncstart\_724.1}.p2)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p2) = =
asType<integer>(div2.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a2) \le
asType < integer > (\$heap_{funcstart\_724.1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724.1}.p3),
asType < int > (\$heap_{funcstart\_724.1}.a3))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p3})) \ / \\
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.rem)
```

```
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) ==
asType<integer>(div3.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a3) \le
asType < integer > (\$heap_{funcstart\_724,1}.p3)) = > !(0 ==
asType < integer > (div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
\mathbf{asType} \small{<} \mathbf{int} \small{>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{r1})) - (\mathbf{asType} \small{<} \mathbf{int} \small{>} (\mathbf{asType} \small{<} \mathbf{short}
int>(div1.quot)) * asType<int>($heap_{funcstart\_724,1}.b1)))
-asType < integer const > (\$heap_{724,1:745,8}.M1) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{p1})
!(0 == asType < integer > (\$heap_{724,1:745.8}.p1))
Proof:
[Take given term]
[5.0] invariant1(heapIs heap_{funcstart\_724,1})
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
[5.1] ((((((0 < asType < integer > (heap_{funcstart_{-724,1}}.p1)) &&
(asType < integer > ($heap_{funcstart\_724,1}.p1) < 
as
Type<integer>(\rho_{funcstart\_724,1}.M1))) & (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(asType<integer>($heap_funcstart_724.1.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})))\ \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.3] (((((0 < \text{heap}_{funcstart\_724,1}.p1) && (\text{heap}_{funcstart\_724,1}.p1 <
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2})))\ \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}))) \ \&\& \\
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [const static or extern object]
[5.4] (((((0 < $heap_{funcstart_{724,1}}.p1) && ($heap_{funcstart_{724,1}}.p1 < ]
```

```
asType < integer > (\$heap_{init}.M1))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType<integer>($heap_{tuncstart\_724,1}.p3) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < $heap_{funcstart_{724,1}}.p1) && ($heap_{funcstart_{724,1}}.p1 < 
asType<integer>(asType<short int>((int)30269)))) && (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [simplify]
[5.16] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \; \land \; (0 < \$heap_{funcstart\_724,1}.p1) \; \land 
(0 < \text{Sheap}_{funcstart_{-724,1},p2})) \&\& (\text{Sheap}_{funcstart_{-724,1},p2} <
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M2}))) \ \&\& \ (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [const static or extern object]
[5.17] \left( \left( \left( \left( -30269 < -\$ \text{heap}_{funcstart\_724,1}.\text{p1} \right) \right. \wedge \left. \left( 0 < \$ \text{heap}_{funcstart\_724,1}.\text{p1} \right) \right. \wedge \right. \right)
(0 < \text{\$heap}_{funcstart_{-724,1}.p2})) \&\& (\text{\$heap}_{funcstart_{-724,1}.p2} <
asType < integer > (\$heap_{init}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType<integer>($heap_funcstart_724,1.p3) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType<integer>(asType<short int>((int)30307)))) && (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})))\ \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M3}))
\rightarrow [simplify]
[5.30] ((-30307 < -$heap_{funcstart\_724,1}.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{-724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{-724,1}.p3})) \&\&
```

```
(\text{\$heap}_{funcstart\_724,1}.\text{p3} < \mathbf{asType} < \mathbf{integer} > (\text{\$heap}_{funcstart\_724,1}.\text{M3}))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -$heap_funcstart_724,1.p2) \land (-30269 <
-\$ heap_{funcstart\_724,1}.p1) \land (0 < \$ heap_{funcstart\_724,1}.p1) \land (0 < \$ heap_{funcstart\_724,1}.p1) \land (0 < \$ heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1.p2}) \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.p3 < asType < integer > (\text{\$heap}_{init}.M3))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap<sub>funcstart_724.1</sub>.p2) \wedge (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{-724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{-724,1}.p3})) \&\&
(\text{sheap}_{funcstart\_724.1}.p3 < asType < integer > (asType < short)
int > ((int)30323))
\rightarrow [simplify]
[5.40] (-30323 < -\$heap_{funcstart\_724,1}.p3) \land (-30307 < -30307)
-\$heap_{funcstart\_724,1}.p2) \land (-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < -\$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.\text{p1}) \land (0 < \text{Sheap}_{funcstart\_724,1}.\text{p2}) \land (0 <
heap_{funcstart_{-724,1}.p3}
[Work on sub-term 4 of conjunction in term 5.40]
[8.0] 0 < $heap_{funcstart_724,1}.p1
[Take given term]
[11.0] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
\rightarrow [simplify]
[11.1]~{\rm div1} == {\rm div}(\mathbf{heapIs}~\$ \mathrm{heap}_{funcstart\_724,1},\,\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType < int > (\$heap_{funcstart\_724.1}.a1))
\rightarrow [const static or extern object]
[11.2] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType < int > (\$heap_{init}.a1))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
[11.3] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType<int>(asType<short int>((int)177)))
\rightarrow [simplify]
[11.6] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1, 177)
[Assume known post-assertion, class invariant or type constraint for term 11.6]
[14.0] (asType<integer>(heap_{funcstart\_724,1}.p1) /
asType<integer>(177)) == asType<integer>(div(heapIs
```

```
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, 177.quot
\rightarrow [simplify]
[14.2] ($heap<sub>funcstart_724,1</sub>.p1 / 177) == asType<integer>(div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}
→ [expand definition of operator './' in class 'int' at built in declaration]
[14.3] ([asType<integer>(sheap_{funcstart\_724,1}.p1) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177), []:
asType < integer > (\$heap_{funcstart\_724.1}.p1) / 177) = =
\mathbf{asType} < \mathbf{integer} > (\mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
177).quot)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[14.4] ([asType<integer>(sheap_{funcstart\_724,1}.p1) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177),
[!(asType < integer > (\$heap_{funcstart\_724.1}.p1) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177) ==
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).quot)
\rightarrow [simplify]
[14.7] ([0 < -$heap<sub>funcstart_724,1.</sub>p1]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177),
[!(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) < 0)]:
asType < integer > (\$heap_{funcstart\_724.1}.p1) / 177) = =
asType<integer>(div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
177).quot)
\rightarrow [from term 8.0, literala < -$heap<sub>funcstart_724,1.</sub>p1 is false whenever -2 < (0
+ literala)]
    Proof of rule precondition:
    [14.7.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [14.7.2] true
[14.8] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177) ==
\mathbf{asType} {<} \mathbf{integer} {>} ( \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}, \\
177).quot)
\rightarrow [simplify]
[14.11] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177), [!(0 <
-$heap<sub>funcstart_724.1</sub>.p1)]: asType<integer>($heap<sub>funcstart_724.1</sub>.p1) / 177)
== asType < integer > (div(heapIs $heap_{funcstart\_724,1},
```

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heap_{funcstart_{-724,1}}.p1, 177).quot
\rightarrow [from term 8.0, literala < -$heap<sub>funcstart_724.1</sub>.p1 is false whenever -2 < (0
+ literala)]
       Proof of rule precondition:
       [14.11.0] - 2 < (0 + 0)
       \rightarrow [simplify]
       [14.11.2] true
[14.12] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177),
[!false]: asType<integer>(\theta_{funcstart\_724,1}.p1) / 177) ==
asType<integer>(div(heapIs $heap_{tuncstart_724.1}, $heap_{tuncstart_724.1.p1},
177).quot)
\rightarrow [simplify]
 [14.17] \ 0 == (-\mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
177).quot + (\text{$heap}_{funcstart\_724,1}.p1 / 177))
[Assume known post-assertion, class invariant or type constraint for term 11.6]
[15.0] (asType<integer>(sheap_{funcstart\_724,1}.p1) %
asType<integer>(177)) == asType<integer>(div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}
\rightarrow [simplify]
[15.2] ($heap_{funcstart\_724,1}.p1 % 177) == asType<integer>(div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p1, 177).rem
→ [expand definition of operator '.%' in class 'int' at built in declaration]
[15.3] ([asType<integer>(peqtention = 15.3] ([asType<integer>(peqtention = 15.3]) ([asType<integer>(peqtention = 15.3) ([asType<integer>(peqtention = 15.3)) 
-(-asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177), []:
asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177) ==
asType<integer>(div(heapIs p_{funcstart\_724,1}, p_{funcstart\_724,1}),
177).rem)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[15.4] ([asType<integer>(sheap_{funcstart\_724,1.p1}) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177),
[!(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177) ==
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).rem)
\rightarrow [simplify]
[15.7] ([0 < -$heap<sub>funcstart_724,1.</sub>p1]:
-(-asType < integer > (\$heap_{funcstart\_724.1}.p1) \% 177),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 0)]:
```

```
asType < integer > (\$heap_{funcstart-724,1}.p1) \% 177) ==
\mathbf{asType} {<} \mathbf{integer} {>} ( \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}. \mathrm{p1}, \\
177).\text{rem}
\rightarrow [from term 8.0, literala < -$heap<sub>funcstart_724,1.</sub>p1 is false whenever -2 < (0
+ literala)]
    Proof of rule precondition:
    [15.7.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [15.7.2] true
[15.8] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 0)]:
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1})~\%~177) ==
\mathbf{asType} < \mathbf{integer} > (\mathbf{div}(\mathbf{heapIs} \ \$ \mathbf{heap}_{funcstart\_724,1}, \ \$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1},
177).rem)
\rightarrow [simplify]
[15.11] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177), [!(0
<-$heap<sub>funcstart_724,1.</sub>p1)]: asType<integer>($heap<sub>funcstart_724,1.</sub>p1) %
177) == asType < integer > (div(heapIs \$heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p1, 177).rem
\rightarrow [from term 8.0, literala < -$heap<sub>funcstart_724,1</sub>.p1 is false whenever -2 < (0
+ literala)]
    Proof of rule precondition:
    [15.11.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [15.11.2] true
\textit{[15.12]} \; ([\mathbf{false}]: \; -(\mathbf{-asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) \; \% \; 177),
[!false]: asType<integer>(sheap_{funcstart\_724,1.p1}) \% 177 ==
\mathbf{asType} < \mathbf{integer} > (\mathbf{div}(\mathbf{heapIs} \$ \mathbf{heap}_{funcstart\_724,1}, \$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1},
177).rem)
\rightarrow [simplify]
[15.17] 0 == (-div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).rem + (\text{$heap}_{funcstart\_724,1}.p1 \% 177))
[Assume known post-assertion, class invariant or type constraint for term
14.17
[20.0] \ \mathbf{minof(int)} \leq \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
177).quot
\rightarrow [simplify]
```

```
\label{eq:condition} \textit{[20.3] -32769} < \text{div}(\textbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).quot
[Take given term]
{\it [24.0]}~(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p1) = =
asType<integer>(div1.rem))
\rightarrow [simplify]
[24.1] \; (\$ heap_{funcstart\_724,1}.p1 < \mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.a1))
=>(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1})==
asType<integer>(div1.rem))
\rightarrow [const static or extern object]
[24.2] ($heap<sub>tuncstart_724,1</sub>.p1 < asType<integer>($heap<sub>init</sub>.a1)) =>
(asType < integer > (\$heap_{funcstart\_724,1}.p1) = =
asType<integer>(div1.rem))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
[24.3] ($heap<sub>funcstart_724,1</sub>.p1 < asType<integer>(asType<short)
int>((int)177))) => (asType<integer>($heap_{funcstart\_724,1}.p1) ==
asType<integer>(div1.rem))
\rightarrow [simplify]
[24.10] \; (\text{-}177 < -\$ \text{heap}_{funcstart\_724,1}.\text{p1}) => (\$ \text{heap}_{funcstart\_724,1}.\text{p1} ==
asType<integer>(div1.rem))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1},p1,177}
[24.11] \; (\text{-}177 < -\$ \text{heap}_{funcstart\_724,1}.\text{p1}) => (\$ \text{heap}_{funcstart\_724,1}.\text{p1} ==
asType<integer>(div(heapIs $heap_{tuncstart\_724.1}, $heap_{tuncstart\_724.1}.p1,
177).rem))
\rightarrow [simplify]
[24.17] (0 == (-\$heap_{funcstart\_724,1}.p1 + div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p1, 177}.\text{rem}) \lor (176 < \text{Sheap}_{funcstart\_724,1.p1})
[Take given term]
[59.0] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1}.\mathbf{quot})) * \mathbf{asType}{<} \mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177
[59.1] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
```

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int>((asType < int) < (asType < short int) < (div(heapIs $heap_{funcstart\_724,1}, 
(asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [simplify]
[59.3] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1.quot})) * \mathbf{asType}{<} \mathbf{int}{>} (\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
\rightarrow [const static or extern object]
[59.4] heap_{724,1:745,8} == heap_{funcstart\_724,1}-replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724.1}, \$heap_{funcstart\_724.1}.p1, 177).rem *
asType < int > (\$heap_{init}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType<int>($heap_{funcstart\_724,1}.b1)))
\rightarrow [expand definition of constant 'r1' at prang.c (15,20)]
[59.5] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType<int>(asType<short int>((int)171))) -
(asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [simplify]
[59.8] heap_{724,1:745,8} == heap_{funcstart\_724,1}-replace(p1 \rightarrow asType<short
int > ((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem * 171)
- (asType<int>(asType<short int>(div1.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177
[59.9] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).rem)
- (asType<int>(asType<short int>(div(heapIs $heap_{funcstart_724,1},))
heap_{funcstart_{724,1},p1,177}, quot)) *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [simplify]
[59.11] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [const static or extern object]
[59.12] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((171 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)
```

```
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType < int > (\$heap_{init}.b1)))
\rightarrow [expand definition of constant 'b1' at prang.c (17,20)]
[59.13] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
\mathbf{int} > ((171 * \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, 177).\operatorname{rem})
- (\text{div}(\textbf{heapIs} \$ \text{heap}_{funcstart\_724.1}, \$ \text{heap}_{funcstart\_724.1}.\text{p1}, 177).\text{quot} *
asType<int>(asType<short int>((int)2))))
\rightarrow [simplify]
[59.19] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724.1}, \ \text{\$heap}_{funcstart\_724.1}, 177).rem)))
[Take goal term]
[1.0] asType<integer>($heap<sub>724.1:745.8</sub>.p1) <
asType<integer>($heap<sub>724,1.745,8</sub>.M1)
\rightarrow [from term 59.19, $heap<sub>724,1;745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs p_{funcstart\_724,1})
heap_{funcstart_{-724,1}}.p1, 177).rem)
[1.1] asType<integer>(\frac{1.1}{\text{neg}}) asType<integer>(\frac{1.1}{\text{neg}})
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p1, \ 177).rem))).p1) <
asType<integer>($heap<sub>724,1:745,8</sub>.M1)
\rightarrow [simplify]
[1.3] ((-2 * div(heapIs $heap_{funcstart\_724.1}, $heap_{funcstart\_724.1}.p1, 177).quot)
+ (171 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart\_724,1}, \text{\$heap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem})) <
asType<integer>($heap<sub>724,1:745,8</sub>.M1)
\rightarrow [from term 59.19, $heap<sub>724,1;745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724,1}),
\text{Sheap}_{funcstart\_724,1}.p1, 177).quot) + (171 * div(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p1, 177).rem}
[1.4] \; ((-2 \; * \; \mathrm{div}(\mathbf{heapIs} \; \$ \mathrm{heap}_{funcstart\_724,1}, \; \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}, \; 177).\mathrm{quot})
+ (171 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)) < 
asType<integer>(p1 \rightarrow ((-2 * div(heapIs) + (-2 * div(heapIs))))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).quot) + (171 * div(heapIs)
\$ heap_{funcstart\_724,1}, \$ heap_{funcstart\_724,1}.p1, 177).rem))).M1)
\rightarrow [const member of object with modified fields]
[1.5] ((-2 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1, 177).quot)
+ (171 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)) < 
asType<integer>($heap_{tuncstart_724.1}.M1)
```

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\rightarrow [const static or extern object]
[1.6] ((-2 * div(heapIs $heap_{funcstart_{724,1}}, $heap_{funcstart_{724,1}}.p1, 177).quot)
+ (171 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)) <
asType < integer > (\$heap_{init}.M1)
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
 [1.7] \; ((-2 * \operatorname{div}(\mathbf{heapIs} \; \$ \operatorname{heap}_{funcstart\_724,1}, \; \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, \; 177).\operatorname{quot}) 
+ (171 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)) <
asType<integer>(asType<short int>((int)30269))
\rightarrow [simplify]
[1.17] -30269 < ((-171 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177).quot)
\rightarrow [negate goal and search for contradiction]
[1.18]!(-30269 < ((-171 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177).quot))
\rightarrow [simplify]
 \label{eq:loss_loss} $[1.23]$ 30268 < ((171* div(\mathbf{heapIs} \$ heap_{funcstart\_724,1}, \$ heap_{funcstart\_724,1}.p1,
177).rem) + (-2 * \text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).quot))
[Branch on disjunction or conditional in term 24.17]
[62.0] (0 == (-$heap<sub>funcstart_724,1</sub>.p1 + div(heapIs $heap<sub>funcstart_724,1</sub>,
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem})) \lor (176 < \text{Sheap}_{funcstart\_724,1}.\text{p1}) \lor !(0 ==
(-\$heap_{funcstart\_724,1}.p1 + div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177).rem
[Copy term 1.23]
[64.0] \ (30268 < ((-2 * div(\mathbf{heapIs} \$ heap_{funcstart\_724,1}, \$ heap_{funcstart\_724,1}.p1,
177).quot) + (171 * div(heapIs heapIs = f_{uncstart_{724,1}}, heap_{funcstart_{724,1}}.p1,
(177).rem))) \lor (176 < heap_{funcstart_{724,1}.p1}) \lor !(0 ==
(-\text{\$heap}_{funcstart\_724,1}.\text{p1} + \text{div}(\text{\textbf{heapIs}} \, \text{\$heap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p1, 177).rem}
\rightarrow [from\ term\ 62.0,\ div(\textbf{heapIs}\ \$heap_{funcstart\_724,1},\ \$heap_{funcstart\_724,1}.p1,
177).rem is equal to heap_{funcstart\_724,1}.p1
\label{eq:continuous} \textit{[64.1]} \ (30268 < ((-2 * div(\textbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1,
177).quot) + (171 * $heap_{funcstart\_724,1}.p1))) \vee ...
[Copy term 15.17]
\textit{[65.0]} \ (0 == (-\text{div}(\textbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).rem + ($\text{heap}_{funcstart\_724,1}.\text{p1} \% 177))) \lambda (176 < $\text{heap}_{funcstart\_724,1}.\text{p1})
```

```
\vee !(0 == (-\$heap_{funcstart\_724,1}.p1 + div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p1, 177).rem}
\rightarrow [from term 62.0, div(heapIs $heap_{funcstart\_724,1}$, $heap_{funcstart\_724,1}.p1,
177).rem is equal to heap_{funcstart\_724,1}.p1
[65.1] (0 == (-$heap_{funcstart_{-724,1}}.p1 + ($heap_{funcstart_{-724,1}}.p1 % 177))) \vee \dots
[Create new term from terms 1.23, 20.3 using rule: transitivity 11r]
[73.0] (1 + 30268 + (-32769 * 2)) < (171 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724.1}}.p1, 177).rem
\rightarrow [simplify]
[73.2] -35269 < (171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1,
177).rem)
\rightarrow [literal comparison of product]
[73.3] ([171 < 0]: (-35269 / -171) < -{\rm div}(\mathbf{heapIs}\ \$ \mathrm{heap}_{funcstart\_724,1},
\theta_{uncstart_{724,1},p1,177}.rem, [0 < 171]: (-35269 / 171) < div(heapIs)
\text{Sheap}_{funcstart\_724.1}, \text{Sheap}_{funcstart\_724.1}.\text{p1}, 177).\text{rem}, [0 == 171]: -35269 < 0)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[73.4] ([171 < 0]: (-35269 / -171) < -\text{div}(\text{heapIs } \text{\$heap}_{funcstart\_724,1},
heap_{funcstart-724,1}.p1, 177).rem, [(0 < 171) \land !(171 < 0)]: (-35269 / 171) < 0
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{rem}, \ [(0 == 171)]
\wedge !(0 < 171) \wedge !(171 < 0)]: -35269 < 0
\rightarrow [simplify]
[73.12] -207 < div(heapIs $heap_{funcstart_724,1}$, $heap_{funcstart_724,1}.p1$,
177).rem
[Assume known post-assertion, class invariant or type constraint for term 65.1]
[74.0] (\text{$heap_{funcstart\_724,1.p1} < 177}) \lor (176 < \text{$heap_{funcstart\_724,1.p1}) \lor!(0
== (-\$heap_{funcstart\_724,1}.p1 + div(heapIs \$heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177).rem
\rightarrow [simplify]
[74.3] (-177 < -\$heap_{funcstart\_724,1}.p1) \lor ...
[Copy term 1.23]
[76.0] 30268 < ((-2 * div(heapIs p_{funcstart_{-724,1}}, p_{funcstart_{-724,1}}, p_{funcstart_{-724,1}})
177).quot) + (171 * div(heapIs heapIs = f_{uncstart_{724,1}}, heap_{funcstart_{724,1}}, p_{total}
177).rem))
\rightarrow [from term 15.17, div(heapIs $heap_{funcstart\_724.1}, $heap_{funcstart\_724.1}.p1,
177).rem is equal to heap_{funcstart\_724,1}.p1 \% 177
[76.1] 30268 < ((-2 * div(heapIs p_{funcstart_{-724,1}}, p_{funcstart_{-724,1}}, p_{funcstart_{-724,1}})
177).quot) + (171 * (\text{$heap}_{funcstart\_724,1}.p1 % 177)))
```

```
[Copy term 64.1]
[77.0] \; (30268 < ((-2 * \operatorname{div}(\mathbf{heapIs} \; \$ \operatorname{heap}_{funcstart\_724,1}, \; \$ \operatorname{heap}_{funcstart\_724,1}.p1, \;
177).quot) + (171 * \text{$heap}_{funcstart\_724,1}.\text{p1}))) \vee (176 <
\theta_{funcstart\_724,1}.p1) \lor !(0 == (-\theta_{funcstart\_724,1}.p1 + div(\mathbf{heapIs}))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).rem)
\rightarrow [from\ term\ 14.17,\ div(\textbf{heapIs}\ \$heap_{funcstart\_724,1},\ \$heap_{funcstart\_724,1}.p1,
177).quot is equal to heap_{funcstart\_724,1}.p1 / 177
[77.1] (30268 < ((-2 * ($heap_{funcstart\_724,1}.p1 / 177)) + (171 *
heap_{funcstart_{-724,1}.p1})) \vee ...
\rightarrow [division by larger divisor]
    Proof of rule precondition 1:
    [77.1.0.0] \ \mathrm{literald} < -\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}
    \rightarrow [unify with term 74.3]
    [77.1.0.1] true
    Proof of rule precondition 2:
    [77.1.1.0] literalc < $heap<sub>funcstart_724,1.</sub>p1
    \rightarrow [unify with term 8.0]
    [77.1.1.1] true
    Proof of rule precondition 3:
    [77.1.2.0] --177 \le 177
    \rightarrow [simplify]
    [77.1.2.2] true
    Proof of rule precondition 4:
    [77.1.3.0] - 2 < 0
    \rightarrow [simplify]
    [77.1.3.1] true
[77.2] (30268 < ((-2 * $heap_{funcstart\_724,1}.p1) + (171 *
heap_{funcstart_{-724,1}.p1)} \vee \dots
\rightarrow [simplify]
[77.4] (30268 < (169 * \text{$heap}_{funcstart\_724,1.p1})) \lor ...
\rightarrow [literal comparison of product]
[77.5] ([169 < 0]: (30268 / -169) < -\$heap_{funcstart\_724,1}.p1, [0 < 169]: (30268
/ 169) < $heap_{funcstart_724,1}.p1, [0 == 169]: 30268 < 0) \vee ...
```

→ [explicitly assert falsehood of skipped guards in subsequent guards]

```
< 0)]: (30268 / 169) < \text{$heap}_{funcstart\_724,1}.p1, [(0 == 169) \land !(0 < 169) \land !(0 < 169) \land !(0 < 169)]
!(169 < 0)]: 30268 < 0) \lor ...
\rightarrow [simplify]
[77.13] (true \land (179 < $heap<sub>funcstart_724,1.</sub>p1)) \lor ...
\rightarrow [from term 74.3, literala < $heap<sub>funcstart_724,1</sub>.p1 is false whenever -2 <
(-177 + literala)
    Proof of rule precondition:
    [77.13.0] - 2 < (-177 + 179)
    \rightarrow [simplify]
    [77.13.2] true
[77.14] (true \wedge false) \vee ...
\rightarrow [simplify]
[77.15] false \vee ...
[Remove 'false' term 77.15 and fetch new term from containing clause]
\label{eq:fine_start_724,1.p1} \ensuremath{[78.0]}\ 176 < \$ heap_{funcstart\_724,1}.p1
[Remove 'false' term 77.15 and fetch new term from containing clause]
[79.0] !(0 == (-\$heap<sub>funcstart_724,1</sub>.p1 + div(heapIs \$heap<sub>funcstart_724,1</sub>,
heap_{funcstart_{-724,1}.p1, 177).rem}
[Create new term from term 14.17 using rule: condition for equality of division]
[83.0] ((177 * (0 + -(-\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}))) < (1 + \text{Sheap}_{funcstart\_724,1}.\text{p1})) \land
(\text{$heap}_{funcstart\_724,1}.\text{p1} < (177 * (0 + 1 + -(-div(\textbf{heapIs}))))
\text{Sheap}_{funcstart_{-724,1}}, \text{Sheap}_{funcstart_{-724,1}}.p1, 177).quot))))
\rightarrow [simplify]
[83.15] \; (-1 < ((-177 * \mathrm{div}(\mathbf{heapIs} \; \$ \mathrm{heap}_{funcstart\_724,1}, \; \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}, \; \$))))
177).quot) + \text{$heap}_{funcstart\_724,1.p1}) \(\lambda\) (-177 < (-\text{$heap}_{funcstart\_724,1.p1} +
(177 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart\_724,1}, \text{\$heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot})))
\rightarrow [separate conjunction and work on first sub-term]
[83.16] \ \hbox{-177} < (-\$ {\rm heap}_{funcstart\_724,1}.{\rm p1} + (177 \ * \ {\rm div}(\textbf{heapIs}
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).quot)
[Create new term from term 79.0 using rule: not-equal implies greater-than or
less-than]
[85.0] (0 < (-$heap_{funcstart_{724,1}}.p1 + div(heapIs $heap_{funcstart_{724,1}},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem})) \vee ((-\text{Sheap}_{funcstart\_724,1}.\text{p1} + \text{div}(\text{heapIs})))
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 177).rem < 0
```

[77.6] ([169 < 0]: (30268 / -169) < -\$heap_{funcstart_724,1.}p1, [(0 < 169) \wedge !(169

```
\rightarrow [simplify]
[85.5] (0 < (-$heap_{tuncstart_{-724,1}}.p1 + div(heapIs $heap_{tuncstart_{-724,1}},
\{\text{heap}_{funcstart\_724,1}, \text{p1}, 177\}.\text{rem}\} \lor \{\text{0} < (-\text{div}(\text{heapIs} \}\text{heap}_{funcstart\_724,1}, \text{p1})\}
heap_{funcstart_{724,1}.p1, 177}.rem + heap_{funcstart_{724,1}.p1}
[Branch on disjunction or conditional in term 85.5]
[86.0] (0 < (-div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p1,
177).rem + heap_{funcstart_{-724,1}.p1} \vee (0 < (-heap_{funcstart_{-724,1}.p1} +
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, \ 177).\operatorname{rem})) \lor !(0 <
(-{\rm div}(\mathbf{heapIs}\ \$ {\rm heap}_{funcstart\_724,1},\ \$ {\rm heap}_{funcstart\_724,1}.{\rm p1},\ 177).{\rm rem}\ +
heap_{funcstart_{724,1}.p1}
[Create new term from terms 86.0, 83.16 using rule: transitivity 1]
[89.0] ((-177 + 0 + 1) < (-div(heapIs $heap_{funcstart\_724,1},
\theta_{funcstart\_724,1.p1}, 177).rem + (177 * div(heapIs \theta_{funcstart\_724,1}),
\{\text{heap}_{funcstart\_724,1}.\text{p1}, 177\}.\text{quot}\}
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).rem)) \lor !(0 <
(-\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724.1}, \$ \text{heap}_{funcstart\_724.1}.\text{p1}, 177).\text{rem} +
heap_{funcstart\_724,1}.p1)
\rightarrow [simplify]
[89.1] \; (\text{-}176 < (-\text{div}(\textbf{heapIs} \; \$ \text{heap}_{funcstart\_724,1}, \, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, \,
177).rem + (177 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).quot))) \lor ...
[Create new term from terms 89.1, 73.12 using rule: transitivity 2]
[91.0] ((-207 + -176 + 1) < (177 * div(heapIs $heap_{funcstart\_724.1},
\$ heap_{funcstart\_724,1}.p1,\ 177).quot)) \ \lor \ (0 < (-\$ heap_{funcstart\_724,1}.p1 \ +
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).rem)) \lor !(0 <
(-\text{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.\text{p1}, \ 177).\text{rem} +
heap_{funcstart_{-724,1},p1}
\rightarrow [simplify]
[91.1] (-382 < (177 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1,
177).quot)) \vee ...
\rightarrow [literal comparison of product]
[91.2] ([177 < 0]: (-382 / -177) < -\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1},
\theta_{uncstart_{-724,1},p1,177}.quot, [0 < 177]: (-382 / 177) < div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}, [0 == 177]: -382 < 0)
```

 \rightarrow [explicitly assert falsehood of skipped guards in subsequent guards] [91.3] ([177 < 0]: (-382 / -177) < $-\text{div}(\mathbf{heapIs} \ \text{sheap}_{funcstart_724,1}, \ \text{sheap}_{funcstart_724,1}.\text{p1}, 177).\text{quot}, [(0 < 177) \land !(177 < 0)]: (-382 / 177) < <math>\text{div}(\mathbf{heapIs} \ \text{sheap}_{funcstart_724,1}, \ \text{sheap}_{funcstart_724,1}.\text{p1}, 177).\text{quot}, [(0 = 177) \land !(177) \land !(1$

```
177) \land !(0 < 177) \land !(177 < 0)]: -382 < 0) \lor ...
\rightarrow [simplify]
[91.11] (-3 < div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1,
177).quot) \vee \dots
[Create new term from terms 91.11, 76.1 using rule: transitivity 11]
[93.0] ((1 + 30268 + (-3 * 2)) < (171 * ($heap_{funcstart\_724,1}.p1 % 177))) \vee (0
< (-$heap<sub>funcstart_724,1</sub>.p1 + div(heapIs $heap<sub>funcstart_724,1</sub>,
\text{Sheap}_{funcstart\_724.1.pl}, 177).rem) \lor !(0 < (-\text{div}(\textbf{heapIs} \text{Sheap}_{funcstart\_724.1},
\$heap_{funcstart\_724,1}.p1,\ 177).rem + \$heap_{funcstart\_724,1}.p1))
\rightarrow [simplify]
[93.2] (30263 < (171 * (\$heap_{funcstart\_724.1}.p1 \% 177))) \lor ...
\rightarrow [literal comparison of product]
[93.3] ([171 < 0]: (30263 / -171) < -($heap_{funcstart\_724,1}.p1 % 177), [0 < 171]:
(30263 / 171) < (\$heap_{funcstart\_724,1}.p1 \% 177), [0 == 171]: 30263 < 0) \lor \dots
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[93.4] ([171 < 0]: (30263 / -171) < -($heap_funcstart_724,1.p1 % 177), [(0 <
171) \land !(171 < 0)]: (30263 / 171) < (\$heap_{funcstart\_724,1}.p1 \% 177), [(0 ==
171) \land !(0 < 171) \land !(171 < 0)]: 30263 < 0) \lor ...
\rightarrow [simplify]
[93.13] false \vee ...
[Remove 'false' term 93.13 and fetch new term from containing clause]
[94.0] 0 < (-\text{\$heap}_{funcstart\_724,1}.\text{p1} + \text{div}(\text{heapIs }\text{\$heap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p1, 177}.rem
[Create new term from terms 94.0, 78.0 using rule: transitivity 2]
[96.0] (0 + 1 + 176) < div(heapIs $heap_{funcstart_724.1}$, $heap_{funcstart_724.1}$,p1,
177).rem
\rightarrow [simplify]
[96.1] 177 < \text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}
[Create new term from terms 96.1, 15.17 using rule: transitivity 16]
[97.0] (0 + 177) < (\text{$heap}_{funcstart\_724.1}.p1 \% 177)
\rightarrow [simplify]
[97.2] false
```

Proof of verification condition: Assertion valid

Condition generated at: C:\Escher\Customers\prang\prang.c (62,12)

```
To prove: -asType<integer const>($heap<sub>724.1:745.8</sub>.M1) <
asType<integer>($heap<sub>724,1;745,8</sub>.p1)
Given:
heap_{init}.LIMIT == (int)80
\theta
\theta_{init}.r1 == asType < short int > ((int)171)
\theta
\theta = asType < short int > ((int)2)
heap_{init}.M2 == asType < short int > ((int)30307)
\theta
heap_{init}.a2 == asType < short int > ((int)176)
\theta
heap_{init}.M3 == asType < short int > ((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart_{-724,1}})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \ \operatorname{\$heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}))~\%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p1) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) = =
asType<integer>(div1.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a1}) \leq
asType < integer > (\$heap_{funcstart-724.1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
```

```
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
\label{eq:div2} \text{div2} == \text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}),
asType < int > (\$heap_{funcstart\_724.1}.a2))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) \%
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.rem)
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) ==
asType<integer>(div2.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a2) \le
asType < integer > (\$heap_{funcstart\_724.1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType < integer > (div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p3})) \ / \\
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3})) =>
(asType < integer > (\$heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a3) \le
asType < integer > (\$heap_{funcstart\_724,1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
```

```
asType < int > (\$heap_{tuncstart-724.1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
Proof:
[Take given term]
[5.0] invariant1(heapIs $heap_{funcstart\_724,1})
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
[5.1] ((((((0 < asType < integer > ($heap_{funcstart_724,1}.p1)) &&
(asType < integer > ($heap_{funcstart\_724,1}.p1) < 
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [simplify]
[5.3] (((((0 < \theta_{funcstart\_724,1.p1) && (\theta_{funcstart\_724,1.p1)
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 < function for the start of the start 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) <
as
Type<integer>(\rho_{funcstart\_724,1}.M2))) & (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [const static or extern object]
[5.4] (((((0 < \text{heap}_{funcstart\_724,1}.p1) && (\text{heap}_{funcstart\_724,1}.p1 <
asType < integer > (\$heap_{init}.M1))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 
asType<integer>(\theta_{tuncstart\_724,1}.M2))) && (0 <
asType < integer > (\$heap_{funcstart_{724,1}}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < $heap_{funcstart_{724,1}}.p1) && ($heap_{funcstart_{724,1}}.p1 < 
asType < integer > (asType < short int > ((int)30269)))) && (0 < integer) && (0 < integer
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
as
Type<integer>(\rho_{funcstart\_724,1}.M2))) & (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) <
```

```
asType < integer > (\$heap_{funcstart_{-724,1}}.M3))
\rightarrow [simplify]
[5.16] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.17] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \; \land \; (0 < \$heap_{funcstart\_724,1}.p1) \; \land 
(0 < \text{$heap}_{funcstart_{-724,1}.p2})) \&\& (\text{$heap}_{funcstart_{-724,1}.p2} <
asType < integer > (\$heap_{init}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M3}))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType < integer > (asType < short int > ((int)30307)))) && (0 < footnote{integer}) && (0 < footnote
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [simplify]
[5.30] ((-30307 < -$heap_{funcstart\_724,1}.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{724,1}.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.\text{p3} < \text{asType} < \text{integer} > (\text{\$heap}_{funcstart\_724,1}.\text{M3}))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \land (-30269 <
 -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.p2) \land (0 < \text{Sheap}_{funcstart\_724,1}.p3)) \&\&
(\text{\$heap}_{funcstart\_724,1}.\text{p3} < \text{asType} < \text{integer} > (\text{\$heap}_{init}.\text{M3}))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap<sub>funcstart_724,1.p2</sub>) \wedge (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{724,1}.p3})) \&\&
(\$heap_{funcstart\_724,1}.p3 < \mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{short}
int > ((int)30323)))
\rightarrow [simplify]
[5.40] (-30323 < -$heap_funcstart_724,1.p3) \land (-30307 <
```

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-\$heap_{funcstart\_724,1}.p2) \wedge (-30269 < -\$heap_{funcstart\_724,1}.p1) \wedge (0 <
\text{Sheap}_{funcstart\_724,1}.\text{p1}) \land (0 < \text{Sheap}_{funcstart\_724,1}.\text{p2}) \land (0 <
heap_{funcstart_{-724,1}.p3}
[Work on sub-term 3 of conjunction in term 5.40]
[7.0] -30269 < -$heap<sub>funcstart_724,1.</sub>p1
[Work on sub-term 4 of conjunction in term 5.40]
[8.0] 0 < $heap_{funcstart_724,1}.p1
[Take given term]
[11.0] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724.1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
\rightarrow [simplify]
[11.1] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType < int > (\$heap_{funcstart\_724,1}.a1))
\rightarrow [const static or extern object]
[11.2] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
asType < int > (\$heap_{init}.a1))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
[11.3] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType<int>(asType<short int>((int)177)))
\rightarrow [simplify]
[11.6] div1 == div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p1, 177)
[Assume known post-assertion, class invariant or type constraint for term 11.6]
[14.0] (asType<integer>(heap_{funcstart\_724,1}.p1) /
asType<integer>(177)) == asType<integer>(div(heapIs
\$heap_{funcstart\_724,1},\,\$heap_{funcstart\_724,1}.p1,\,177).quot)
\rightarrow [simplify]
[14.2] ($heap_{funcstart\_724,1}.p1 / 177) == asType < integer > (div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).quot
→ [expand definition of operator './' in class 'int' at built in declaration]
[14.3] ([asType<integer>($heap_{funcstart\_724,1}.p1) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177), []:
asType < integer > (\$heap_{funcstart\_724.1}.p1) / 177) = =
\mathbf{asType} {<} \mathbf{integer} {>} ( \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}, \\
177).quot)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
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```
[14.4] ([asType<integer>(sheap_{funcstart\_724,1}.p1) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177),
[!(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177) = =
asType<integer>(div(heapIs p_{funcstart\_724,1}, p_{funcstart\_724,1}),
177).quot)
\rightarrow [simplify]
[14.7] ([0 < -$heap<sub>funcstart_724,1.</sub>p1]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p1) / 177),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 0)]:
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1})~/~177) ==
asType<integer>(div(heapIs p_{funcstart\_724,1}, p_{funcstart\_724,1}),
177).quot)
\rightarrow [from term 8.0, literala < -$heap<sub>funcstart_724.1</sub>.p1 is false whenever -2 < (0
+ literala)]
    Proof of rule precondition:
    [14.7.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [14.7.2] true
[14.8] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) \; / \; 177),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 0)]:
asType < integer > (\$heap_{funcstart\_724.1}.p1) / 177) = =
asType<integer>(div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p1,
177).quot)
\rightarrow [simplify]
[14.11] \; ([{\bf false}]: \; -({\bf -asType}{<} {\bf integer}{>} (\$ {\rm heap}_{funcstart\_724,1}.{\rm p1}) \; / \; 177), \; [!(0 < 
-\$heap_{funcstart\_724,1}.p1)]: asType<integer>(\$heap_{funcstart\_724,1}.p1) / 177)
== asType < integer > (div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p1, 177}.quot)
\rightarrow [from term 8.0, literala < -$heap<sub>funcstart_724,1</sub>.p1 is false whenever -2 < (0
+ literala)]
    Proof of rule precondition:
    [14.11.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [14.11.2] true
[14.12] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) \; / \; 177),
[!false]: asType<integer>($heap<sub>funcstart_724,1.</sub>p1) / 177) ==
\mathbf{asType} < \mathbf{integer} > (\mathbf{div}(\mathbf{heapIs} \ \$ \mathbf{heap}_{funcstart\_724,1}, \ \$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}, \\
177).quot)
```

```
\rightarrow [simplify]
[14.17] 0 == (-\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).quot + (\text{$heap}_{funcstart\_724,1}.p1 / 177))
[Assume known post-assertion, class invariant or type constraint for term 11.6]
[15.0] (as
Type<integer>($heap_{funcstart\_724,1}.p1) \%
asType<integer>(177)) == asType<integer>(div(heapIs
\$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)
\rightarrow [simplify]
[15.2] (\text{heap}_{funcstart\_724,1}.p1 % 177) == asType<integer>(div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}
→ [expand definition of operator '.%' in class 'int' at built in declaration]
[15.3] ([asType<integer>(sheap_{funcstart\_724,1}.p1) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177), []:
asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177) ==
asType<integer>(div(heapIs $heap_{tuncstart\_724.1}, $heap_{tuncstart\_724.1}.p1,
177).rem)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[15.4] \; ([\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) < 0] :
-(-asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177) ==
\mathbf{asType} {<} \mathbf{integer} {>} ( \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}, \\
177).\text{rem}
\rightarrow [simplify]
[15.7] ([0 < -$heap<sub>funcstart_724,1</sub>.p1]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177) ==
asType<integer>(div(heapIs $heap_{tuncstart\_724.1}, $heap_{tuncstart\_724.1}.p1,
177).rem)
\rightarrow [from term 8.0, literala < -$heap<sub>funcstart_724,1</sub>.p1 is false whenever -2 < (0
+ literala)]
   Proof of rule precondition:
   [15.7.0] - 2 < (0 + 0)
   \rightarrow [simplify]
   [15.7.2] true
[15.8] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 0)]:
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asType < integer > (\$heap_{funcstart-724,1}.p1) \% 177) ==
\mathbf{asType} {<} \mathbf{integer} {>} ( \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}. \mathrm{p1}, \\
177).\text{rem}
\rightarrow [simplify]
[15.11] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p1) \% 177), [!(0)]
<-$heap<sub>funcstart_724.1</sub>.p1)]: asType<integer>($heap<sub>funcstart_724,1</sub>.p1) %
177) == asType<integer>(div(heapIs heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p1, 177}.rem
\rightarrow [from term 8.0, literala < -$heap<sub>funcstart_724,1</sub>.p1 is false whenever -2 < (0
+ literala)]
            Proof of rule precondition:
            [15.11.0] - 2 < (0 + 0)
            \rightarrow [simplify]
            [15.11.2] true
[15.12] ([false]: -(-asType < integer > (\$heap_{funcstart\_724.1}.p1) \% 177),
[!false]: asType<integer>(sheap_{funcstart\_724,1.p1}) \% 177 ==
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).rem)
\rightarrow [simplify]
[15.17] 0 == (-\operatorname{div}(\mathbf{heapIs} \ \hat{\mathbf{s}}_{funcstart\_724,1}, \ \hat{\mathbf{s}}_{funcstart\_724,1}.p1,
177).rem + (heap_{funcstart\_724,1}.p1 \% 177)
[Take given term]
[59.0] \rho_{1745,8} == \rho_{1745,8} == \rho_{1745,8} == \rho_{1745,8}._replace(p1 \rightarrow \rho_{1745,8} == \rho_{1745,8}
int>((asType<int>(asType<short int>(div1.rem)) *
\mathbf{asType} \small{<} \mathbf{int} \small{>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{r1})) \\ - (\mathbf{asType} \small{<} \mathbf{int} \small{>} (\mathbf{asType} \small{<} \mathbf{short}
int>(div1.quot)) * asType< int>($heap_{tuncstart\_724.1}.b1))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177)
[59.1] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},))
\theta_{funcstart\_724,1.p1, 177}.rem) * asType < int > (\theta_{funcstart\_724,1.p1, 177}.rem) - (\theta_{funcstart\_
(asType<int>(asType<short int>(div1.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [simplify]
[59.3] \rho_{1745,8} == \rho_{1745
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType < int > (\$heap_{tuncstart\_724.1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{tuncstart\_724.1}.b1))))
```

```
\rightarrow [const static or extern object]
[59.4] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType < int > (\$heap_{init}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1.quot})) * \mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
\rightarrow [expand definition of constant 'r1' at prang.c (15,20)]
[59.5] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType<int>(asType<short int>((int)171))) -
(asType < int > (asType < short int > (div1.quot)) *
asType < int > (\$heap_{funcstart_{-724.1}}.b1)))
\rightarrow [simplify]
[59.8] \rho_{724,1;745,8} == \rho_{funcstart\_724,1}.\_replace(p1 \rightarrow asType < short)
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem * 171)
- (asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177)
[59.9] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
\mathbf{int} > ((171 * \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, 177).\operatorname{rem})
- (asType<int>(asType<short int>(div(heapIs $heap_{funcstart_724.1},
heap_{funcstart_{724,1},p1, 177}, quot)) *
asType < int > (\$heap_{funcstart\_724.1}.b1)))
\rightarrow [simplify]
[59.11] \$ heap_{724,1;745,8} == \$ heap_{funcstart\_724,1}.\_\mathbf{replace} (p1 \to \mathbf{asType} < \mathbf{short})
int > ((171 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724.1}, \$ \text{heap}_{funcstart\_724.1}. \text{p1}, 177).\text{quot} *
asType < int > (\$heap_{funcstart\_724.1}.b1)))
\rightarrow [const static or extern object]
[59.12] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType < int > (\$heap_{init}.b1)))
\rightarrow [expand definition of constant 'b1' at prang.c (17,20)]
[59.13] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType<int>(asType<short int>((int)2))))
\rightarrow [simplify]
```

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[59.19] $heap<sub>724,1;745,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).rem)))
[Take goal term]
[1.0] -asType<integer const>($heap_{724,1;745,8}.M1) <
asType<integer>($heap<sub>724.1:745.8</sub>.p1)
\rightarrow [from term 59.19, $heap<sub>724,1;745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724,1}),
heap_{funcstart_{-724,1}}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart_{-724,1}})
heap_{funcstart_{724,1}.p1, 177).rem}
[1.1] -asType < integer const > (\$heap_{funcstart\_724.1}.\_replace(p1 \rightarrow ((-2 * 
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).rem))).M1) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{p1})
→ [const member of object with modified fields]
{\it [1.2]-asType}{<} \mathbf{integer\ const}{>} (\$ {\it heap}_{funcstart\_724,1}.{\it M1}) <
asType < integer > ($heap_{724,1;745,8}.p1)
\rightarrow [const static or extern object]
[1.3] -asType<integer const>($heap_{init}.M1) <
asType<integer>($heap<sub>724,1;745,8</sub>.p1)
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[1.4] -asType<integer const>(asType<short int>((int)30269)) <
asType<integer>($heap<sub>724.1:745.8</sub>.p1)
\rightarrow [simplify]
[1.8] -30269 < asType<integer>($heap_{724,1;745,8}.p1)
\rightarrow [from term 59.19, $heap<sub>724,1;745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.p1, 177).quot + (171 * div(\textbf{heapIs} \$heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177).rem)
[1.9] -30269 < asType<integer>($heap_funcstart_724,1._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}. p1, \ 177). \operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).rem))).p1)
\rightarrow [simplify]
 [1.11] -30269 < ((-2 * div(\mathbf{heapIs} \$ heap_{funcstart\_724,1}, \$ heap_{funcstart\_724,1}.p1,
177).quot) + (171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1,
177).rem))
\rightarrow [negate goal and search for contradiction]
[1.12]!(-30269 < ((-2 * div(heapIs $heap_{funcstart\_724,1},
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\text{Sheap}_{funcstart_{-724,1},p1, 177}.\text{quot}) + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart_{-724,1}})
heap_{funcstart_{-724,1}.p1, 177).rem}
\rightarrow [simplify]
 \label{eq:loss_loss} $[1.17] \ 30268 < ((2* \ \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}, 
177).quot) + (-171 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).rem))
[Copy term 1.17]
[79.0] 30268 < ((-171 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177).quot)
\rightarrow [from term 15.17, div(heapIs $heap_{funcstart\_724,1}$, $heap_{funcstart\_724,1}.p1,
177).rem is equal to heap_{funcstart\_724,1}.p1 \% 177
[79.1] 30268 < ((-171 * (\$heap_{funcstart\_724.1}.p1 \% 177)) + (2 * div(heapIs)]
\$ heap_{funcstart\_724,1}, \$ heap_{funcstart\_724,1}.p1, 177).quot))
[Create new term from term 14.17 using rule: condition for equality of division]
[83.0] ((177 * (0 + -(-\text{div}(\mathbf{heapIs} \$heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}))) < (1 + \text{Sheap}_{funcstart\_724,1}.\text{p1})) \land
(\text{\$heap}_{funcstart\_724,1}.\text{p1} < (177 * (0 + 1 + -(-\text{div}(\textbf{heapIs}))))
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 177).quot))))
\rightarrow [simplify]
[83.15] \; (-1 < ((-177 * \mathrm{div}(\mathbf{heapIs} \; \$ \mathrm{heap}_{funcstart\_724,1}, \; \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}, \; \$))))
(-177).quot) + \text{heap}_{funcstart\_724,1}.p1)) \land (-177 < (-\text{heap}_{funcstart\_724,1}.p1 +
(177*\operatorname{div}(\mathbf{heapIs}\ \$\operatorname{heap}_{funcstart\_724,1},\ \$\operatorname{heap}_{funcstart\_724,1}.\operatorname{p1},\ 177).\operatorname{quot})))
[Work on sub-term 2 of conjunction in term 83.15]
\label{eq:sheap_funcstart_724,1} \textit{$[84.0]$ -1 < ((-177 * div(\textbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, $]) | $(-177 * div(\textbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, \$heap_{funcstart\_
177).quot) + $heap<sub>funcstart_724.1</sub>.p1)
[Create new term from terms 84.0, 7.0 using rule: transitivity 2]
[118.0] (-30269 + -1 + 1) < (-177 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177).quot
\rightarrow [simplify]
[118.1] -30269 < (-177 * div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177).quot
\rightarrow [literal comparison of product]
[118.2] ([-177 < 0]: (-30269 / 177) < -\text{div}(\mathbf{heapIs} \ \$ heap_{funcstart\_724.1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}, [0 < -177]: (-30269 / -177) < \text{div}(\textbf{heapIs})
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}, [-177 == 0]: -30269 <
0)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
```

```
[118.3] ([-177 < 0]: (-30269 / 177) < -\text{div}(\mathbf{heapIs} \$ \mathbf{heap}_{funcstart\_724,1},
\theta_{1.7} = \theta_{1.7} + \theta_{1.7} = \theta_{1.7} = \theta_{1.7} + \theta_{1.7} = \theta_{1
< div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1, 177).quot, [(-177)
==0) \land !(-177 < 0) \land !(0 < -177)]: -30269 < 0)
\rightarrow [simplify]
[118.7] -172 < -\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).quot
[Create new term from terms 118.7, 79.1 using rule: transitivity 5]
[121.0] 30268 < ((-171 * ($heap_{funcstart\_724,1}.p1 % 177)) + (2 * -(-172 + 1)))
\rightarrow [simplify]
[121.5] 29926 < (-171 * (\$heap_{funcstart\_724,1}.p1 \% 177))
\rightarrow [literal comparison of product]
[121.6] ([-171 < 0]: (29926 / 171) < –($heap _{funcstart\_724,1}.p1 % 177), [0 <
-171]: (29926 / -171) < (\text{$heap}_{funcstart\_724,1}.\text{p1 } \% 177), [-171 == 0]: 29926 <
0)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
-171) \land !(-171 < 0)]: (29926 / -171) < ($heap_{funcstart\_724,1}.p1 % 177), [(-171
==0) \land !(-171 < 0) \land !(0 < -171)]: 29926 < 0)
\rightarrow [simplify]
[121.12] false
Proof of verification condition: Type constraint satisfied in explicit
conversion from 'int' to 'short int'
Condition generated at: C:\Escher\Customers\prang\prang.c (63,15)
Condition defined at:
To prove: minof(short int) \le div2.rem
Given:
heap_{init}.LIMIT == (int)80
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
```

 $$heap_{init}.r1 == asType < short int > ((int)171)$ $$heap_{init}.a1 == asType < short int > ((int)177)$ $$heap_{init}.b1 == asType < short int > ((int)2)$

 $\rho_{init}.M2 == asType < short int > ((int)30307)$ $\rho_{init}.r2 == asType < short int > ((int)172)$

```
\theta_{init}.a2 == asType<short int>((int)176)
\theta sheap<sub>init</sub>.b2 == asType<short int>((int)35)
\theta sheap<sub>init</sub>.M3 == asType<short int>((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
heap_{init}.b3 == asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
invariant
1<br/>( \mathbf{heapIs}\ \$ \mathbf{heap}_{funcstart\_724,1})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \ \operatorname{\$heap}_{funcstart\_724,1},
\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(asType<int>(asType<int>($heap_{tuncstart\_724.1}.p1)) /
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}))) = =
asType<integer>(div1.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) ==
asType<integer>(div1.rem))
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) /
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))) ==
asType<integer>(div2.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
```

```
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a2})) = >
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) ==
asType<integer>(div2.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a2}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}),
asType < int > (\$heap_{funcstart_{-724,1}}.a3))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(asType<int>(asType<int>($heap_{tuncstart\_724.1}.p3)) %
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a3}))) = =
asType<integer>(div3.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a3) \le
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})) => !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
heap_{724,1:745,8} == heap_{funcstart_{724,1}}.replace(p1 \rightarrow asType < short)
int>((asType<int>(asType<short int>(div1.rem)) *
\mathbf{asType} \hspace{-0.1em}<\hspace{-0.1em} \mathbf{int} \hspace{-0.1em}> \hspace{-0.1em} (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{r1})) - (\mathbf{asType} \hspace{-0.1em}<\hspace{-0.1em} \mathbf{int} \hspace{-0.1em}> \hspace{-0.1em} (\mathbf{asType} \hspace{-0.1em}<\hspace{-0.1em} \mathbf{short})
int>(div1.quot)) * asType<int>($heap_{funcstart\_724,1}.b1)))
-asType<integer const>($heap<sub>724,1:745,8</sub>.M1) <
asType<integer>($heap<sub>724,1:745,8</sub>.p1)
!(0 == asType < integer > (\$heap_{724,1:745.8}.p1))
asType<integer>($heap<sub>724.1:745.8</sub>.p1) <
asType<integer>($heap<sub>724,1:745,8</sub>.M1)
Proof:
[Take given term]
[5.0] invariant1(heapIs heap_{funcstart\_724,1})
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
```

```
 \texttt{[5.1]} \left( \left( \left( \left( \left( 0 < \mathbf{asType} < \mathbf{integer} > \left( \$ \mathsf{heap}_{funcstart\_724,1}.\mathsf{p1} \right) \right) \right. \&\& \right. \right. 
(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 
asType<integer>($heap_{funcstart\_724,1}.M1))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.3] (((((0 < \theta_{funcstart\_724,1.p1) && (\theta_{funcstart\_724,1.p1)
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M1})))~\&\&~(0<
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 < function 0)
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [const static or extern object]
[5.4] (((((0 < $heap_{funcstart_724,1}.p1) && ($heap_{funcstart_724,1}.p1 < function for the content of the 
asType < integer > (\$heap_{init}.M1))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType<integer>(heap_{funcstart\_724,1}.M2))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < $heap_{funcstart_{724,1}}.p1) && ($heap_{funcstart_{724,1}}.p1 < 
asType < integer > (asType < short int > ((int)30269)))) && (0 < footnote{integer}) && (0 < footnote
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart_{-724.1}}.M3))
\rightarrow [simplify]
[5.16] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1
(0 < \text{\$heap}_{funcstart\_724,1}.\text{p2})) \&\& (\text{\$heap}_{funcstart\_724,1}.\text{p2} <
as
Type<integer>(\rho_{funcstart\_724,1}.M2))) & (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p3) <
```

```
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [const static or extern object]
[5.17] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < \mathrm{\$heap}_{funcstart\_724,1}.\mathrm{p2})) && (\mathrm{\$heap}_{funcstart\_724,1}.\mathrm{p2} <
asType < integer > (\$heap_{init}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < \text{\$heap}_{funcstart_{-724,1},p2})) \&\& (\text{\$heap}_{funcstart_{-724,1},p2} <
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.30] ((-30307 < -$heap_{funcstart\_724,1}.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.p2) \land (0 < \text{Sheap}_{funcstart\_724,1}.p3)) \&\&
(\text{\$heap}_{funcstart\_724,1}.p3 < asType < integer > (\text{\$heap}_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -$heap_funcstart_724.1.p2) \land (-30269 <
-\$ heap_{funcstart\_724,1}.p1) \land (0 < \$ heap_{funcstart\_724,1}.p1) \land (0 < \$ heap_{funcstart\_724,1}.p1) \land (0 < \$ heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{724,1}.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.p3 < asType < integer > (\text{\$heap}_{init}.M3))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \land (-30269 <
 -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{724,1}.p3})) \&\&
(\text{sheap}_{funcstart\_724,1}.\text{p3} < \text{asType} < \text{integer} > (\text{asType} < \text{short})
int > ((int)30323)))
\rightarrow [simplify]
[5.40] (-30323 < -$heap<sub>funcstart_724,1.</sub>p3) \wedge (-30307 <
-\$heap_{funcstart\_724,1.p2}) \land (-30269 < -\$heap_{funcstart\_724,1.p1}) \land (0 < -\$heap_{funcstart\_724,1.p2})
\text{Sheap}_{funcstart\_724,1}.\text{p1}) \land (0 < \text{Sheap}_{funcstart\_724,1}.\text{p2}) \land (0 <
\$ heap_{funcstart\_724,1}.p3)
[Work on sub-term 5 of conjunction in term 5.40]
\textit{[9.0] 0} < \$ heap_{funcstart\_724,1}.p2
[Take given term]
```

```
[27.0] \operatorname{div2} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
\rightarrow [simplify]
[27.1] div2 == div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}.p2,
asType < int > (\$heap_{funcstart\_724,1}.a2))
\rightarrow [const static or extern object]
[27.2] div2 == div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p2,
asType < int > (\$heap_{init}.a2))
\rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
[27.3]~{\rm div2} == {\rm div}(\mathbf{heapIs}~\$ \mathrm{heap}_{funcstart\_724,1},\,\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2},
asType<int>(asType<short int>((int)176)))
\rightarrow [simplify]
[27.6] div2 == div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176)
[Assume known post-assertion, class invariant or type constraint for term 27.6]
[31.0] (asType<integer>(\ensuremath{\text{sheap}}_{funcstart\_724,1}.p2) %
asType<integer>(176)) == asType<integer>(div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem
\rightarrow [simplify]
[31.2] ($heap_{funcstart\_724,1}.p2 % 176) == asType<integer>(div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2, 176).rem
→ [expand definition of operator '.%' in class 'int' at built in declaration]
[31.3] ([asType<integer>(peqtin = 1.31.3) ([a
-(-asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176), []:
asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176) ==
asType<integer>(div(heapIs p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1})
176).rem)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[31.4] ([asType<integer>(sheap_{funcstart\_724,1.p2}) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176),
[!(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176) ==
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2,
176).rem)
\rightarrow [simplify]
[31.7] ([0 < -$heap<sub>funcstart_724,1.</sub>p2]:
-(-asType < integer > (\$heap_{funcstart\_724.1}.p2) \% 176),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 0)]:
```

```
asType < integer > (\$heap_{funcstart-724,1}.p2) \% 176) ==
\mathbf{asType} {<} \mathbf{integer} {>} ( \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}, \\
176).rem)
\rightarrow [from term 9.0, literala < -$heap<sub>funcstart_724,1.</sub>p2 is false whenever -2 < (0
+ literala)]
    Proof of rule precondition:
    [31.7.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [31.7.2] true
[31.8] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 0)]:
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) \% 176) ==
\mathbf{asType} < \mathbf{integer} > (\mathbf{div}(\mathbf{heapIs} \ \$ \mathbf{heap}_{funcstart\_724,1}, \ \$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}, \\
176).rem)
\rightarrow [simplify]
[31.11] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176), [!(0
<-$heap_{funcstart\_724,1}.p2)]: asType<integer>($heap_{funcstart\_724,1}.p2) %
176) == asType < integer > (div(heapIs \$heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p2, 176).rem
\rightarrow [from term 9.0, literala < -$heap<sub>funcstart_724,1</sub>.p2 is false whenever -2 < (0
+ literala)]
    Proof of rule precondition:
    [31.11.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [31.11.2] true
\textit{[31.12]} \ ( \textbf{[false]} : \ -(\textbf{-asType} < \textbf{integer} > (\$ \text{heap}_{funcstart\_724,1}.\text{p2}) \ \% \ 176),
[!false]: asType<integer>(sheap_{funcstart_724,1.p2}) \% 176 ==
\mathbf{asType} < \mathbf{integer} > (\mathbf{div}(\mathbf{heapIs} \$ \mathbf{heap}_{funcstart\_724,1}, \$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2},
176).rem)
\rightarrow [simplify]
[31.17] 0 == (-div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2,
176).rem + (\text{$heap}_{funcstart\_724,1}.p2 % 176))
[Assume known post-assertion, class invariant or type constraint for term
31.17
[38.0] \operatorname{\mathbf{minof}}(\operatorname{\mathbf{int}}) \leq \operatorname{div}(\operatorname{\mathbf{heapIs}} \operatorname{\$heap}_{funcstart\_724,1}, \operatorname{\$heap}_{funcstart\_724,1}.p2,
176).rem
\rightarrow [simplify]
```

```
[38.3] -32769 < div(heapIs $heap_{funcstart_{-724,1}}, $heap_{funcstart_{-724,1}}.p2,
176).rem
[Take goal term]
[1.0] minof(short int) \leq div2.rem
\rightarrow [simplify]
[1.1] -32768 \le \text{div} 2.\text{rem}
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{tuncstart\_724.1},
$heap_{funcstart\_724,1}.p2, 176)]
[1.2] \ -32768 \leq \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2},
176).rem
\rightarrow [simplify]
[1.4] -32769 < div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p2,
176).rem
\rightarrow [from term 38.3, literala < div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p2, 176}.rem is true whenever (-1 + literala) < -32769
   Proof of rule precondition:
   [1.4.0](-32769 + -1) < -32769
   \rightarrow [simplify]
   [1.4.2] true
[1.5] true
Proof of verification condition: Type constraint satisfied in explicit
conversion from 'int' to 'short int'
Condition generated at: C:\Escher\Customers\prang\prang.c (63,15)
Condition defined at:
To prove: div2.rem \le maxof(short int)
Given:
heap_{init}.LIMIT == (int)80
\theta
\theta
heap_{init}.a1 == asType < short int > ((int)177)
\theta
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
```

```
\theta_{init}.a2 == asType<short int>((int)176)
\theta sheap<sub>init</sub>.b2 == asType<short int>((int)35)
\theta sheap<sub>init</sub>.M3 == asType<short int>((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
heap_{init}.b3 == asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
invariant
1<br/>( \mathbf{heapIs}\ \$ \mathbf{heap}_{funcstart\_724,1})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \ \operatorname{\$heap}_{funcstart\_724,1},
\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(asType<int>(asType<int>($heap_{tuncstart\_724.1}.p1)) /
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}))) = =
asType<integer>(div1.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) ==
asType<integer>(div1.rem))
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) /
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))) ==
asType<integer>(div2.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
```

```
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a2})) = >
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) ==
asType<integer>(div2.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a2}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}),
asType < int > (\$heap_{funcstart_{-724,1}}.a3))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(asType<int>(sheap<sub>funcstart_724,1.</sub>p3)) %
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))) ==
asType<integer>(div3.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a3) \le
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})) => !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
heap_{724,1:745,8} == heap_{funcstart_{724,1}}.replace(p1 \rightarrow asType < short)
int>((asType<int>(asType<short int>(div1.rem)) *
\mathbf{asType} \hspace{-0.1em}<\hspace{-0.1em} \mathbf{int} \hspace{-0.1em}> \hspace{-0.1em} (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{r1})) - (\mathbf{asType} \hspace{-0.1em}<\hspace{-0.1em} \mathbf{int} \hspace{-0.1em}> \hspace{-0.1em} (\mathbf{asType} \hspace{-0.1em}<\hspace{-0.1em} \mathbf{short})
int>(div1.quot)) * asType<int>($heap_{funcstart\_724,1}.b1)))
-asType<integer const>($heap<sub>724,1:745,8</sub>.M1) <
asType<integer>($heap<sub>724,1:745,8</sub>.p1)
!(0 == asType < integer > (\$heap_{724,1:745.8}.p1))
asType<integer>($heap<sub>724.1:745.8</sub>.p1) <
asType<integer>($heap<sub>724,1:745,8</sub>.M1)
Proof:
[Take given term]
[5.0] invariant1(heapIs heap_{funcstart\_724,1})
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
```

```
 \texttt{[5.1]} \left( \left( \left( \left( \left( 0 < \mathbf{asType} < \mathbf{integer} > \left( \$ \mathsf{heap}_{funcstart\_724,1}.\mathsf{p1} \right) \right) \right. \&\& \right. \right. 
(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 
asType<integer>($heap_{funcstart\_724,1}.M1))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.3] (((((0 < \theta_{funcstart\_724,1.p1) && (\theta_{funcstart\_724,1.p1)
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M1})))~\&\&~(0<
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 < function for the sum of the 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [const static or extern object]
[5.4] (((((0 < $heap_{funcstart_{724,1}}.p1) && ($heap_{funcstart_{724,1}}.p1 < 
asType < integer > (\$heap_{init}.M1))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType<integer>(heap_{funcstart\_724,1}.M2))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] \ (((((0 < \text{\$heap}_{funcstart\_724,1}.\text{p1}) \&\& \ (\text{\$heap}_{funcstart\_724,1}.\text{p1} <
asType < integer > (asType < short int > ((int)30269)))) && (0 < footnote{integer}) && (0 < footnote
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart_{-724.1}}.M3))
\rightarrow [simplify]
[5.16] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1
(0 < \text{\$heap}_{funcstart\_724,1}.\text{p2})) && ($\text{$heap}_{funcstart\_724,1}.\text{$p2} < 0
as
Type<integer>(\rho_{funcstart\_724,1}.M2))) & (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p3) <
```

```
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [const static or extern object]
[5.17] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < \mathrm{\$heap}_{funcstart\_724,1}.\mathrm{p2})) && (\mathrm{\$heap}_{funcstart\_724,1}.\mathrm{p2} <
asType < integer > (\$heap_{init}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < \text{$heap}_{funcstart_{-724,1},p2})) \&\& (\text{$heap}_{funcstart_{-724,1},p2} <
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.30] ((-30307 < -$heap_{funcstart\_724,1}.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.p2) \land (0 < \text{Sheap}_{funcstart\_724,1}.p3)) \&\&
(\text{\$heap}_{funcstart\_724,1}.p3 < asType < integer > (\text{\$heap}_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -$heap_funcstart_724.1.p2) \land (-30269 <
-\$ heap_{funcstart\_724,1}.p1) \land (0 < \$ heap_{funcstart\_724,1}.p1) \land (0 < \$ heap_{funcstart\_724,1}.p1) \land (0 < \$ heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{724,1}.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.p3 < asType < integer > (\text{\$heap}_{init}.M3))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \land (-30269 <
 -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{724,1}.p3})) \&\&
(\text{sheap}_{funcstart\_724,1}.\text{p3} < \text{asType} < \text{integer} > (\text{asType} < \text{short})
int > ((int)30323)))
\rightarrow [simplify]
[5.40] (-30323 < -$heap<sub>funcstart_724,1.</sub>p3) \wedge (-30307 <
-\$heap_{funcstart\_724,1.p2}) \land (-30269 < -\$heap_{funcstart\_724,1.p1}) \land (0 <
\text{Sheap}_{funcstart\_724,1}.\text{p1}) \land (0 < \text{Sheap}_{funcstart\_724,1}.\text{p2}) \land (0 <
\$ heap_{funcstart\_724,1}.p3)
[Work on sub-term 5 of conjunction in term 5.40]
\textit{[9.0] 0} < \$ heap_{funcstart\_724,1}.p2
[Take given term]
```

```
[27.0] \operatorname{div2} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
\rightarrow [simplify]
[27.1] div2 == div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}.p2,
asType < int > (\$heap_{funcstart\_724,1}.a2))
\rightarrow [const static or extern object]
[27.2] div2 == div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p2,
asType < int > (\$heap_{init}.a2))
\rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
[27.3]~{\rm div2} == {\rm div}(\mathbf{heapIs}~\$ \mathrm{heap}_{funcstart\_724,1},\,\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2},
asType<int>(asType<short int>((int)176)))
\rightarrow [simplify]
[27.6] div2 == div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176)
[Assume known post-assertion, class invariant or type constraint for term 27.6]
[31.0] (asType<integer>(sheap_{funcstart\_724,1}.p2) %
asType < integer > (176)) == asType < integer > (div(heapIs))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem
\rightarrow [simplify]
[31.2] ($heap_{funcstart\_724,1}.p2 % 176) == asType<integer>(div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2, 176).rem
→ [expand definition of operator '.%' in class 'int' at built in declaration]
[31.3] ([asType<integer>(peqtylength{$^{13}$}) ([asType<integer>(peqtylength{$^{13}$}) ([asType<integer)):
-(-asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176), []:
asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176) ==
asType<integer>(div(heapIs p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1})
176).rem)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[31.4] ([asType<integer>(sheap_{funcstart\_724,1.p2}) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176),
[!(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176) ==
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2,
176).rem)
\rightarrow [simplify]
[31.7] ([0 < -$heap<sub>funcstart_724,1.</sub>p2]:
-(-asType < integer > (\$heap_{funcstart\_724.1}.p2) \% 176),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 0)]:
```

```
asType < integer > (\$heap_{funcstart-724,1}.p2) \% 176) ==
\mathbf{asType} {<} \mathbf{integer} {>} ( \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}, \\
176).rem)
\rightarrow [from term 9.0, literala < -$heap<sub>funcstart_724,1.</sub>p2 is false whenever -2 < (0
+ literala)]
    Proof of rule precondition:
    [31.7.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [31.7.2] true
[31.8] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 0)]:
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) \% 176) ==
\mathbf{asType} < \mathbf{integer} > (\mathbf{div}(\mathbf{heapIs} \ \$ \mathbf{heap}_{funcstart\_724,1}, \ \$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}, \\
176).rem)
\rightarrow [simplify]
[31.11] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176), [!(0
<-$heap_{funcstart\_724,1}.p2)]: asType<integer>($heap_{funcstart\_724,1}.p2) %
176) == asType < integer > (div(heapIs \$heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p2, 176).rem
\rightarrow [from term 9.0, literala < -$heap<sub>funcstart_724,1</sub>.p2 is false whenever -2 < (0
+ literala)
    Proof of rule precondition:
    [31.11.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [31.11.2] true
\textit{[31.12]} \ ( \textbf{[false]} : \ -(\textbf{-asType} < \textbf{integer} > (\$ \text{heap}_{funcstart\_724,1}.\text{p2}) \ \% \ 176),
[!false]: asType<integer>(sheap_{funcstart_724,1.p2}) \% 176 ==
\mathbf{asType} < \mathbf{integer} > (\mathbf{div}(\mathbf{heapIs} \$ \mathbf{heap}_{funcstart\_724,1}, \$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2},
176).rem)
\rightarrow [simplify]
[31.17] 0 == (-div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2,
176).rem + (\text{$heap}_{funcstart\_724,1}.p2 % 176))
[Assume known post-assertion, class invariant or type constraint for term
31.17
[39.0] div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}.p2, 176).rem \leq
maxof(int)
\rightarrow [simplify]
```

```
[39.9] -32768 < -\text{div}(\text{heapIs } \text{$heap}_{funcstart\_724,1}, \text{$heap}_{funcstart\_724,1}.p2,
176).rem
[Take goal term]
[1.0] div2.rem \leq maxof(short int)
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1}}.p2, 176
[1.1] div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem \leq
maxof(short int)
\rightarrow [simplify]
[1.10] -32768 < -\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p2},
176).rem
\rightarrow [from term 39.9, literala < -\text{div}(\text{heapIs } \text{\$heap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p2, 176).rem is true whenever (-1 + literala) < -32768
   Proof of rule precondition:
   [1.10.0](-32768 + -1) < -32768
   \rightarrow [simplify]
   [1.10.2] true
[1.11] true
Proof of verification condition: Type constraint satisfied in implicit
conversion from 'short int' to 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (63,15)
Condition defined at:
To prove: minof(int) \le asType < short int > (div2.rem)
Given:
heap_{init}.LIMIT == (int)80
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
\theta
\theta = asType < short int > ((int)35)
```

```
heap_{init}.M3 == asType < short int > ((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
heap_{init}.b3 == asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs $heap_{tuncstart_724.1})
div1 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}),
asType < int > (\$heap_{funcstart_{-724,1}}.a1))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) /
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}))) = =
asType<integer>(div1.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) ==
asType<integer>(div1.rem))
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724.1}.a2))) = =
asType<integer>(div2.quot)
(asType < integer > (asType < int > (\$heap_{tuncstart\_724,1}.p2)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p2) <
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a2})) = >
(asType < integer > (\$heap_{funcstart_{-724.1}}.p2) = =
```

```
asType<integer>(div2.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a2) \le
asType < integer > (\$heap_{funcstart\_724,1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
(asType<int>(asType<int>($heap_{tuncstart\_724.1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724.1}.a3))) = =
asType<integer>(div3.quot)
(asType<int>(asType<int>($heap_{funcstart\_724,1}.p3)) %
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a3}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
\$heap_{724,1;745,8} == \$heap_{funcstart\_724,1}.\_\textbf{replace}(p1 \rightarrow \textbf{asType} < \textbf{short}
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724.1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{tuncstart\_724.1}.b1))))
-\mathbf{asType}{<}\mathbf{integer}\ \mathbf{const}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{M1}) <
asType<integer>($heap<sub>724,1:745,8</sub>.p1)
!(0 == \mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathrm{heap}_{724,1;745,8}.\mathrm{p1}))
asType < integer > (\$heap_{724,1;745,8}.p1) <
asType < integer > (\$heap_{724,1;745,8}.M1)
Proof:
[Take given term]
[5.0] invariant1(heapIs heap_{funcstart\_724,1})
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
[5.1] ((((((0 < asType<integer>(heap_{funcstart\_724,1.p1)) &&
```

```
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}) <
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}))) \ \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p2) < 
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.3] (((((0 < \text{heap}_{funcstart\_724,1}.p1) && (\text{heap}_{funcstart\_724,1}.p1 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M1})))~\&\&~(0<
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))~\&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 < function for the sum of the 
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.4] (((((0 < \theta_{funcstart\_724,1.p1) && (\theta_{funcstart\_724,1.p1)
asType<integer>(heap_{init}.M1))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})))\ \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M3}))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < $heap_{funcstart_{724,1}}.p1) && ($heap_{funcstart_{724,1}}.p1 < 
asType<integer>(asType<short int>((int)30269)))) && (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})))\ \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M3}))
\rightarrow [simplify]
[5.16] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
\mathbf{asType} \small{<} \mathbf{integer} \small{>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M2}))) \ \&\& \ (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
```

```
\rightarrow [const static or extern object]
[5.17] \left( \left( \left( \left( -30269 < -\$ \text{heap}_{funcstart\_724,1}.\text{p1} \right) \right. \wedge \left. \left( 0 < \$ \text{heap}_{funcstart\_724,1}.\text{p1} \right) \right. \wedge \right. \right) \\
(0 < $heap_{funcstart\_724,1}.p2)) && ($heap_{funcstart\_724,1}.p2 <
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{init}.\mathbf{M2}))) \ \&\& \ (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \; \land \; (0 < \$heap_{funcstart\_724,1}.p1) \; \land 
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType < integer > (asType < short int > ((int)30307)))) \&\& (0 < integer)
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}) <
asType < integer > (\$heap_{funcstart\_724.1}.M3))
\rightarrow [simplify]
[5.30] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \wedge (-30269 <
 -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{-724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{-724,1}.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.p3 < asType < integer > (\text{\$heap}_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -$heap_{funcstart\_724,1}.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1.p2}) \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\$ heap_{funcstart\_724,1}.p3 < \textbf{asType} < \textbf{integer} > (\$ heap_{init}.M3))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap_{funcstart\_724,1}.p2) \land (-30269 <
-\$heap_{funcstart_{724,1}.p1}) \land (0 < \$heap_{funcstart_{724,1}.p1}) \land (0 <
\text{Sheap}_{funcstart_{724,1},p2} \land (0 < \text{Sheap}_{funcstart_{724,1},p3})) \&\&
(\text{sheap}_{funcstart\_724,1}.\text{p3} < \text{asType} < \text{integer} > (\text{asType} < \text{short})
int > ((int)30323)))
\rightarrow [simplify]
[5.40] (-30323 < -$heap_{funcstart\_724,1}.p3) \land (-30307 <
-\$heap_{funcstart\_724,1}.p2) \land (-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < -\$heap_{funcstart\_724,1}.p2)
\text{Sheap}_{funcstart\_724,1}.\text{p1}) \land (0 < \text{Sheap}_{funcstart\_724,1}.\text{p2}) \land (0 <
heap_{funcstart\_724,1}.p3
[Work on sub-term 5 of conjunction in term 5.40]
[9.0] 0 < \text{$heap}_{funcstart\_724,1}.p2
[Take given term]
[27.0] div2 == div(heapIs $heap_{funcstart\_724,1},
```

```
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}),
asType < int > (\$heap_{funcstart\_724,1}.a2))
\rightarrow [simplify]
[27.1] \ \mathrm{div2} == \ \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2},
asType < int > (\$heap_{funcstart\_724,1}.a2))
\rightarrow [const static or extern object]
[27.2] \operatorname{div2} == \operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p2,
asType < int > (\$heap_{init}.a2))
\rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
[27.3] \operatorname{div2} == \operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p2,
asType<int>(asType<short int>((int)176)))
\rightarrow [simplify]
[27.6] \text{ div2} == \text{div}(\text{heapIs } \text{$heap}_{funcstart\_724,1}, \text{$heap}_{funcstart\_724,1}.p2, 176)
[Assume known post-assertion, class invariant or type constraint for term 27.6]
[31.0] (as
Type<integer>($heap_{funcstart\_724,1}.p2) \%
asType<integer>(176)) == asType<integer>(div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem
\rightarrow [simplify]
[31.2] ($heap<sub>funcstart_724,1.</sub>p2 % 176) == asType<integer>(div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem
→ [expand definition of operator '.%' in class 'int' at built in declaration]
[31.3] ([asType<integer>(sheap_{funcstart\_724,1}.p2) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176), []:
asType < integer > (\$heap_{funcstart\ 724,1}.p2) \% 176) ==
asType<integer>(div(heapIs $heap_funcstart_724.1, $heap_funcstart_724.1.p2,
176).rem)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[31.4] ([asType<integer>(sheap_{funcstart_{-724,1}}.p2) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724.1}.p2) \% 176),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 0)]:
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) \% \ 176) = =
\mathbf{asType} \small{<} \mathbf{integer} \small{>} ( \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}, \\
176).rem)
\rightarrow [simplify]
[31.7] ([0 < -$heap<sub>funcstart_724,1</sub>.p2]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176) ==
```

```
asType<integer>(div(heapIs $heap_{tuncstart_724.1}, $heap_{tuncstart_724.1.p2},
176).rem)
\rightarrow [from term 9.0, literala < -$heap<sub>funcstart_724,1.</sub>p2 is false whenever -2 < (0
+ literala)]
    Proof of rule precondition:
    [31.7.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [31.7.2] true
[31.8] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176) ==
\mathbf{asType} {<} \mathbf{integer} {>} ( \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}, \\
176).rem)
\rightarrow [simplify]
[31.11] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176), [!(0
<-$heap<sub>funcstart_724,1.</sub>p2)]: asType<integer>($heap<sub>funcstart_724,1.</sub>p2) %
176) == asType < integer > (div(heapIs \$heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p2, 176}.rem
\rightarrow [from term 9.0, literala < -$heap<sub>funcstart_724,1</sub>.p2 is false whenever -2 < (0
+ literala)
    Proof of rule precondition:
    [31.11.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [31.11.2] true
[31.12] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176),
[!false]: asType<integer>(peq_{funcstart\_724,1}.p2) % 176) ==
asType<integer>(div(heapIs $heap_{tuncstart\_724.1}, $heap_{tuncstart\_724.1}.p2,
176).rem)
\rightarrow [simplify]
[31.17] 0 == (-div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2,
176).rem + (\text{$heap}_{funcstart\_724,1}.p2 \% 176))
[Assume known post-assertion, class invariant or type constraint for term
31.17
[38.0] \operatorname{\mathbf{minof}}(\operatorname{\mathbf{int}}) \leq \operatorname{div}(\operatorname{\mathbf{heapIs}} \operatorname{\$heap}_{funcstart\_724,1}, \operatorname{\$heap}_{funcstart\_724,1}.\operatorname{p2},
176).rem
\rightarrow [simplify]
\label{eq:constant_724,1} \mbox{-}38.3 \mbox{]} \mbox{-}32769 < \mbox{div}(\mathbf{heapIs} \mbox{\$heap}_{funcstart\_724,1}, \mbox{\$heap}_{funcstart\_724,1}.p2,
```

```
176).rem
[Take goal term]
[1.0] minof(int) \leq asType<short int>(div2.rem)
\rightarrow [simplify]
[1.1] -32768 \leq asType<short int>(div2.rem)
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p2, 176)
[1.2] -32768 \leq asType<short int>(div(heapIs $heap<sub>funcstart-724,1</sub>,
heap_{funcstart_{724,1}}.p2, 176).rem
\rightarrow [simplify]
[1.5] -32769 < \text{div}(\text{heapIs } \text{\$heap}_{funcstart\_724,1}, \text{\$heap}_{funcstart\_724,1}.p2,
176).rem
\rightarrow [from term 38.3, literala < div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p2, 176).rem is true whenever (-1 + literala) < -32769
   Proof of rule precondition:
   [1.5.0](-32769 + -1) < -32769
   \rightarrow [simplify]
   [1.5.2] true
[1.6] true
Proof of verification condition: Type constraint satisfied in implicit
conversion from 'short int' to 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (63,15)
Condition defined at:
To prove: asType < short int > (div2.rem) \le maxof(int)
Given:
heap_{init}.LIMIT == (int)80
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
```

```
\theta sheap<sub>init</sub>.b2 == asType<short int>((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
heap_{init}.b3 == asType < short int > ((int)63)
\theta
\theta
\theta = asType < short int > ((int)3)
invariant
1(heap<br/>Is \theta_{funcstart\_724,1}
div1 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ / \ 
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(asType < integer > ($heap_{funcstart\_724,1}.p1) < 
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) ==
asType<integer>(div1.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathtt{a1}) \leq
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1})) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p2})) \ / \\
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))) ==
asType<integer>(div2.quot)
(asType < integer > (asType < int > (\$heap_{tuncstart\_724.1}.p2)) \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.rem)
(asType<integer>($heap_{tuncstart\_724,1}.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
```

```
(\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}) = =
asType<integer>(div2.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a2) \le
asType < integer > (\$heap_{funcstart\_724,1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
(asType<int>(asType<int>($heap_{tuncstart\_724.1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) \%
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a3}))) = =
asType<integer>(div3.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(asType < integer > ($heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a3) \le
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})) => !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
\$heap_{724,1;745,8} == \$heap_{funcstart\_724,1}.\_\textbf{replace}(p1 \rightarrow \textbf{asType} < \textbf{short}
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1.quot})) * \mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
-{\bf asType}{<} {\bf integer~const}{>} (\${\rm heap}_{724,1;745,8}.{\rm M1}) <
asType<integer>($heap<sub>724,1:745,8</sub>.p1)
!(0 == asType < integer > (\$heap_{724,1:745.8}.p1))
asType < integer > (\$heap_{724,1;745,8}.p1) <
asType<integer>($heap<sub>724.1:745.8</sub>.M1)
Proof:
[Take given term]
[5.0] invariant1(heapIs heap_{funcstart\_724,1})
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
```

```
 \texttt{[5.1]} \left( \left( \left( \left( \left( 0 < \mathbf{asType} < \mathbf{integer} > \left( \$ \mathsf{heap}_{funcstart\_724,1}.\mathsf{p1} \right) \right) \right. \&\& \right. \right. 
(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 
asType<integer>($heap_{funcstart\_724,1}.M1))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.3] (((((0 < \theta_{funcstart\_724,1.p1) && (\theta_{funcstart\_724,1.p1)
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M1})))~\&\&~(0<
asType < integer > ($heap_{funcstart\_724,1}.p2))) &&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 < function for the start of the start 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [const static or extern object]
[5.4] (((((0 < $heap_{funcstart_{724,1}}.p1) && ($heap_{funcstart_{724,1}}.p1 < 
asType < integer > (\$heap_{init}.M1))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType<integer>(heap_{funcstart\_724,1}.M2))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < $heap_{funcstart_{724,1}}.p1) && ($heap_{funcstart_{724,1}}.p1 < 
asType < integer > (asType < short int > ((int)30269)))) && (0 < footnote{integer}) && (0 < footnote
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(asType<integer>($heap_funcstart_724.1.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart_{-724.1}}.M3))
\rightarrow [simplify]
[5.16] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1
(0 < \text{\$heap}_{funcstart\_724,1}.\text{p2})) && ($\text{$heap}_{funcstart\_724,1}.\text{$p2} < 0
as
Type<integer>(\rho_{funcstart\_724,1}.M2))) & (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p3) <
```

```
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [const static or extern object]
[5.17] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < \mathrm{\$heap}_{funcstart\_724,1}.\mathrm{p2})) && (\mathrm{\$heap}_{funcstart\_724,1}.\mathrm{p2} <
asType < integer > (\$heap_{init}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < \text{$heap}_{funcstart_{-724,1},p2})) \&\& (\text{$heap}_{funcstart_{-724,1},p2} <
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.30] ((-30307 < -$heap_{funcstart\_724,1}.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.p2) \land (0 < \text{Sheap}_{funcstart\_724,1}.p3)) \&\&
(\text{\$heap}_{funcstart\_724,1}.p3 < asType < integer > (\text{\$heap}_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -$heap_{tuncstart_724,1}.p2) \land (-30269 <
-\$ heap_{funcstart\_724,1}.p1) \land (0 < \$ heap_{funcstart\_724,1}.p1) \land (0 < \$ heap_{funcstart\_724,1}.p1) \land (0 < \$ heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{724,1}.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.p3 < asType < integer > (\text{\$heap}_{init}.M3))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \land (-30269 <
 -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{724,1}.p3})) \&\&
(\text{sheap}_{funcstart\_724,1}.\text{p3} < \text{asType} < \text{integer} > (\text{asType} < \text{short})
int > ((int)30323)))
\rightarrow [simplify]
[5.40] (-30323 < -$heap<sub>funcstart_724,1.</sub>p3) \wedge (-30307 <
-\$heap_{funcstart\_724,1.p2}) \land (-30269 < -\$heap_{funcstart\_724,1.p1}) \land (0 <
\text{Sheap}_{funcstart\_724,1}.\text{p1}) \land (0 < \text{Sheap}_{funcstart\_724,1}.\text{p2}) \land (0 <
\$ heap_{funcstart\_724,1}.p3)
[Work on sub-term 5 of conjunction in term 5.40]
\textit{[9.0] 0} < \$ heap_{funcstart\_724,1}.p2
[Take given term]
```

```
[27.0] \operatorname{div2} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
\rightarrow [simplify]
[27.1] div2 == div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}.p2,
asType < int > (\$heap_{funcstart\_724,1}.a2))
\rightarrow [const static or extern object]
[27.2] div2 == div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p2,
asType < int > (\$heap_{init}.a2))
\rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
[27.3]~{\rm div2} == {\rm div}(\mathbf{heapIs}~\$ \mathrm{heap}_{funcstart\_724,1},\,\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2},
asType<int>(asType<short int>((int)176)))
\rightarrow [simplify]
[27.6] div2 == div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176)
[Assume known post-assertion, class invariant or type constraint for term 27.6]
[31.0] (asType<integer>(\ensuremath{\text{sheap}}_{funcstart\_724,1}.p2) %
asType < integer > (176)) == asType < integer > (div(heapIs))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem
\rightarrow [simplify]
[31.2] ($heap_{funcstart\_724,1}.p2 % 176) == asType<integer>(div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2, 176).rem
→ [expand definition of operator '.%' in class 'int' at built in declaration]
[31.3] ([asType<integer>(peqtylength{$^{13}$}) ([asType<integer>(peqtylength{$^{13}$}) ([asType<integer)):
-(-asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176), []:
asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176) ==
asType<integer>(div(heapIs p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1})
176).rem)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[31.4] ([asType<integer>(sheap_{funcstart\_724,1.p2}) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176),
[!(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176) ==
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2,
176).rem)
\rightarrow [simplify]
[31.7] ([0 < -$heap<sub>funcstart_724,1.</sub>p2]:
-(-asType < integer > (\$heap_{funcstart\_724.1}.p2) \% 176),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 0)]:
```

```
asType < integer > (\$heap_{funcstart-724,1}.p2) \% 176) ==
\mathbf{asType} {<} \mathbf{integer} {>} ( \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}, \\
176).rem)
\rightarrow [from term 9.0, literala < -$heap<sub>funcstart_724,1.</sub>p2 is false whenever -2 < (0
+ literala)]
    Proof of rule precondition:
    [31.7.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [31.7.2] true
[31.8] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 0)]:
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) \% 176) ==
\mathbf{asType} < \mathbf{integer} > (\mathbf{div}(\mathbf{heapIs} \ \$ \mathbf{heap}_{funcstart\_724,1}, \ \$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}, \\
176).rem)
\rightarrow [simplify]
[31.11] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176), [!(0
<-$heap_{funcstart\_724,1}.p2)]: asType<integer>($heap_{funcstart\_724,1}.p2) %
176) == asType < integer > (div(heapIs \$heap_{funcstart\_724,1},
\theta_{funcstart\_724,1}.p2, 176).rem
\rightarrow [from term 9.0, literala < -$heap<sub>funcstart_724,1</sub>.p2 is false whenever -2 < (0
+ literala)
    Proof of rule precondition:
    [31.11.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [31.11.2] true
\textit{[31.12]} \ ( \textbf{[false]} : \ -(\textbf{-asType} < \textbf{integer} > (\$ \text{heap}_{funcstart\_724,1}.\text{p2}) \ \% \ 176),
[!false]: asType<integer>(sheap_{funcstart_724,1.p2}) \% 176 ==
\mathbf{asType} < \mathbf{integer} > (\mathbf{div}(\mathbf{heapIs} \$ \mathbf{heap}_{funcstart\_724,1}, \$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2},
176).rem)
\rightarrow [simplify]
[31.17] 0 == (-div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2,
176).rem + (\text{$heap}_{funcstart\_724,1}.p2 % 176))
[Assume known post-assertion, class invariant or type constraint for term
31.17
[39.0] div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}.p2, 176).rem \leq
maxof(int)
\rightarrow [simplify]
```

```
\label{eq:continuous} \textit{[39.9] -32768} < -\text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p2},
176).rem
[Take goal term]
[1.0] asType<short int>(div2.rem) \leq maxof(int)
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p2, 176)
[1.1] asType<short int>(div(heapIs heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).rem \leq \text{maxof(int)}
\rightarrow [simplify]
[1.11] -32768 < -\text{div}(\text{heapIs } \text{$heap}_{funcstart\_724,1}, \text{$heap}_{funcstart\_724,1}.\text{p2},
176).rem
\rightarrow [from term 39.9, literala < -\text{div}(\text{heapIs } \text{\$heap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p2, 176).rem is true whenever (-1 + literala) < -32768
   Proof of rule precondition:
   [1.11.0](-32768 + -1) < -32768
   \rightarrow [simplify]
   [1.11.2] true
[1.12] true
Proof of verification condition: Type constraint satisfied in implicit
conversion from 'short int const' to 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (63,10)
Condition defined at:
To prove: minof(int) \le \$heap_{724,1;745,8}.r2
Given:
heap_{init}.LIMIT == (int)80
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
\theta
\theta = asType < short int > ((int)35)
```

```
heap_{init}.M3 == asType < short int > ((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
heap_{init}.b3 == asType < short int > ((int)63)
\theta
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs $heap_{tuncstart_724.1})
div1 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}),
asType < int > (\$heap_{funcstart_{-724,1}}.a1))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) /
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}))) = =
asType<integer>(div1.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) ==
asType<integer>(div1.rem))
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724.1}.a2))) = =
asType<integer>(div2.quot)
(asType < integer > (asType < int > (\$heap_{tuncstart\_724,1}.p2)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p2) <
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a2})) = >
(asType < integer > (\$heap_{funcstart_{-724.1}}.p2) = =
```

```
asType<integer>(div2.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a2) \le
asType < integer > (\$heap_{funcstart\_724,1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
(asType<int>(asType<int>($heap_{tuncstart\_724.1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724.1}.a3))) = =
asType<integer>(div3.quot)
(asType<int>(asType<int>($heap_{funcstart\_724,1}.p3)) %
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p3) <
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a3}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
\$heap_{724,1;745,8} == \$heap_{funcstart\_724,1}.\_\textbf{replace}(p1 \rightarrow \textbf{asType} < \textbf{short}
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724.1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{tuncstart\_724.1}.b1))))
-\mathbf{asType}{<}\mathbf{integer}\ \mathbf{const}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{M1}) <
asType<integer>($heap<sub>724,1:745,8</sub>.p1)
!(0 == \mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathrm{heap}_{724,1;745,8}.\mathrm{p1}))
asType < integer > (\$heap_{724,1;745,8}.p1) <
\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{724,1;745,8}.\mathrm{M1})
Proof:
[Take given term]
[11.0] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
\rightarrow [simplify]
```

```
\textit{[11.1]} \ \text{div1} == \text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
asType < int > (\$heap_{funcstart\_724,1}.a1))
\rightarrow [const static or extern object]
\textit{[11.2]} \ \text{div1} == \text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
asType < int > (\$heap_{init}.a1))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
[11.3] div1 == div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p1,
asType<int>(asType<short int>((int)177)))
\rightarrow [simplify]
[11.6] div1 == div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1, 177)
[Take given term]
[59.0] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
\mathbf{asType} \small{<} \mathbf{int} \small{>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{r1})) - (\mathbf{asType} \small{<} \mathbf{int} \small{>} (\mathbf{asType} \small{<} \mathbf{short}
int>(div1.quot)) * asType< int>($heap_{tuncstart\_724.1}.b1))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1}}.p1, 177
[59.1] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},))
\theta_{funcstart\_724,1}.p1, 177).rem ** asType<int>(\theta_{funcstart\_724,1}.r1)) -
(asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724.1}.b1))))
\rightarrow [simplify]
[59.3] \rho_{1745,8} == \rho_{1745,8} == \rho_{1745,8} == \rho_{1745,8}._replace(p1 \rightarrow \rho_{1745,8} == \rho_{1745,8})
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType < int > (\$heap_{tuncstart\_724.1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{tuncstart\_724.1}.b1))))
\rightarrow [const static or extern object]
\text{[59.4] \$heap}_{724,1;745,8} == \$heap_{funcstart\_724,1}.\_\textbf{replace}(p1 \rightarrow \textbf{asType} < \textbf{short}
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{init}.\mathbf{r1})) - (\mathbf{asType} < \mathbf{int} > (\mathbf{asType} < \mathbf{short}))
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
\rightarrow [expand definition of constant 'r1' at prang.c (15,20)]
[59.5] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType<int>(asType<short int>((int)171))) -
(asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724.1}.b1))))
```

```
\rightarrow [simplify]
[59.8] \rho_{724,1;745,8} == \rho_{funcstart\_724,1}.\_replace(p1 \rightarrow asType < short)
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem * 171)
- (asType<int>(asType<short int>(div1.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1}}.p1, 177
[59.9] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
\mathbf{int} > ((171 * \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, 177).\operatorname{rem})
- (asType < int > (asType < short int > (div(heapIs $heap_{funcstart\_724,1}, 
heap_{funcstart_{-724,1}}.p1, 177).quot)
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [simplify]
[59.11] \rho_{124,1;745,8} == \rho_{
int>((171 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\textbf{heapIs} \$ \text{heap}_{funcstart\_724.1}, \$ \text{heap}_{funcstart\_724.1}. \text{p1}, 177).\text{quot} *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [const static or extern object]
[59.12] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
\mathbf{int} > ((171 * \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, 177).\operatorname{rem})
- (div(heapIs \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1.p1}, 177).quot *
asType < int > (\$heap_{init}.b1)))
\rightarrow [expand definition of constant 'b1' at prang.c (17,20)]
[59.13] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType<int>(asType<short int>((int)2))))
\rightarrow [simplify]
[59.19] $\text{heap}_{724,1:745,8} == \text{$heap}_{funcstart\_724,1}._\text{$replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, \ 177).\operatorname{rem})))
[Take goal term]
[1.0] minof(int) \leq $heap<sub>724,1;745,8</sub>.r2
\rightarrow [simplify]
[1.1] -32768 \leq $heap<sub>724,1;745,8</sub>.r2
\rightarrow [from term 59.19, $heap<sub>724.1:745.8</sub> is equal to
heap_{funcstart\_724.1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724.1}),
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs p_{funcstart\_724,1}),
heap_{funcstart_{-724,1}}.p1, 177).rem)
```

```
[1.2] -32768 \leq $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 * div(heapIs)
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p1, 177).quot) + (171 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).rem))).r2
\rightarrow [const member of object with modified fields]
[1.3] -32768 \le \text{$heap}_{funcstart\_724,1}.r2
\rightarrow [const static or extern object]
[1.4] -32768 \le \text{$heap}_{init}.r2
\rightarrow [expand definition of constant 'r2' at prang.c (20,20)]
[1.5] -32768 \le asType < short int > ((int)172)
\rightarrow [simplify]
[1.8] true
Proof of verification condition: Type constraint satisfied in implicit
conversion from 'short int const' to 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (63,10)
Condition defined at:
To prove: heap_{724,1:745,8}.r2 \le maxof(int)
Given:
heap_{init}.LIMIT == (int)80
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta
heap_{init}.M2 == asType < short int > ((int)30307)
\theta_{init}.r2 == asType<short int>((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta
\theta
```

```
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart_{-724,1}})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \ \operatorname{\$heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ / \\
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))) = =
asType<integer>(div1.quot)
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}))) = =
asType<integer>(div1.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p1) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) = =
asType<integer>(div1.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathtt{a1}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart_{-724.1}},
asType < int > (\$heap_{funcstart\_724.1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
(asType<integer>(asType<int>($heap_{funcstart\_724,1}.p2)) /
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType < integer > (div2.quot)
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}))~\%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.rem)
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}) ==
asType<integer>(div2.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a2) \le
asType < integer > (\$heap_{funcstart\_724,1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart_{-724.1}},
asType < int > (\$heap_{funcstart\_724,1}.p3),
```

```
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
(asType<int>(sheap<sub>funcstart_724,1</sub>.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.rem)
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}) ==
asType<integer>(div3.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a3) \le
\mathbf{asType} \small{<} \mathbf{integer} \small{>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3})) => !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1.quot})) * \mathbf{asType}{<} \mathbf{int}{>} (\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
-asType<integer const>($heap<sub>724.1:745.8</sub>.M1) <
asType<integer>($heap<sub>724,1:745,8</sub>.p1)
!(0 == asType < integer > (\$heap_{724,1:745.8}.p1))
asType < integer > (\$heap_{724,1;745,8}.p1) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{M1})
Proof:
[Take given term]
[11.0] div1 == div(heapIs heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
\rightarrow [simplify]
[11.1] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \operatorname{\$heap}_{funcstart\_724,1}, \operatorname{\$heap}_{funcstart\_724,1}.p1,
asType < int > (\$heap_{funcstart\_724,1}.a1))
\rightarrow [const static or extern object]
[11.2] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType < int > (\$heap_{init}.a1))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
 [11.3] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}, \\
```

```
asType<int>(asType<short int>((int)177)))
\rightarrow [simplify]
[11.6] div1 == div(heapIs $heap_{funcstart\_724,1}$, $heap_{funcstart\_724,1}.p1, 177)
[Take given term]
[59.0] \rho_{1745,8} == \rho_{1745,8} == \rho_{1745,8} == \rho_{1745,8} - \rho_{1745,8} == \rho_{1745,8}
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{tuncstart\_724.1}.b1))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart_{724,1}},
heap_{funcstart_{-724,1}}.p1, 177)
[59.1] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div(heapIs $heap_{tuncstart\_724.1},
\text{sheap}_{funcstart\_724.1}.\text{p1}, 177).\text{rem} ** asType<int>(\text{sheap}_{funcstart\_724.1}.\text{r1})) -
(asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [simplify]
[59.3] \rho_{724,1;745,8} == \rho_{funcstart\_724,1}.\_replace(p1 \rightarrow asType < short)
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1.quot})) \ * \ \mathbf{asType}{<} \mathbf{int}{>} (\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
\rightarrow [const static or extern object]
[59.4] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType < int > (\$heap_{init}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{tuncstart\_724.1}.b1))))
\rightarrow [expand definition of constant 'r1' at prang.c (15,20)]
[59.5] \rho_{724,1;745,8} == \rho_{funcstart\_724,1}.\_replace(p1 \rightarrow asType < short)
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType<int>(asType<short int>((int)171))) -
(asType<int>(asType<short int>(div1.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [simplify]
[59.8] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem * 171)
- (asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart_724,1},
heap_{funcstart_{-724,1}}.p1, 177
[59.9] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
```

```
int>((171 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)
- (asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1}}.p1, 177).quot) *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [simplify]
[59.11] \theta == 
int>((171 * div(heapIs $heap_{funcstart_724,1}, $heap_{funcstart_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [const static or extern object]
[59.12] $\text{heap}_{724.1:745.8} == $\text{heap}_{funcstart\_724.1}._\text{replace}(p1 \rightarrow \text{asType} < \text{short}
int>((171 * div(heapIs \$heap_{funcstart\_724.1}, \$heap_{funcstart\_724.1}, p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{init}.\mathrm{b1}))))
\rightarrow [expand definition of constant 'b1' at prang.c (17,20)]
[59.13] heap_{724,1;745,8} == heap_{funcstart\_724,1}. replace(p1 \rightarrow asType<short
int>((171 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)
- (div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1, 177).quot *
asType < int > (asType < short int > ((int)2))))
\rightarrow [simplify]
[59.19] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).rem)))
[Take goal term]
[1.0] $heap<sub>724.1:745.8</sub>.r2 \leq maxof(int)
\rightarrow [from term 59.19, $heap<sub>724,1;745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs p_{funcstart\_724,1})
heap_{funcstart_{-724,1}.p1, 177).rem}
[1.1] \text{Sheap}_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs}))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).rem))).r2 \leq \mathbf{maxof(int)}
\rightarrow [const member of object with modified fields]
[1.2] heap_{funcstart\_724,1}.r2 \leq maxof(int)
\rightarrow [const static or extern object]
[1.3] $heap<sub>init</sub>.r2 \leq maxof(int)
\rightarrow [expand definition of constant 'r2' at prang.c (20,20)]
[1.4] asType<short int>((int)172) \le maxof(int)
```

```
[1.8] true
Proof of verification condition: Arithmetic result of operator '*' is within
limit of type 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (63,13)
Condition defined at:
To prove: minof(int) \le (asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724,1;745,8}.r2))
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta = asType < short int > ((int)2)
heap_{init}.M2 == asType < short int > ((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta sheap<sub>init</sub>.b2 == asType<short int>((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart\_724,1})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1})) \ / \\
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(asType < integer > (asType < int > (\$heap_{tuncstart\_724.1}.p1)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
```

 \rightarrow [simplify]

```
asType<integer>(div1.rem)
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathtt{p1}) = =
asType<integer>(div1.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathtt{a1}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType < integer > (div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart_{-724.1}},
asType < int > (\$heap_{funcstart\_724.1}.p2),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}))\ /
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.quot)
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2})) \ \%
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.rem)
(asType<integer>($heap_{tuncstart\_724,1}.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(asType < integer > ($heap_{funcstart\_724.1}.p2) = =
asType<integer>(div2.rem))
(asType<integer>(sheap_{funcstart\_724,1}.a2) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p2)) => !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
\label{eq:div3} \text{div3} == \text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a3}))
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3})) \ / \\
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3})) \ \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.rem)
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(asType < integer > (\$heap_{funcstart\_724.1}.p3) = =
```

```
asType<integer>(div3.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a3) \le
asType < integer > (\$heap_{funcstart\_724,1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
$heap_{724,1;745,8} == $heap_{funcstart\_724,1}.\_replace(p1 \rightarrow asType < short)
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart-724,1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
-asType<integer const>($heap<sub>724.1:745.8</sub>.M1) <
asType<integer>($heap<sub>724,1:745,8</sub>.p1)
!(0 == asType < integer > (\$heap_{724,1;745,8}.p1))
asType<integer>($heap<sub>724.1:745.8</sub>.p1) <
asType<integer>($heap<sub>724,1:745,8</sub>.M1)
Proof:
[Take given term]
[5.0] invariant1(heapIs heap_{funcstart\_724,1})
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
 \texttt{[5.1]} \left( \left( \left( \left( \left( 0 < \mathbf{asType} < \mathbf{integer} > \left( \$ \mathsf{heap}_{funcstart\_724,1}.\mathsf{p1} \right) \right) \right. \&\& \right. \right. 
(asType<integer>($heap_funcstart_724.1.p1) <
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2})))\ \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType<integer>($heap_{tuncstart\_724,1}.p3) <
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M3}))
\rightarrow [simplify]
[5.3] (((((0 < \text{heap}_{funcstart\_724,1}.p1) && (\text{heap}_{funcstart\_724,1}.p1 <
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 < function for the start of the start 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2})))\ \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType<integer>(heap_{funcstart\_724,1}.M2))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.4] (((((0 < $heap_{funcstart\_724,1}.p1) && ($heap_{funcstart\_724,1}.p1 <
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asType < integer > (\$heap_{init}.M1))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > ($heap_{funcstart\_724,1}.p3))) &&
(asType<integer>($heap_{tuncstart\_724,1}.p3) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < $heap_{funcstart_{724,1}}.p1) && ($heap_{funcstart_{724,1}}.p1 < 
asType<integer>(asType<short int>((int)30269)))) && (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [simplify]
[5.16] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \; \land \; (0 < \$heap_{funcstart\_724,1}.p1) \; \land 
(0 < \text{Sheap}_{funcstart_{-724,1},p2})) \&\& (\text{Sheap}_{funcstart_{-724,1},p2} <
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M2}))) \ \&\& \ (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [const static or extern object]
[5.17] \left( \left( \left( \left( -30269 < -\$ \text{heap}_{funcstart\_724,1}.\text{p1} \right) \right. \wedge \left. \left( 0 < \$ \text{heap}_{funcstart\_724,1}.\text{p1} \right) \right. \wedge \right. \right)
(0 < \text{\$heap}_{funcstart_{-724,1}.p2})) \&\& (\text{\$heap}_{funcstart_{-724,1}.p2} <
asType < integer > (\$heap_{init}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType<integer>($heap_funcstart_724,1.p3) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType<integer>(asType<short int>((int)30307)))) && (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})))\ \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M3}))
\rightarrow [simplify]
[5.30] ((-30307 < -$heap_{funcstart\_724,1}.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{-724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{-724,1}.p3})) \&\&
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(\text{\$heap}_{funcstart\_724,1}.\text{p3} < \mathbf{asType} < \mathbf{integer} > (\text{\$heap}_{funcstart\_724,1}.\text{M3}))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \land (-30269 <
-\$ heap_{funcstart\_724,1}.p1) \land (0 < \$ heap_{funcstart\_724,1}.p1) \land (0 < \$ heap_{funcstart\_724,1}.p1) \land (0 < \$ heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1.p2}) \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.p3 < asType < integer > (\text{\$heap}_{init}.M3))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap<sub>funcstart_724.1</sub>.p2) \wedge (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{-724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{-724,1}.p3})) \&\&
(\text{sheap}_{funcstart\_724.1}.p3 < asType < integer > (asType < short)
int > ((int)30323))
\rightarrow [simplify]
[5.40] (-30323 < -\$heap_{funcstart\_724,1}.p3) \land (-30307 < -30307)
-\$heap_{funcstart\_724,1}.p2) \land (-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < -\$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.\text{p1}) \land (0 < \text{Sheap}_{funcstart\_724,1}.\text{p2}) \land (0 <
heap_{funcstart_{-724,1}.p3}
[Work on sub-term 5 of conjunction in term 5.40]
[9.0] 0 < $heap_{funcstart_724,1}.p2
[Take given term]
[11.0] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
\rightarrow [simplify]
[11.1]~{\rm div1} == {\rm div}(\mathbf{heapIs}~\$ \mathrm{heap}_{funcstart\_724,1},\,\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType < int > (\$heap_{funcstart\_724.1}.a1))
\rightarrow [const static or extern object]
[11.2] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType < int > ($heap_{init}.a1))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
[11.3] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType<int>(asType<short int>((int)177)))
\rightarrow [simplify]
[11.6] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1, 177)
[Take given term]
[27.0] div2 == div(heapIs $heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
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\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
\rightarrow [simplify]
[27.1] \operatorname{div2} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p2,
asType < int > (\$heap_{funcstart\_724,1}.a2))
\rightarrow [const static or extern object]
[27.2] \operatorname{div2} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p2,
asType < int > (\$heap_{init}.a2))
\rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
[27.3] \operatorname{div2} == \operatorname{div}(\mathbf{heapIs} \ \text{$heap}_{funcstart\_724,1}, \ \text{$heap}_{funcstart\_724,1}.p2,
asType<int>(asType<short int>((int)176)))
\rightarrow [simplify]
[27.6] \text{ div2} == \text{div}(\text{heapIs } \text{$heap}_{funcstart\_724,1}, \text{$heap}_{funcstart\_724,1}.\text{p2}, 176)
[Assume known post-assertion, class invariant or type constraint for term 27.6]
[31.0] (as
Type<integer>($heap_{funcstart\_724,1}.p2) \%
asType<integer>(176)) == asType<integer>(div(heapIs
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, p2, 176).rem
\rightarrow [simplify]
[31.2] ($heap<sub>funcstart_724,1.</sub>p2 % 176) == asType<integer>(div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem
→ [expand definition of operator '.%' in class 'int' at built in declaration]
[31.3] ([asType<integer>(heap_{funcstart\_724,1}.p2) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176), []:
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})~\%~176) ==
asType<integer>(div(heapIs $heap_{tuncstart\_724.1}, $heap_{tuncstart\_724.1}.p2,
176).rem)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[31.4] ([asType<integer>($heap_{funcstart\_724,1}.p2) < 0]:
-(-\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}) \% \ 176),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176) = =
\mathbf{asType} \small{<} \mathbf{integer} \small{>} ( \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}, \\
176).rem)
\rightarrow [simplify]
[31.7] ([0 < -\$heap_{funcstart\_724,1}.p2]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176) ==
\mathbf{asType} \small{<} \mathbf{integer} \small{>} ( \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}, \\
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176).rem)
\rightarrow [from term 9.0, literala < -$heap<sub>funcstart_724,1</sub>.p2 is false whenever -2 < (0
+ literala)]
         Proof of rule precondition:
         [31.7.0] - 2 < (0 + 0)
         \rightarrow [simplify]
         [31.7.2] true
[31.8] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176),
[!(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176) = =
\mathbf{asType} {<} \mathbf{integer} {>} ( \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}, \\
176).rem)
\rightarrow [simplify]
[31.11] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) \; \% \; 176), \; [!(0.11)] \; ((\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) \; \% \; 176), \; [!(0.11)] \; ((\mathbf{false}): \; -(-\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) \; \% \; 176), \; [!(0.11)] \; ((\mathbf{false}): \; -(-\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) \; \% \; 176), \; [!(0.11)] \; ((\mathbf{false}): \; -(-\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) \; \% \; 176), \; [!(0.11)] \; ((\mathbf{false}): \; -(-\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) \; \% \; 176), \; [!(0.11)] \; ((\mathbf{false}): \; -(-\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) \; \% \; 176), \; [!(0.11)] \; ((\mathbf{false}): \; -(-\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) \; \% \; 176), \; [!(0.11)] \; ((\mathbf{false}): \; -(-\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) \; \% \; 176), \; [!(0.11)] \; ((\mathbf{false}): \; -(-\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) \; \% \; 176), \; [!(0.11)] \; ((\mathbf{false}): \; -(-\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) \; \% \; 176), \; [!(0.11)] \; ((\mathbf{false}): \; -(-\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) \; \% \; 176), \; [!(0.11)] \; ((\mathbf{false}): \; -(-\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) \; \% \; 176), \; [!(0.11)] \; ((\mathbf{false}): \; -(-\mathbf{false}): 
<-$heap<sub>funcstart_724,1.</sub>p2)]: asType<integer>($heap<sub>funcstart_724,1.</sub>p2) %
176) == asType < integer > (div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p2, 176}.rem
\rightarrow [from term 9.0, literala < -$heap<sub>funcstart_724,1</sub>.p2 is false whenever -2 < (0
+ literala)]
         Proof of rule precondition:
         [31.11.0] - 2 < (0 + 0)
         \rightarrow [simplify]
         [31.11.2] true
[31.12] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176),
[!false]: asType<integer>(sheap_{funcstart\_724,1.p2}) \% 176 ==
asType<integer>(div(heapIs p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1})
176).rem)
\rightarrow [simplify]
[31.17] 0 == (-\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p2},
176).rem + (\text{$heap}_{funcstart\_724,1}.p2 \% 176))
[Take given term]
[59.0] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177)
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[59.1] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div(heapIs $heap_{funcstart_724,1},))
\theta_{funcstart\_724,1}.p1, 177).rem ** asType<int>($\text{heap}_{funcstart\_724,1}.r1)) -
(asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [simplify]
[59.3] \rho_{1745,8} == \rho_{1745
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{r1})) - (\mathbf{asType} < \mathbf{int} > (\mathbf{asType} < \mathbf{short}))
\mathbf{int}{>}(\mathbf{div1}.\mathbf{quot})) * \mathbf{asType}{<} \mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
\rightarrow [const static or extern object]
[59.4] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType < int > (\$heap_{init}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1}.\mathbf{quot})) * \mathbf{asType}{<} \mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
\rightarrow [expand definition of constant 'r1' at prang.c (15,20)]
[59.5] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType < int > (asType < short int > ((int)171))) -
(asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\ 724.1}.b1))))
\rightarrow [simplify]
[59.8] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem * 171)
- (asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177
[59.9] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).rem)
- (asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},))
heap_{funcstart_{-724,1}}.p1, 177).quot)
asType < int > (\$heap_{funcstart_{724,1}}.b1)))
\rightarrow [simplify]
[59.11] \$ heap_{724,1;745,8} == \$ heap_{funcstart\_724,1}.\_\mathbf{replace} (p1 \to \mathbf{asType} < \mathbf{short})
int>((171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).rem)
- (div(heapIs \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1.p1}, 177).quot *
asType < int > (\$heap_{funcstart\_724,1}.b1)))
\rightarrow [const static or extern object]
[59.12] $\text{heap}_{724,1:745,8} == \text{heap}_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
```

```
int>((171 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType < int > (\$heap_{init}.b1)))
\rightarrow [expand definition of constant 'b1' at prang.c (17,20)]
[59.13] heap_{724,1;745,8} == heap_{funcstart\_724,1}. replace(p1 \rightarrow asType<short
int>((171 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)
- (div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1, 177).quot *
asType<int>(asType<short int>((int)2))))
\rightarrow [simplify]
[59.19] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, \ 177).\operatorname{rem})))
[Take goal term]
[1.0]  minof(int) \leq (asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724,1;745,8}.r2))
\rightarrow [simplify]
[1.1] -32768 \leq (asType\leqint>(asType\leqshort int>(div2.rem)) *
asType<int>($heap<sub>724,1;745,8</sub>.r2))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{funcstart_{724,1}},
heap_{funcstart_{724,1}}.p2, 176
[1.2] -32768 \le (asType<int>(asType<short int>(div(heapIs
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1},p2, 176}.rem)
asType < int > ($heap_{724,1;745,8}.r2))
\rightarrow [simplify]
[1.4] -32768 \leq (\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p2},
176).rem * asType<int>($heap<sub>724.1:745.8</sub>.r2))
\rightarrow [from term 59.19, $heap<sub>724.1:745.8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs p_{funcstart\_724,1}),
heap_{funcstart_{724,1},p1, 177}, quot) + (171 * div(heapIs heap_{funcstart_{724,1},p1, 177})
heap_{funcstart_{-724,1}}.p1, 177).rem)
[1.5] -32768 \leq (div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p2,
176).rem * asType<int>(heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}. p1, \ 177). quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, \ 177).\operatorname{rem}))).\operatorname{r2}))
\rightarrow [const member of object with modified fields]
[1.6] -32768 \leq (div(heapIs $heap_{funcstart_{-724.1}}, $heap_{funcstart_{-724.1}}.p2,
176).rem * asType < int > (\$heap_{funcstart\_724,1}.r2))
\rightarrow [const static or extern object]
```

```
[1.7] -32768 \leq (div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p2,
176).rem * asType < int > (\$heap_{init}.r2))
\rightarrow [expand definition of constant 'r2' at prang.c (20,20)]
\textit{[1.8] -32768} \leq (\text{div}(\textbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p2},
176).rem * asType<int>(asType<short int>((int)172)))
\rightarrow [simplify]
[1.13] -32769 < (172 * div(heapIs \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1},
176).rem)
\rightarrow [literal comparison of product]
[1.14] ([172 < 0]: (-32769 / -172) < -\text{div}(\mathbf{heapIs} \$ \mathbf{heap}_{funcstart\_724,1},
\theta_{funcstart\_724,1}.p2, 176.rem, [0 < 172]: (-32769 / 172) < div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem}, [0 == 172]: -32769 < 0)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[1.15] ([172 < 0]: (-32769 / -172) < -\text{div}(\text{heapIs } \text{$heap}_{funcstart\_724.1},
\text{Sheap}_{funcstart_724.1}.\text{p2}, 176).\text{rem}, [(0 < 172) \land !(172 < 0)]: (-32769 / 172) < 0
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p2, \ 176).rem, \ [(0 == 172)]
\wedge !(0 < 172) \wedge !(172 < 0): -32769 < 0
\rightarrow [simplify]
\textit{[1.23]} - 191 < \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}, \ 176).\mathrm{rem}
\rightarrow [negate goal and search for contradiction]
 [1.24] ! (-191 < \operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p2}, 
176).rem)
\rightarrow [simplify]
[1.26] 190 < -\text{div}(\text{heapIs } \text{heap}_{funcstart\_724,1}, \text{heap}_{funcstart\_724,1}.p2,
176).rem
[Create new term from terms 1.26, 31.17 using rule: transitivity 15]
[77.0] (0 + 190) < -($heap_funcstart_724,1.p2 % 176)
\rightarrow [simplify]
[77.2] false
Proof of verification condition: Arithmetic result of operator '*' is within
limit of type 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (63,13)
Condition defined at:
```

To prove: (asType<int>(asType<short int>(div2.rem)) *

 $asType < int > (\$heap_{724,1;745,8}.r2)) \le maxof(int)$

Given:

```
heap_{init}.LIMIT == (int)80
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta = asType < short int > ((int)2)
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
\theta_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
heap_{init}.a3 == asType<short int>((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
invariant
1(heap<br/>Is heap_{funcstart\_724,1})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \ \operatorname{\$heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) /
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}))) = =
asType<integer>(div1.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))) = =
asType<integer>(div1.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1})) =>
(asType < integer > (\$heap_{funcstart\_724,1}.p1) = =
asType<integer>(div1.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathtt{a1}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
```

```
div2 == div(\mathbf{heapIs} \ \text{$heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
(asType<int>(asType<int>($heap_{tuncstart\_724.1}.p2)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.quot)
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}))~\%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724.1}.a2)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p2) = =
asType<integer>(div2.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a2}) \leq
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})) => !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
asType < int > (\$heap_{funcstart\ 724.1}.a3))
(asType<int>(asType<int>($heap_{tuncstart\_724.1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))) ==
asType<integer>(div3.rem)
(asType<integer>($heap_funcstart_724.1.p3) <
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) ==
asType<integer>(div3.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a3) \le
asType < integer > (\$heap_{funcstart\_724,1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
\text{Sheap}_{724,1;745,8} == \text{Sheap}_{funcstart\_724,1}.\_\mathbf{replace}(\text{p1} \to \mathbf{asType} < \mathbf{short})
int>((asType<int>(asType<short int>(div1.rem)) *
\mathbf{asType} \small{<} \mathbf{int} \small{>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{r1})) \\ - (\mathbf{asType} \small{<} \mathbf{int} \small{>} (\mathbf{asType} \small{<} \mathbf{short}
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
```

```
-asType < integer const > (\$heap_{724.1:745.8}.M1) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{p1})
!(0 == \mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathrm{heap}_{724,1;745,8}.\mathrm{p1}))
asType<integer>($heap<sub>724,1;745,8</sub>.p1) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{M1})
Proof:
[Take given term]
[5.0] invariant1(heapIs heap_{funcstart\_724,1})
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
[5.1] ((((((0 < asType<integer>(sheap_{funcstart\_724.1}.p1)) &&
(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 < funcstart\_724,1)
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.3] \ (((((0 < \text{\$heap}_{funcstart\_724,1}.\text{p1}) \&\& \ (\text{\$heap}_{funcstart\_724,1}.\text{p1} <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M1})))~\&\&~(0<
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2})))\ \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p2) < 
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [const static or extern object]
[5.4] (((((0 < \text{\$heap}_{funcstart\_724,1}.p1) \&\& (\text{\$heap}_{funcstart\_724,1}.p1 <
asType<integer>(\theta_{init}.M1))) && (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})))\ \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] \ (((((0 < \text{\$heap}_{funcstart\_724,1}.\text{p1}) \&\& \ (\text{\$heap}_{funcstart\_724,1}.\text{p1} <
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
```

```
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p3) < 
asType<integer>($heap_funcstart_724,1.M3))
\rightarrow [simplify]
[5.16] ((((-30269 < -$heap_{funcstart\_724,1}.p1) \lambda (0 < $heap_{funcstart\_724,1}.p1) \lambda
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType<integer>(heap_{funcstart\_724,1}.M2))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.17] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \; \land \; (0 < \$heap_{funcstart\_724,1}.p1) \; \land 
(0 < \text{Sheap}_{funcstart_{724,1}.p2})) \&\& (\text{Sheap}_{funcstart_{724,1}.p2} <
asType < integer > (\$heap_{init}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) <
asType < integer > (\$heap_{tuncstart_{-724.1}}.M3))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < \text{$heap}_{funcstart\_724,1}.p2)) \&\& (\text{$heap}_{funcstart\_724,1}.p2 <
asType < integer > (asType < short int > ((int)30307)))) && (0 < integer) && (0 < integer
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.30] ((-30307 < -$heap<sub>funcstart_724,1</sub>.p2) \wedge (-30269 <
  -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{724,1}.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.\text{p3} < \mathbf{asType} < \mathbf{integer} > (\text{\$heap}_{funcstart\_724,1}.\text{M3}))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -$heap_funcstart_724,1.p2) \land (-30269 <
-$heap_{funcstart\_724,1}.p1) \land (0 < $heap_{funcstart\_724,1}.p1) \land (0 <
\text{Sheap}_{funcstart\_724,1.p2} \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\$heap_{funcstart\_724,1}.p3 < \textbf{asType} < \textbf{integer} > (\$heap_{init}.M3))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap_{tuncstart\_724,1}.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1.p2}) \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\text{sheap}_{funcstart\_724,1}.\text{p3} < \text{asType} < \text{integer} > (\text{asType} < \text{short})
```

```
int > ((int)30323)))
\rightarrow [simplify]
[5.40] (-30323 < -\$heap_{funcstart\_724,1}.p3) \land (-30307 < -30307)
-\$heap_{funcstart\_724,1}.p2) \land (-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < -\$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.\text{p1}) \land (0 < \text{Sheap}_{funcstart\_724,1}.\text{p2}) \land (0 <
heap_{funcstart_{-724,1}.p3}
[Work on sub-term 5 of conjunction in term 5.40]
[9.0] 0 < \text{$heap}_{funcstart\_724,1}.p2
[Take given term]
[11.0] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a1}))
\rightarrow [simplify]
[11.1] div1 == div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
asType < int > (\$heap_{funcstart\_724.1}.a1))
\rightarrow [const static or extern object]
[11.2] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType < int > (\$heap_{init}.a1))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
\textit{[11.3]} \ \text{div1} == \text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
asType<int>(asType<short int>((int)177)))
\rightarrow [simplify]
[11.6] div1 == div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p1, 177)
[Take given term]
[27.0] div2 == div(heapIs $heap_{tuncstart\_724.1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
\rightarrow [simplify]
[27.1]~{\rm div2} == {\rm div}(\mathbf{heapIs}~\$ \mathrm{heap}_{funcstart\_724,1},\,\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2},
asType < int > (\$heap_{funcstart\_724,1}.a2))
\rightarrow [const static or extern object]
[27.2]~{\rm div2} == {\rm div}(\mathbf{heapIs}~\$ \mathrm{heap}_{funcstart\_724,1},\,\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2},
asType < int > (\$heap_{init}.a2))
\rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
[27.3] \operatorname{div2} == \operatorname{div}(\mathbf{heapIs} \operatorname{\$heap}_{funcstart\_724,1}, \operatorname{\$heap}_{funcstart\_724,1}.p2,
asType<int>(asType<short int>((int)176)))
```

```
\rightarrow [simplify]
[27.6] \text{ div2} == \text{div}(\mathbf{heapIs} \$ heap_{funcstart\_724,1}, \$ heap_{funcstart\_724,1}.p2, 176)
[Take given term]
[59.0] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1.quot})) \ * \ \mathbf{asType}{<} \mathbf{int}{>} (\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1},p1,177}
[59.1] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}) * asType < int > (\text{Sheap}_{funcstart\_724,1}.\text{r1})) -
(asType<int>(asType<short int>(div1.quot)) *
\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
\rightarrow [simplify]
[59.3] \rho_{1745,8} == \rho_{1745
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType < int > (\$heap_{tuncstart\_724.1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
\rightarrow [const static or extern object]
[59.4] \rho_{1745,8} == \rho_{1745,8} == \rho_{1745,8} == \rho_{1745,8}._replace(p1 \rightarrow \rho_{1745,8} == \rho_{1745,8}
\mathbf{int}{>}((\mathrm{div}(\mathbf{heapIs}\ \$\mathrm{heap}_{funcstart\_724,1},\ \$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},\ 177).\mathrm{rem}\ *
asType < int > (\$heap_{init}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
\rightarrow [expand definition of constant 'r1' at prang.c (15,20)]
[59.5] \rho_{1745,8} == \rho_{1745,8} == \rho_{1745,8} == \rho_{1745,8}._replace(p1 \rightarrow \rho_{1745,8} == \rho_{1745,8}
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType<int>(asType<short int>((int)171))) -
(asType<int>(asType<short int>(div1.quot)) *
\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
\rightarrow [simplify]
[59.8] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
\mathbf{int} > ((\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, \ 177).\operatorname{rem} \ * \ 171)
- (asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177
[59.9] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).rem)
```

```
- (asType<int>(asType<short int>(div(heapIs $heap_{tuncstart\_724.1},
heap_{funcstart_{-724,1}.p1, 177}.quot) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [simplify]
[59.11] \theta == 
int>((171 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [const static or extern object]
[59.12] heap_{724,1;745,8} == heap_{funcstart\_724,1}. replace(p1 \rightarrow asType<short
int>((171 * div(heapIs \$heap_{funcstart\_724.1}, \$heap_{funcstart\_724.1}, p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType < int > (\$heap_{init}.b1)))
\rightarrow [expand definition of constant 'b1' at prang.c (17,20)]
[59.13] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((171 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)
- (div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, 177).quot *
asType<int>(asType<short int>((int)2))))
\rightarrow [simplify]
[59.19] \text{heap}_{724,1;745,8} == \text{heap}_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724.1}, \ \text{\$heap}_{funcstart\_724.1}, 177).rem)))
[Take goal term]
[1.0] (asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724.1:745.8}.r2)) \le maxof(int)
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1},p2,176}
[1.1] (asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},))
\text{sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem}) * asType<int>(\text{sheap}_{724,1;745,8}.\text{r2}))
maxof(int)
\rightarrow [simplify]
[1.3] (div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1},p2, 176}).rem *
asType < int > (\$heap_{724,1:745,8}.r2)) \le maxof(int)
\rightarrow [from term 59.19, heap_{724,1;745,8} is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724,1}),
\text{Sheap}_{funcstart\_724,1}.p1, 177).quot + (171 * div(\textbf{heapIs} \$heap_{funcstart\_724,1},
heap_{funcstart_{724,1},p1,177,rem})
[1.4] (div(heapIs heap_{funcstart_{-724.1}}, heap_{funcstart_{-724.1},p2, 176}).rem *
\mathbf{asType}{<}\mathbf{int}{>}(\$\text{heap}_{funcstart\_724,1}.\_\mathbf{replace}(\text{p1} \rightarrow ((\text{-2} * \text{div}(\mathbf{heapIs}
```

```
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
\operatorname{Sheap}_{funcstart\_724,1}, \operatorname{Sheap}_{funcstart\_724,1}.p1, 177).rem)).r2)) \leq \operatorname{maxof(int)}
\rightarrow [const member of object with modified fields]
[1.5] (div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem *
asType < int > (\$heap_{funcstart\_724,1}.r2)) \le maxof(int)
\rightarrow [const static or extern object]
[1.6] (div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
asType < int > (\$heap_{init}.r2)) \le maxof(int)
\rightarrow [expand definition of constant 'r2' at prang.c (20,20)]
[1.7] (div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem *
asType < int > (asType < short int > ((int)172))) \le maxof(int)
\rightarrow [simplify]
[1.20] -32768 < (-172 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1}.p2, 176}.rem
\rightarrow [literal comparison of product]
[1.21] ([-172 < 0]: (-32768 / 172) < -\text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1},
\rho_{funcstart_{-724,1},p2,176}.rem, [0 < -172]: (-32768 / -172) < \text{div}(heapIs)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[1.22] ([-172 < 0]: (-32768 / 172) < -\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1},
\rho_{tuncstart_{-724,1},p2,176}.rem, [(0 < -172) \land !(-172 < 0)]: (-32768 / -172) < 0
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p2, \ 176).rem, \ [(-172 ==
0) \wedge !(-172 < 0) \wedge !(0 < -172)]: -32768 < 0)
\rightarrow [simplify]
[1.26] -191 < -\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p2},
176).rem
\rightarrow [negate goal and search for contradiction]
[1.27]!(-191 < -\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p2},
176).rem)
\rightarrow [simplify]
[1.30] 190 < \text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem}
[Assume known post-assertion, class invariant or type constraint for term 27.6]
[31.0] (asType<integer>(heap_{funcstart\_724,1}.p2) %
asType<integer>(176)) == asType<integer>(div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem}
\rightarrow [simplify]
```

```
[31.2] ($heap<sub>funcstart-724.1</sub>.p2 % 176) == asType<integer>(div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem
→ [expand definition of operator '.%' in class 'int' at built in declaration]
[31.3] ([asType<integer>($heap_{funcstart\_724,1}.p2) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176), []:
asType < integer > (\$heap_{funcstart\_724.1}.p2) \% 176) ==
asType<integer>(div(heapIs $heap_{tuncstart\_724.1}, $heap_{tuncstart\_724.1}.p2,
176).rem)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[31.4] ([asType<integer>(heap_{funcstart\_724,1}.p2) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724.1}.p2) \% 176),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176) ==
asType<integer>(div(heapIs p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1})
176).rem)
\rightarrow [simplify]
[31.7] ([0 < -$heap<sub>funcstart_724,1.</sub>p2]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 0)]:
asType<integer>($heap<sub>funcstart_724,1.</sub>p2) % 176) ==
asType<integer>(div(heapIs p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1})
176).rem)
\rightarrow [from term 9.0, literala < -$heap<sub>funcstart_724,1</sub>.p2 is false whenever -2 < (0
+ literala)]
   Proof of rule precondition:
   [31.7.0] - 2 < (0 + 0)
   \rightarrow [simplify]
   [31.7.2] true
[31.8] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176),
[!(asType < integer > (\$heap_{funcstart\_724.1}.p2) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176) = =
asType<integer>(div(heapIs $heap_{funcstart_724,1}, $heap_{funcstart_724,1}.p2,
176).rem)
\rightarrow [simplify]
[31.11] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176), [!(0
< -$heap<sub>funcstart_724.1.</sub>p2)]: asType<integer>($heap<sub>funcstart_724.1.</sub>p2) %
176) == asType<integer>(div(heapIs heapIs heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p2, 176}.rem
\rightarrow [from term 9.0, literala < -$heap<sub>funcstart_724,1</sub>.p2 is false whenever -2 < (0
```

```
+ literala)]
    Proof of rule precondition:
    [31.11.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [31.11.2] true
[31.12] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176),
[!false]: asType<integer>($heap_{funcstart\_724,1}.p2) % 176) ==
\mathbf{asType} < \mathbf{integer} > (\mathbf{div}(\mathbf{heapIs} \$ \mathbf{heap}_{funcstart\_724,1}, \$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2},
176).rem)
\rightarrow [simplify]
[31.17] \ 0 == (-\text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p2},
176).rem + (\text{$heap}_{funcstart\_724,1}.p2 % 176))
\rightarrow [remainder is less than divisor]
    Proof of rule precondition:
    [31.17.0] (176 + -\text{div}(\mathbf{heapIs} \$ heap_{funcstart\_724,1}, \$ heap_{funcstart\_724,1}.p2,
    176).\text{rem} \le 0
    \rightarrow [simplify]
    \textit{[31.17.11]} \ 175 < \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2},
    176).rem
    \rightarrow [from term 1.30, literala < div(heapIs $heap_{funcstart\_724,1},
    heap_{funcstart\_724,1}.p2, 176.rem is true whenever (-1 + literala) < 190
        Proof of rule precondition:
        [31.17.11.0](-1 + 175) < 190
        \rightarrow [simplify]
        [31.17.11.2] true
    [31.17.12] true
[31.18] false
Proof of verification condition: Type constraint satisfied in explicit
conversion from 'int' to 'short int'
Condition generated at: C:\Escher\Customers\prang\prang.c (63,40)
Condition defined at:
To prove: minof(short int) \le div2.quot
Given:
```

 $heap_{init}.LIMIT == (int)80$

```
heap_{init}.M1 == asType < short int > ((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta = asType < short int > ((int)2)
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart_{724,1}})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724.1}.p1),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ / \ 
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}))~\%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p1) = =
asType<integer>(div1.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathtt{a1}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
```

```
asType < int > (\$heap_{funcstart\_724.1}.a2))
(asType<integer>(asType<int>($heap_{funcstart\_724,1}.p2)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.rem)
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}) ==
asType<integer>(div2.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a2) \le
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2})) = > !(0 = =
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})) \ / \\
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))) ==
asType<integer>(div3.quot)
(asType<int>(asType<int>($heap_funcstart_724.1.p3)) %
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.a3) \leq
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})) => !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
heap_{724,1;745,8} == heap_{funcstart\_724,1}.\_replace(p1 \rightarrow asType < short)
\mathbf{int}{>}((\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{short}\ \mathbf{int}{>}(\mathbf{div}1.\mathbf{rem}))\ ^*
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1.quot})) * \mathbf{asType}{<} \mathbf{int}{>} (\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
-asType < integer const > (\$heap_{724,1;745,8}.M1) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{p1})
```

```
!(0 == asType < integer > (\$heap_{724,1:745.8}.p1))
asType<integer>($heap<sub>724.1:745.8</sub>.p1) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{M1})
Proof:
[Take given term]
[5.0] invariant1(heapIs heapIs
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
[5.1] (((((0 < \mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p1)) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 
asType < integer > (\$heap_{funcstart_{-724,1}}.M1))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart_{-724,1}}.p3))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M3}))
\rightarrow [simplify]
[5.3] \ (((((0 < \$heap_{funcstart\_724,1}.p1) \&\& \ (\$heap_{funcstart\_724,1}.p1 < (
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart_{-724,1}}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
asType < integer > (\$heap_{init}.M1))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 
asType<integer>(sheap_{funcstart\_724,1}.M2)) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < $heap_{funcstart_724,1}.p1) && ($heap_{funcstart_724,1}.p1 < footnote{in the content of the c
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M2})))~\&\&~(0<
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
```

```
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.16] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \; \land \; (0 < \$heap_{funcstart\_724,1}.p1) \; \land 
(0 < \mathrm{\$heap}_{funcstart\_724,1}.\mathrm{p2})) && (\mathrm{\$heap}_{funcstart\_724,1}.\mathrm{p2} <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})))\ \&\&
(asType<integer>($heap_{tuncstart\_724,1}.p3) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [const static or extern object]
[5.17] \left( \left( \left( \left( -30269 < -\$ \text{heap}_{funcstart\_724,1}.\text{p1} \right) \right. \wedge \left. \left( 0 < \$ \text{heap}_{funcstart\_724,1}.\text{p1} \right) \right. \wedge \right. \right)
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType < integer > (\$heap_{init}.M2))) \&\& (0 <
asType < integer > ($heap_{funcstart\_724,1}.p3))) &&
(asType < integer > ($heap_{funcstart\_724,1}.p3) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < \$ heap_{funcstart\_724,1}.p2)) && (\$ heap_{funcstart\_724,1}.p2 <
asType < integer > (asType < short int > ((int)30307)))) && (0 < integer) && (0 < integer
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [simplify]
[5.30] ((-30307 < -\$heap_{funcstart\_724,1}.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{724,1}.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.p3 < asType < integer > (\text{\$heap}_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \land (-30269 <
 -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{724,1}.p3})) \&\&
(\$heap_{funcstart\_724,1}.p3 < \textbf{asType} < \textbf{integer} > (\$heap_{init}.M3))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap_funcstart_724,1.p2) \land (-30269 <
-$heap_{funcstart\_724,1}.p1) \land (0 < $heap_{funcstart\_724,1}.p1) \land (0 <
\text{Sheap}_{funcstart_{724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{724,1}.p3})) \&\&
(\text{sheap}_{funcstart\_724,1}.p3 < asType < integer > (asType < short)
int > ((int)30323)))
\rightarrow [simplify]
```

```
[5.40] (-30323 < -\$heap_{funcstart\_724,1}.p3) \land (-30307 < -30307)
-\$heap_{funcstart\_724,1}.p2) \land (-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < -\$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.\text{p1}) \land (0 < \text{Sheap}_{funcstart\_724,1}.\text{p2}) \land (0 <
heap_{funcstart_{-724,1}.p3}
[Work on sub-term 5 of conjunction in term 5.40]
[9.0] 0 < \text{$heap}_{funcstart\_724,1}.p2
[Take given term]
[27.0] div2 == div(heapIs $heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a2}))
\rightarrow [simplify]
[27.1]~{\rm div2} == {\rm div}(\mathbf{heapIs}~\$ \mathrm{heap}_{funcstart\_724,1},\,\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
\rightarrow [const static or extern object]
[27.2] div2 == div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2,
asType < int > (\$heap_{init}.a2))
\rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
\label{eq:continuous} \textit{[27.3]} \ \text{div2} == \text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p2},
asType<int>(asType<short int>((int)176)))
\rightarrow [simplify]
[27.6] \text{ div2} == \text{div}(\mathbf{heapIs} \$ heap_{funcstart\_724,1}, \$ heap_{funcstart\_724,1}.p2, 176)
[Assume known post-assertion, class invariant or type constraint for term 27.6]
[30.0] (asType<integer>($heap_{funcstart\_724,1}.p2) /
asType<integer>(176)) == asType<integer>(div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).quot)
\rightarrow [simplify]
[30.2] ($heap<sub>funcstart_724,1.</sub>p2 / 176) == asType<integer>(div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).quot
→ [expand definition of operator './' in class 'int' at built in declaration]
[30.3] ([asType<integer>(heap_{funcstart\_724,1}.p2) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724.1}.p2) / 176), []:
asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176) = =
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2,
176).quot)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[30.4] ([asType<integer>(sheap_{funcstart_{-724,1}.p2}) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176),
```

```
[!(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176) ==
\mathbf{asType} {<} \mathbf{integer} {>} ( \mathbf{div} (\mathbf{heapIs} \ \$ \mathbf{heap}_{funcstart\_724,1}, \ \$ \mathbf{heap}_{funcstart\_724,1}. \mathbf{p2}, \\
176).quot)
\rightarrow [simplify]
[30.7] ([0 < -$heap<sub>funcstart_724,1.</sub>p2]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176) ==
asType<integer>(div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2,
176).quot)
\rightarrow [from term 9.0, literala < -$heap<sub>funcstart_724,1.</sub>p2 is false whenever -2 < (0
+ literala)]
    Proof of rule precondition:
    [30.7.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [30.7.2] true
[30.8] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176),
[!(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p2) < 0)]:
\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p2) \ / \ 176) = =
\mathbf{asType} < \mathbf{integer} > (\mathbf{div}(\mathbf{heapIs} \ \$ \mathbf{heap}_{funcstart\_724,1}, \ \$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}, \\
176).quot)
\rightarrow [simplify]
[30.11] ([false]: -(-asType < integer > (\$heap_{funcstart\_724.1}.p2) / 176), [!(0 <
-\$heap_{funcstart\_724,1}.p2)]: \ \mathbf{asType} < \mathbf{integer} > (\$heap_{funcstart\_724,1}.p2) \ / \ 176)
== asType < integer > (div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p2, 176).quot
\rightarrow [from term 9.0, literala < -$heap<sub>funcstart_724,1</sub>.p2 is false whenever -2 < (0
+ literala)]
    Proof of rule precondition:
    [30.11.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [30.11.2] true
[30.12] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176),
[!false]: asType<integer>($heap<sub>funcstart_724,1.</sub>p2) / 176) ==
\mathbf{asType} < \mathbf{integer} > (\mathbf{div}(\mathbf{heapIs} \ \$ \mathbf{heap}_{funcstart\_724,1}, \ \$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}, \\
176).quot)
\rightarrow [simplify]
```

```
[30.17] \ 0 == (-\text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p2},
176).quot + (\text{$heap}_{funcstart\_724,1}.p2 / 176))
[Assume known post-assertion, class invariant or type constraint for term
30.17]
[36.0] \operatorname{minof(int)} \leq \operatorname{div}(\operatorname{heapIs} \operatorname{\$heap}_{funcstart\_724,1}, \operatorname{\$heap}_{funcstart\_724,1}.p2,
176).quot
\rightarrow [simplify]
[36.3] \ -32769 < {\rm div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2},
176).quot
[Take goal term]
[1.0] minof(short int) \leq div2.quot
\rightarrow [simplify]
[1.1] -32768 \le \text{div2.quot}
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p2, 176
[1.2] -32768 \leq div(heapIs $heap_{funcstart_{-724,1}}, $heap_{funcstart_{-724,1}}.p2,
176).quot
\rightarrow [simplify]
[1.4] -32769 < \text{div}(\text{heapIs } \text{\$heap}_{funcstart\_724,1}, \text{\$heap}_{funcstart\_724,1}.p2,
176).quot
\rightarrow [from term 36.3, literala < div(heapIs $heap_{funcstart\_724,1},
$heap_{funcstart\_724,1}.p2, 176).quot is true whenever (-1 + literala) < -32769]
    Proof of rule precondition:
    [1.4.0](-32769 + -1) < -32769
    \rightarrow [simplify]
    [1.4.2] true
[1.5] true
Proof of verification condition: Type constraint satisfied in explicit
conversion from 'int' to 'short int'
Condition generated at: C:\Escher\Customers\prang\prang.c (63,40)
Condition defined at:
To prove: div2.quot \leq maxof(short int)
Given:
```

 $heap_{init}.LIMIT == (int)80$

```
heap_{init}.M1 == asType < short int > ((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta = asType < short int > ((int)2)
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart_{724,1}})
div1 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724.1}.p1),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ / \ 
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(asType < int > (asType < int > (\$heap_{funcstart\_724,1}.p1)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p1) = =
asType<integer>(div1.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathtt{a1}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
```

```
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
(asType<integer>(asType<int>($heap_{funcstart\_724,1}.p2)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.rem)
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}) ==
asType<integer>(div2.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a2) \le
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2})) = > !(0 = =
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})) \ / \\
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))) ==
asType<integer>(div3.quot)
(asType<int>(asType<int>($heap_funcstart_724.1.p3)) %
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.a3) \leq
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})) => !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
heap_{724,1;745,8} == heap_{funcstart\_724,1}.\_replace(p1 \rightarrow asType < short)
\mathbf{int}{>}((\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{short}\ \mathbf{int}{>}(\mathbf{div}1.\mathbf{rem}))\ ^*
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1.quot})) * \mathbf{asType}{<} \mathbf{int}{>} (\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
-asType < integer const > (\$heap_{724,1;745,8}.M1) < 
asType<integer>($heap<sub>724,1:745,8:p1</sub>)
```

```
!(0 == asType < integer > (\$heap_{724,1:745.8}.p1))
asType<integer>($heap<sub>724.1:745.8</sub>.p1) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{M1})
Proof:
[Take given term]
[5.0] invariant1(heapIs heapIs
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
[5.1] (((((0 < \mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p1)) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 
asType < integer > (\$heap_{funcstart_{-724,1}}.M1))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart_{-724,1}}.p3))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M3}))
\rightarrow [simplify]
[5.3] \ (((((0 < \$heap_{funcstart\_724,1}.p1) \&\& \ (\$heap_{funcstart\_724,1}.p1 < (
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart_{-724,1}}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
asType < integer > (\$heap_{init}.M1))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 
asType<integer>(sheap_{funcstart\_724,1}.M2)) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < $heap_{funcstart_724,1}.p1) && ($heap_{funcstart_724,1}.p1 < footnote{in the content of the c
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M2})))~\&\&~(0<
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
```

```
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.16] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \; \land \; (0 < \$heap_{funcstart\_724,1}.p1) \; \land 
(0 < \mathrm{\$heap}_{funcstart\_724,1}.\mathrm{p2})) && (\mathrm{\$heap}_{funcstart\_724,1}.\mathrm{p2} <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})))\ \&\&
(asType<integer>($heap_{tuncstart\_724,1}.p3) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [const static or extern object]
[5.17] \left( \left( \left( \left( -30269 < -\$ \text{heap}_{funcstart\_724,1}.\text{p1} \right) \right. \wedge \left. \left( 0 < \$ \text{heap}_{funcstart\_724,1}.\text{p1} \right) \right. \wedge \right. \right)
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType < integer > (\$heap_{init}.M2))) \&\& (0 <
asType < integer > ($heap_{funcstart\_724,1}.p3))) &&
(asType < integer > ($heap_{funcstart\_724,1}.p3) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < \$ heap_{funcstart\_724,1}.p2)) && (\$ heap_{funcstart\_724,1}.p2 <
asType < integer > (asType < short int > ((int)30307)))) && (0 < integer) && (0 < integer
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [simplify]
[5.30] ((-30307 < -\$heap_{funcstart\_724,1}.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{724,1}.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.p3 < asType < integer > (\text{\$heap}_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \land (-30269 <
 -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{724,1}.p3})) \&\&
(\$heap_{funcstart\_724,1}.p3 < \textbf{asType} < \textbf{integer} > (\$heap_{init}.M3))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap_funcstart_724,1.p2) \land (-30269 <
-$heap_{funcstart\_724,1}.p1) \land (0 < $heap_{funcstart\_724,1}.p1) \land (0 <
\text{Sheap}_{funcstart_{724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{724,1}.p3})) \&\&
(\text{sheap}_{funcstart\_724,1}.p3 < asType < integer > (asType < short)
int > ((int)30323)))
\rightarrow [simplify]
```

```
[5.40] (-30323 < -\$heap_{funcstart\_724,1}.p3) \land (-30307 < -30307)
-\$heap_{funcstart\_724,1}.p2) \land (-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < -\$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.\text{p1}) \land (0 < \text{Sheap}_{funcstart\_724,1}.\text{p2}) \land (0 <
heap_{funcstart_{-724,1}.p3}
[Work on sub-term 5 of conjunction in term 5.40]
[9.0] 0 < \text{$heap}_{funcstart\_724,1}.p2
[Take given term]
[27.0] div2 == div(heapIs $heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a2}))
\rightarrow [simplify]
[27.1]~{\rm div2} == {\rm div}(\mathbf{heapIs}~\$ \mathrm{heap}_{funcstart\_724,1},\,\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
\rightarrow [const static or extern object]
[27.2] div2 == div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2,
asType < int > (\$heap_{init}.a2))
\rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
\label{eq:continuous} \textit{[27.3]} \ \text{div2} == \text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p2},
asType<int>(asType<short int>((int)176)))
\rightarrow [simplify]
[27.6] \text{ div2} == \text{div}(\mathbf{heapIs} \$ heap_{funcstart\_724,1}, \$ heap_{funcstart\_724,1}.p2, 176)
[Assume known post-assertion, class invariant or type constraint for term 27.6]
[30.0] (asType<integer>($heap_{funcstart\_724,1}.p2) /
asType<integer>(176)) == asType<integer>(div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).quot)
\rightarrow [simplify]
[30.2] ($heap<sub>funcstart_724,1.</sub>p2 / 176) == asType<integer>(div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).quot
→ [expand definition of operator './' in class 'int' at built in declaration]
[30.3] ([asType<integer>(heap_{funcstart\_724,1}.p2) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724.1}.p2) / 176), []:
asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176) = =
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2,
176).quot)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[30.4] ([asType<integer>(sheap_{funcstart_{-724,1}.p2}) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176),
```

```
[!(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176) ==
\mathbf{asType} {<} \mathbf{integer} {>} ( \mathbf{div} (\mathbf{heapIs} \ \$ \mathbf{heap}_{funcstart\_724,1}, \ \$ \mathbf{heap}_{funcstart\_724,1}. \mathbf{p2}, \\
176).quot)
\rightarrow [simplify]
[30.7] ([0 < -$heap<sub>funcstart_724,1.</sub>p2]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176) ==
asType<integer>(div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p2,
176).quot)
\rightarrow [from term 9.0, literala < -$heap<sub>funcstart_724,1.</sub>p2 is false whenever -2 < (0
+ literala)]
    Proof of rule precondition:
    [30.7.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [30.7.2] true
[30.8] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176),
[!(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p2) < 0)]:
\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p2) \ / \ 176) = =
\mathbf{asType} {<} \mathbf{integer} {>} ( \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}, \\
176).quot)
\rightarrow [simplify]
[30.11] ([false]: -(-asType < integer > (\$heap_{funcstart\_724.1}.p2) / 176), [!(0 <
-\$heap_{funcstart\_724,1}.p2)]: \ \mathbf{asType} < \mathbf{integer} > (\$heap_{funcstart\_724,1}.p2) \ / \ 176)
== asType < integer > (div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p2, 176).quot
\rightarrow [from term 9.0, literala < -$heap<sub>funcstart_724,1</sub>.p2 is false whenever -2 < (0
+ literala)]
    Proof of rule precondition:
    [30.11.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [30.11.2] true
[30.12] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176),
[!false]: asType<integer>($heap<sub>funcstart_724,1.</sub>p2) / 176) ==
\mathbf{asType} < \mathbf{integer} > (\mathbf{div}(\mathbf{heapIs} \ \$ \mathbf{heap}_{funcstart\_724,1}, \ \$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}, \\
176).quot)
\rightarrow [simplify]
```

```
[30.17] 0 == (-\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p2},
176).quot + (\text{$heap}_{funcstart\_724,1}.p2 / 176))
[Assume known post-assertion, class invariant or type constraint for term
30.17]
[37.0] div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot \leq
maxof(int)
\rightarrow [simplify]
[37.9] -32768 < -\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p2},
176).quot
[Take goal term]
[1.0] div2.quot \leq maxof(short int)
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1}}.p2, 176)
[1.1] div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot \leq
maxof(short int)
\rightarrow [simplify]
[1.10] \ -32768 < -{\rm div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2},
176).quot
\rightarrow [from term 37.9, literala < -div(heapIs $heap_{funcstart\_724,1},
$heap_{funcstart\_724,1}.p2, 176).quot is true whenever (-1 + literala) < -32768]
   Proof of rule precondition:
   [1.10.0](-32768 + -1) < -32768
   \rightarrow [simplify]
   [1.10.2] true
[1.11] true
Proof of verification condition: Type constraint satisfied in implicit
conversion from 'short int' to 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (63,40)
Condition defined at:
To prove: minof(int) \le asType < short int > (div2.quot)
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
```

```
heap_{init}.a1 == asType < short int > ((int)177)
\theta = asType < short int > ((int)2)
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
\theta_{init}.a2 == asType<short int>((int)176)
heap_{init}.b2 == asType<short int>((int)35)
\theta = asType < short int > ((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta
\theta
\theta = asType < short int > ((int)3)
invariant
1(heap<br/>Is \rho_{funcstart\_724,1}
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \ \operatorname{\$heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
(asType<integer>(asType<int>($heap_{funcstart\_724,1}.p1)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p1) = =
asType<integer>(div1.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a1) \le
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}),
asType < int > (\$heap_{funcstart\_724,1}.a2))
(asType<integer>(asType<int>($heap_{tuncstart\_724,1}.p2)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
```

```
asType<integer>(div2.quot)
(asType < int > (asType < int > (\$heap_{funcstart\_724,1}.p2)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a2})) = >
(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p2) ==
asType<integer>(div2.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a2}) \leq
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2})) = > !(0 = =
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
\label{eq:div3} \text{div3} == \text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1},
\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}),
asType < int > (\$heap_{funcstart\_724.1}.a3))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) \%
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a3}))) = =
asType<integer>(div3.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a3) \le
asType < integer > (\$heap_{funcstart\_724,1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
\$heap_{724,1;745,8} == \$heap_{funcstart\_724,1}.\_\mathbf{replace}(p1 \to \mathbf{asType} {<} \mathbf{short}
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType<int>($heap_{funcstart\_724,1}.b1)))
-asType<integer const>($heap_{724,1:745,8}.M1) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{p1})
!(0 == asType < integer > (\$heap_{724,1;745,8}.p1))
asType<integer>($heap<sub>724.1:745.8</sub>.p1) <
asType<integer>($heap<sub>724.1:745.8</sub>.M1)
```

Proof:

```
[Take given term]
[5.0] invariant1(heapIs heap_{funcstart\_724,1})
\rightarrow [expand definition of function 'invariant1' at prang.c (34.1)]
[5.1] (((((0 < asType<integer>(sheap_{funcstart\_724,1}.p1)) &&
(asType < integer > ($heap_{funcstart\_724,1}.p1) < 
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p2) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M2})))~\&\&~(0<
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType<integer>($heap_{tuncstart_724.1}.p3) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.3] \ (((((0 < \$heap_{funcstart\_724,1}.p1) \&\& \ (\$heap_{funcstart\_724,1}.p1 < (
\mathbf{asType} \small{<} \mathbf{integer} \small{>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M1}))) \ \&\& \ (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType<integer>($heap_{tuncstart}, 724.1.p3) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [const static or extern object]
[5.4] (((((0 < \theta_{funcstart\_724,1.p1) && (\theta_{funcstart\_724,1.p1)
asType < integer > (\$heap_{init}.M1))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < $heap_{funcstart_724,1}.p1) && ($heap_{funcstart_724,1}.p1 < 
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p2) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M2})))~\&\&~(0<
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart_{-724.1}}.M3))
\rightarrow [simplify]
```

```
[5.16] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType<integer>($heap_{funcstart\_724,1}.M2))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType<integer>($heap_funcstart_724,1.M3))
\rightarrow [const static or extern object]
[5.17] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \; \land \; (0 < \$heap_{funcstart\_724,1}.p1) \; \land 
(0 < \text{$heap}_{funcstart\_724,1}.p2)) \&\& (\text{$heap}_{funcstart\_724,1}.p2 <
asType < integer > (\$heap_{init}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType<integer>($heap_{tuncstart\_724,1}.p3) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \; \land \; (0 < \$heap_{funcstart\_724,1}.p1) \; \land 
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > (\$heap_{funcstart_{-724,1}}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.30] ((-30307 < -\$heap_{funcstart\_724,1}.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{724,1}.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.p3 < asType < integer > (\text{\$heap}_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1.p2}) \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.\text{p3} < \mathbf{asType} < \mathbf{integer} > (\text{\$heap}_{init}.\text{M3}))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \wedge (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1.p2} \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\$heap_{funcstart\_724,1}.p3 < \mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{short}
int > ((int)30323)))
\rightarrow [simplify]
[5.40] (-30323 < -\$heap_{funcstart\_724,1}.p3) \land (-30307 < -30307)
-\$heap_{funcstart\_724,1}.p2) \land (-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < -\$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.\text{p1}) \land (0 < \text{Sheap}_{funcstart\_724,1}.\text{p2}) \land (0 <
heap_{funcstart_{-724,1}.p3}
```

```
[Work on sub-term 5 of conjunction in term 5.40]
\textit{[9.0] 0} < \$ heap_{funcstart\_724,1}.p2
[Take given term]
[27.0] div2 == div(heapIs $heap<sub>funcstart_724,1</sub>,
asType < int > (\$heap_{funcstart\_724,1}.p2),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
\rightarrow [simplify]
[27.1] div2 == div(heapIs $heap_{funcstart\_724.1}, $heap_{funcstart\_724.1}.p2,
asType < int > (\$heap_{funcstart\_724,1}.a2))
\rightarrow [const static or extern object]
[27.2]~{\rm div2} == {\rm div}(\mathbf{heapIs}~\$ \mathrm{heap}_{funcstart\_724,1},\,\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2},
asType < int > (\$heap_{init}.a2))
\rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
[27.3] \operatorname{div2} == \operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p2,
asType < int > (asType < short int > ((int)176)))
\rightarrow [simplify]
[27.6] div2 == div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p2, 176)
[Assume known post-assertion, class invariant or type constraint for term 27.6]
[30.0] (asType<integer>($heap_{funcstart_724.1}.p2) /
asType<integer>(176)) == asType<integer>(div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).quot
\rightarrow [simplify]
[30.2] ($heap<sub>funcstart_724,1.</sub>p2 / 176) == asType<integer>(div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).quot)
→ [expand definition of operator './' in class 'int' at built in declaration]
[30.3] ([asType<integer>($heap_{funcstart\_724,1}.p2) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176), []:
asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176) = =
\mathbf{asType} {<} \mathbf{integer} {>} ( \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2},
176).quot)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[30.4] ([asType<integer>($heap_{funcstart\_724,1}.p2) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176),
[!(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176) ==
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2,
176).quot)
```

```
\rightarrow [simplify]
[30.7] ([0 < -$heap<sub>funcstart_724,1.</sub>p2]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176),
[!(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p2) < 0)]:
asType < integer > (\$heap_{funcstart\_724.1}.p2) / 176) = =
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2,
176).quot)
\rightarrow [from term 9.0, literala < -$heap<sub>funcstart_724,1.</sub>p2 is false whenever -2 < (0
+ literala)]
    Proof of rule precondition:
    [30.7.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [30.7.2] true
[30.8] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176) ==
asType<integer>(div(heapIs $heap_{tuncstart\_724.1}, $heap_{tuncstart\_724.1}.p2,
176).quot)
\rightarrow [simplify]
[30.11] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176), [!(0 < integer > (\$heap_{funcstart\_724,1}.p2) / 176)]
-\$heap_{funcstart\_724,1}.p2)]: asType<integer>(\$heap_{funcstart\_724,1}.p2) / 176)
== asType<integer>(div(heapIs $heap_{tuncstart\_724,1},
heap_{funcstart_{-724,1}.p2, 176}, quot
\rightarrow [from term 9.0, literala < -$heap<sub>funcstart_724.1</sub>.p2 is false whenever -2 < (0
+ literala)]
    Proof of rule precondition:
    [30.11.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [30.11.2] true
[30.12] \; ([{\bf false}]: \; -({\bf -asType} < {\bf integer} > (\$ {\bf heap}_{funcstart\_724,1}.{\bf p2}) \; / \; 176),
[!false]: asType<integer>(\ensuremath{\text{sheap}}_{funcstart\_724,1}.p2) / 176) ==
\mathbf{asType} < \mathbf{integer} > (\mathbf{div}(\mathbf{heapIs} \ \$ \mathbf{heap}_{funcstart\_724,1}, \ \$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}, \\
176).quot)
\rightarrow [simplify]
[30.17] 0 == (-\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p2},
176).quot + ({\rm \$heap}_{funcstart\_724,1}.{\rm p2} \ / \ 176))
[Assume known post-assertion, class invariant or type constraint for term
30.17
```

```
[36.0] \operatorname{minof(int)} \leq \operatorname{div}(\operatorname{heapIs} \operatorname{\$heap}_{funcstart\_724,1}, \operatorname{\$heap}_{funcstart\_724,1}.p2,
176).quot
\rightarrow [simplify]
\label{eq:continuous} \textit{[36.3] -32769} < \text{div}(\textbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p2},
176).quot
[Take goal term]
[1.0] minof(int) \leq asType<short int>(div2.quot)
\rightarrow [simplify]
[1.1] -32768 \leq asType<short int>(div2.quot)
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p2, 176
[1.2] -32768 \leq asType<short int>(div(heapIs $heap_{tuncstart\_724,1},)
heap_{funcstart_{-724,1}}.p2, 176).quot
\rightarrow [simplify]
[1.5] -32769 < \text{div}(\text{heapIs } \text{\$heap}_{funcstart\_724,1}, \text{\$heap}_{funcstart\_724,1}.p2,
176).quot
\rightarrow [from term 36.3, literala < div(heapIs $heap_{funcstart_724.1},
heap_{funcstart\_724,1}.p2, 176).quot is true whenever (-1 + literala) < -32769
   Proof of rule precondition:
   [1.5.0] (-32769 + -1) < -32769
   \rightarrow [simplify]
   [1.5.2] true
[1.6] true
Proof of verification condition: Type constraint satisfied in implicit
conversion from 'short int' to 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (63,40)
Condition defined at:
To prove: asType<short int>(div2.quot) \le maxof(int)
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
heap_{init}.r1 == asType < short int > ((int)171)
\theta sheap<sub>init</sub>.a1 == asType<short int>((int)177)
\theta
```

```
heap_{init}.M2 == asType < short int > ((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
\theta
heap_{init}.b2 == asType<short int>((int)35)
\theta sheap<sub>init</sub>.M3 == asType<short int>((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\rho = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart_{-724,1}})
div1 == div(\mathbf{heapIs} \$ heap_{funcstart\_724.1},
asType < int > (\$heap_{funcstart\_724.1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) ==
asType<integer>(div1.quot)
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \%
asType < integer > (asType < int > (\$heap_{funcstart_{-724.1}}.a1))) = =
asType<integer>(div1.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1})) =>
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}) ==
asType<integer>(div1.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a1) \le
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart_{-724.1}},
asType < int > (\$heap_{funcstart\_724,1}.p2),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p2})) \ / \\
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) \%
```

```
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(asType < integer > ($heap_{funcstart\_724.1}.p2) = =
asType<integer>(div2.rem))
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a3}))
(asType<integer>(asType<int>($heap_{tuncstart\_724.1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724.1}.a3))) = =
asType<integer>(div3.quot)
(asType < integer > (asType < int > (\$heap_{tuncstart\_724,1}.p3)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) ==
asType<integer>(div3.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a3}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
\$heap_{724,1;745,8} == \$heap_{funcstart\_724,1}.\_\mathbf{replace}(p1 \rightarrow \mathbf{asType} < \mathbf{short}
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
-asType<integer const>($heap<sub>724,1;745,8</sub>.M1) <
asType<integer>($heap<sub>724,1;745,8</sub>.p1)
!(0 == \mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathrm{heap}_{724,1;745,8}.\mathrm{p1}))
asType<integer>($heap<sub>724,1;745,8</sub>.p1) <
asType<integer>($heap<sub>724,1;745,8</sub>.M1)
Proof:
```

```
[Take given term]
[5.0] invariant1(heapIs heap_{funcstart\_724,1})
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
[5.1] ((((((0 < asType < integer > ($heap_{funcstart\_724,1}.p1)) &&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) <
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M2})))~\&\&~(0<
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.3] (((((0 < $heap_{funcstart_724,1}.p1) && ($heap_{funcstart_724,1}.p1 < function for the content of the 
asType<integer>(sheap_{funcstart\_724,1}.M1))) && (0 <
asType < integer > (\$heap_{funcstart_{-724,1}}.p2))) \&\&
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 < funcstart\_724,1.M2))
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})))\ \&\&
(asType < integer > (\$heap_{funcstart\_724.1}.p3) < 
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M3}))
\rightarrow [const static or extern object]
[5.4] (((((0 < $heap_{funcstart_{724,1}}.p1) && ($heap_{funcstart_{724,1}}.p1 < 
asType < integer > (\$heap_{init}.M1))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})))\ \&\&
(asType<integer>($heap_funcstart_724.1.p3) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < $heap_{funcstart_{724,1}}.p1) && ($heap_{funcstart_{724,1}}.p1 < 
asType<integer>(asType<short int>((int)30269)))) && (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2})))\ \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.16] ((((-30269 < -$heap_{funcstart\_724,1}.p1) \lambda (0 < $heap_{funcstart\_724,1}.p1) \lambda
```

```
(0 < \text{\$heap}_{funcstart_{-724,1}.p2})) \&\& (\text{\$heap}_{funcstart_{-724,1}.p2} <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p3) < 
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M3}))
\rightarrow [const static or extern object]
[5.17] ((((-30269 < -$heap_{funcstart\_724,1}.p1) \lambda (0 < $heap_{funcstart\_724,1}.p1) \lambda
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType<integer>(heap_{init}.M2))) && (0 <
asType<integer>($heap_tuncstart_724.1.p3))) &&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M3}))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \; \land \; (0 < \$heap_{funcstart\_724,1}.p1) \; \land 
(0 < \text{Sheap}_{funcstart_{724,1},p2})) \&\& (\text{Sheap}_{funcstart_{724,1},p2} < 0
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{tuncstart_{-724.1}}.M3))
\rightarrow [simplify]
[5.30] ((-30307 < -$heap_funcstart_724,1.p2) \land (-30269 <
-$heap_{funcstart\_724,1}.p1) \land (0 < $heap_{funcstart\_724,1}.p1) \land (0 <
\text{Sheap}_{funcstart\_724,1.p2} \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.p3 < asType < integer > (\text{\$heap}_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -$heap_{funcstart\_724,1}.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1.p2}) \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.\text{p3} < \mathbf{asType} < \mathbf{integer} > (\text{\$heap}_{init}.\text{M3}))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap_funcstart_724,1.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{-724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{-724,1}.p3})) \&\&
(\text{sheap}_{funcstart\_724,1}.\text{p3} < \text{asType} < \text{integer} > (\text{asType} < \text{short})
int > ((int)30323)))
\rightarrow [simplify]
[5.40] (-30323 < -\$heap_{funcstart\_724,1}.p3) \land (-30307 < -30307)
-\$heap_{funcstart\_724,1}.p2) \land (-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < -\$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.\text{p1}) \land (0 < \text{Sheap}_{funcstart\_724,1}.\text{p2}) \land (0 <
heap_{funcstart_{-724,1}.p3}
```

```
[Work on sub-term 5 of conjunction in term 5.40]
\textit{[9.0] 0} < \$ heap_{funcstart\_724,1}.p2
[Take given term]
[27.0] div2 == div(heapIs $heap<sub>funcstart_724,1</sub>,
asType < int > (\$heap_{funcstart\_724,1}.p2),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
\rightarrow [simplify]
[27.1] div2 == div(heapIs $heap_{funcstart\_724.1}, $heap_{funcstart\_724.1}.p2,
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
\rightarrow [const static or extern object]
[27.2]~{\rm div2} == {\rm div}(\mathbf{heapIs}~\$ \mathrm{heap}_{funcstart\_724,1},\,\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2},
asType < int > (\$heap_{init}.a2))
\rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
[27.3] \operatorname{div2} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p2,
asType < int > (asType < short int > ((int)176)))
\rightarrow [simplify]
[27.6] div2 == div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p2, 176)
[Assume known post-assertion, class invariant or type constraint for term 27.6]
[30.0] (asType<integer>($heap_{tuncstart_724.1}.p2) /
asType<integer>(176)) == asType<integer>(div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).quot
\rightarrow [simplify]
[30.2] ($heap<sub>funcstart_724,1.</sub>p2 / 176) == asType<integer>(div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).quot)
→ [expand definition of operator './' in class 'int' at built in declaration]
[30.3] ([asType<integer>($heap_{funcstart\_724,1}.p2) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176), []:
asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176) = =
\mathbf{asType} {<} \mathbf{integer} {>} ( \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2},
176).quot)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[30.4] ([asType<integer>($heap_{funcstart\_724,1}.p2) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176),
[!(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176) ==
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2,
176).quot)
```

```
\rightarrow [simplify]
[30.7] ([0 < -$heap<sub>funcstart_724,1.</sub>p2]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176),
[!(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p2) < 0)]:
asType < integer > (\$heap_{funcstart\_724.1}.p2) / 176) = =
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2,
176).quot)
\rightarrow [from term 9.0, literala < -$heap<sub>funcstart_724,1.</sub>p2 is false whenever -2 < (0
+ literala)]
    Proof of rule precondition:
    [30.7.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [30.7.2] true
[30.8] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176) = =
asType<integer>(div(heapIs $heap_{tuncstart\_724.1}, $heap_{tuncstart\_724.1}.p2,
176).quot)
\rightarrow [simplify]
[30.11] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176), [!(0 < integer > (\$heap_{funcstart\_724,1}.p2) / 176)]
-\$heap_{funcstart\_724,1}.p2)]: asType<integer>(\$heap_{funcstart\_724,1}.p2) / 176)
== asType<integer>(div(heapIs $heap_{tuncstart\_724,1},
heap_{funcstart_{-724,1}}.p2, 176).quot
\rightarrow [from term 9.0, literala < -$heap<sub>funcstart_724.1</sub>.p2 is false whenever -2 < (0
+ literala)]
    Proof of rule precondition:
    [30.11.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [30.11.2] true
[30.12] \; ([{\bf false}]: \; -({\bf -asType} < {\bf integer} > (\$ {\bf heap}_{funcstart\_724,1}.{\bf p2}) \; / \; 176),
[!false]: asType<integer>(\ensuremath{\text{sheap}}_{funcstart\_724,1}.p2) / 176) ==
\mathbf{asType} < \mathbf{integer} > (\mathbf{div}(\mathbf{heapIs} \ \$ \mathbf{heap}_{funcstart\_724,1}, \ \$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}, \\
176).quot)
\rightarrow [simplify]
[30.17] 0 == (-\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p2},
176).quot + ({\rm \$heap}_{funcstart\_724,1}.{\rm p2} \ / \ 176))
[Assume known post-assertion, class invariant or type constraint for term
30.17
```

```
[37.0] div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot \leq
maxof(int)
\rightarrow [simplify]
176).quot
[Take goal term]
[1.0] asType<short int>(div2.quot) \le maxof(int)
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{funcstart_{724,1}},
heap_{funcstart_{-724,1}}.p2, 176
[1.1] asType<short int>(div(heapIs heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} \leq \text{maxof(int)}
\rightarrow [simplify]
\label{eq:continuous} \mbox{[1.11] -32768} < -\mbox{div}(\mbox{\bf heapIs} \ \mbox{\$heap}_{funcstart\_724,1}, \ \mbox{\$heap}_{funcstart\_724,1}.\ \mbox{p2},
176).quot
\rightarrow [from term 37.9, literala < -div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p2, 176).quot is true whenever (-1 + literala) < -32768
   Proof of rule precondition:
   [1.11.0](-32768 + -1) < -32768
   \rightarrow [simplify]
   [1.11.2] true
[1.12] true
Proof of verification condition: Type constraint satisfied in implicit
conversion from 'short int const' to 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (63,35)
Condition defined at:
To prove: minof(int) \le \$heap_{724,1:745.8}.b2
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
heap_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta
\theta
\theta_{init}.r2 == asType < short int > ((int)172)
```

```
\theta_{init}.a2 == asType<short int>((int)176)
\theta sheap<sub>init</sub>.b2 == asType<short int>((int)35)
\theta sheap<sub>init</sub>.M3 == asType<short int>((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
heap_{init}.b3 == asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
invariant
1<br/>( \mathbf{heapIs}\ \$ \mathbf{heap}_{funcstart\_724,1})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \ \operatorname{\$heap}_{funcstart\_724,1},
\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(asType<int>(asType<int>($heap_{tuncstart\_724.1}.p1)) /
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}))) = =
asType<integer>(div1.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) ==
asType<integer>(div1.rem))
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) /
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))) ==
asType<integer>(div2.rem)
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) <
```

```
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a2})) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}) ==
asType<integer>(div2.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a2}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p2)) => !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
\mathbf{asType} < \mathbf{int} > (\$ heap_{funcstart\_724,1}.p3),
asType < int > (\$heap_{funcstart_{-724,1}}.a3))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(asType<int>(sheap<sub>funcstart_724,1.</sub>p3)) %
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a3}))) = =
asType<integer>(div3.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.a3) \leq
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})) => !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
\mathbf{asType} \hspace{-0.1em}<\hspace{-0.1em} \mathbf{int} \hspace{-0.1em}> \hspace{-0.1em} (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{r1})) - (\mathbf{asType} \hspace{-0.1em}<\hspace{-0.1em} \mathbf{int} \hspace{-0.1em}> \hspace{-0.1em} (\mathbf{asType} \hspace{-0.1em}<\hspace{-0.1em} \mathbf{short})
int>(div1.quot)) * asType<int>($heap_{funcstart\_724,1}.b1)))
-asType<integer const>($heap<sub>724,1:745,8</sub>.M1) <
asType<integer>($heap<sub>724,1:745,8</sub>.p1)
!(0 == asType < integer > (\$heap_{724,1:745.8}.p1))
asType<integer>($heap<sub>724.1:745.8</sub>.p1) <
asType<integer>($heap<sub>724,1:745,8</sub>.M1)
Proof:
[Take given term]
[11.0] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}),
```

```
asType < int > (\$heap_{funcstart\_724.1}.a1))
\rightarrow [simplify]
[11.1] div1 == div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
asType < int > (\$heap_{funcstart\_724,1}.a1))
\rightarrow [const static or extern object]
[11.2] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
asType < int > (\$heap_{init}.a1))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
[11.3] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
asType<int>(asType<short int>((int)177)))
\rightarrow [simplify]
[11.6] div1 == div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1, 177)
[Take given term]
\text{[59.0] \$heap}_{724,1;745,8} == \$heap_{funcstart\_724,1}.\_\textbf{replace}(p1 \rightarrow \textbf{asType} < \textbf{short}
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1.quot})) * \mathbf{asType}{<} \mathbf{int}{>} (\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{tuncstart\_724.1},
heap_{funcstart_{-724,1}}.p1, 177
[59.1] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},
\theta_{funcstart\_724,1}.p1, 177).rem ** asType<int>($\text{heap}_{funcstart\_724,1}.r1)) -
(asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [simplify]
[59.3] \rho_{1745,8} == \rho_{1745,8} == \rho_{1745,8} == \rho_{1745,8}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType < int > (\$heap_{funcstart\_724.1}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1.quot})) * \mathbf{asType}{<} \mathbf{int}{>} (\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
\rightarrow [const static or extern object]
[59.4] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType < int > (\$heap_{init}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1.quot})) * \mathbf{asType}{<} \mathbf{int}{>} (\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
\rightarrow [expand definition of constant 'r1' at prang.c (15,20)]
\text{[59.5] \$heap}_{724,1;745,8} == \$heap_{funcstart\_724,1}.\_\textbf{replace}(p1 \rightarrow \textbf{asType} < \textbf{short}
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType<int>(asType<short int>((int)171))) -
```

```
(asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [simplify]
[59.8] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem * 171)
- (asType<int>(asType<short int>(div1.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart_{724,1}},
heap_{funcstart_{-724,1}}.p1, 177
[59.9] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((171 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)
- (asType<int>(asType<short int>(div(heapIs $heap_{funcstart_724.1},
heap_{funcstart_{724,1}}.p1, 177).quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [simplify]
[59.11] \text{heap}_{724,1;745,8} == \text{heap}_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((171 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [const static or extern object]
[59.12] heap_{724,1;745,8} == heap_{funcstart\_724,1}. replace(p1 \rightarrow asType<short
int>((171 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType < int > (\$heap_{init}.b1)))
\rightarrow [expand definition of constant 'b1' at prang.c (17,20)]
[59.13] heap_{724,1;745,8} == heap_{funcstart\_724,1}. replace(p1 \rightarrow asType<short
int>((171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType<int>(asType<short int>((int)2))))
\rightarrow [simplify]
[59.19] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724.1}, \ \text{\$heap}_{funcstart\_724.1}, 177).rem)))
[Take goal term]
[1.0] minof(int) \leq $heap<sub>724.1:745.8</sub>.b2
\rightarrow [simplify]
[1.1] -32768 \leq $heap<sub>724,1;745,8</sub>.b2
\rightarrow [from term 59.19, $heap<sub>724.1:745.8</sub> is equal to
```

```
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177).rem)
[1.2] -32768 \leq $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 * div(heapIs
\text{Sheap}_{funcstart_{-724.1}}, \text{Sheap}_{funcstart_{-724.1}}, \text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs}))
\$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem))).b2
\rightarrow [const member of object with modified fields]
[1.3] -32768 \le \text{$heap}_{funcstart\_724,1}.b2
\rightarrow [const static or extern object]
[1.4] -32768 \le \text{$heap}_{init}.b2
\rightarrow [expand definition of constant 'b2' at prang.c (22,20)]
[1.5] -32768 \leq asType<short int>((int)35)
\rightarrow [simplify]
[1.8] true
Proof of verification condition: Type constraint satisfied in implicit
conversion from 'short int const' to 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (63,35)
Condition defined at:
To prove: heap_{724.1:745.8}.b2 \le maxof(int)
Given:
heap_{init}.LIMIT == (int)80
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta
\theta
\theta_{init}.r2 == asType<short int>((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
heap_{init}.b2 == asType < short int > ((int)35)
\theta = asType < short int > ((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
heap_{init}.a3 == asType<short int>((int)178)
\theta = asType < short int > ((int)63)
```

```
\theta
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs $heap_{tuncstart_{724.1}})
div1 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ / \\
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}))) = =
asType<integer>(div1.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p1) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1})) =>
(asType < integer > (\$heap_{funcstart\_724,1}.p1) = =
asType<integer>(div1.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a1) \le
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart\_724.1},
asType < int > (\$heap_{funcstart\_724.1}.p2),
asType < int > (\$heap_{funcstart\_724.1}.a2))
(asType<integer>(asType<int>($heap_{funcstart\_724,1}.p2)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p2) = =
asType<integer>(div2.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a2) \le
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})) => !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
```

```
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a3}))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) \%
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a3}))) = =
asType<integer>(div3.rem)
(asType<integer>($heap_{tuncstart\_724.1}.p3) <
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a3})) = {>}
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) ==
asType<integer>(div3.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a3}) \leq
asType < integer > (\$heap_{funcstart\_724.1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
\$heap_{724,1;745,8} == \$heap_{funcstart\_724,1}.\_\textbf{replace}(p1 \rightarrow \textbf{asType} < \textbf{short}
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{tuncstart\_724.1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType<int>($heap_{funcstart\_724,1}.b1)))
-{\bf asType}{<} {\bf integer~const}{>} (\${\rm heap}_{724,1;745,8}.{\rm M1}) <
asType<integer>($heap<sub>724,1:745,8</sub>.p1)
!(0 == asType < integer > (\$heap_{724,1;745,8}.p1))
asType<integer>($heap<sub>724,1;745,8</sub>.p1) <
asType<integer>($heap<sub>724.1:745.8</sub>.M1)
Proof:
[Take given term]
[11.0] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
\rightarrow [simplify]
[11.1] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType < int > (\$heap_{funcstart\_724,1}.a1))
\rightarrow [const static or extern object]
[11.2] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \operatorname{\$heap}_{funcstart\_724,1}, \operatorname{\$heap}_{funcstart\_724,1}.p1,
```

```
asType < int > (\$heap_{init}.a1))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
[11.3] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \operatorname{\$heap}_{funcstart\_724,1}, \operatorname{\$heap}_{funcstart\_724,1}.p1,
asType<int>(asType<short int>((int)177)))
\rightarrow [simplify]
[11.6] div1 == div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1, 177)
[Take given term]
[59.0] \rho_{1745,8} == \rho_{1745
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{tuncstart\_724.1}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1.quot})) * \mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177
[59.1] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div(heapIs $heap_{tuncstart_724.1},
\rho_{funcstart\_724,1.p1, 177).rem} * asType<int>(\rho_{funcstart\_724,1.r1}) -
(asType<int>(asType<short int>(div1.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [simplify]
[59.3] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
\mathbf{asType} \small{<} \mathbf{int} \small{>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{r1})) - (\mathbf{asType} \small{<} \mathbf{int} \small{>} (\mathbf{asType} \small{<} \mathbf{short}
int>(div1.quot)) * asType<int>($heap_{funcstart\_724,1}.b1)))
\rightarrow [const static or extern object]
[59.4] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724.1}, \$heap_{funcstart\_724.1}, p1, 177).rem *
asType < int > (\$heap_{init}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1.quot})) \ * \ \mathbf{asType}{<} \mathbf{int}{>} (\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
\rightarrow [expand definition of constant 'r1' at prang.c (15,20)]
\text{[59.5] \$heap}_{724,1;745,8} == \$heap_{funcstart\_724,1}.\_\textbf{replace}(p1 \rightarrow \textbf{asType} < \textbf{short}
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType<int>(asType<short int>((int)171))) -
(asType<int>(asType<short int>(div1.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [simplify]
[59.8] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int > ((div(heapIs \$heap_{funcstart\_724.1}, \$heap_{funcstart\_724.1}, p1, 177).rem * 171)
- (asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
```

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\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177)
[59.9] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int > ((171 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)
- (asType<int>(asType<short int>(div(heapIs $heap_{funcstart_724.1},
heap_{funcstart_{-724,1}}.p1, 177).quot)
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [simplify]
[59.11] \$ heap_{724,1;745,8} == \$ heap_{funcstart\_724,1}.\_\mathbf{replace} (p1 \to \mathbf{asType} < \mathbf{short})
int>((171 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)
- (div(heapIs heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 177).quot *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [const static or extern object]
[59.12] \theta_{12} = \theta_{124,1;745,8} = \theta_{124,1;74
int > ((171 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724.1}, \$ \text{heap}_{funcstart\_724.1}.\text{p1}, 177).\text{quot} *
asType < int > (\$heap_{init}.b1)))
\rightarrow [expand definition of constant 'b1' at prang.c (17,20)]
[59.13] \theta_{13} = \theta_
int>((171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType<int>(asType<short int>((int)2))))
\rightarrow [simplify]
[59.19] $\text{heap}_{724,1;745,8} == \text{$heap}_{funcstart\_724,1}$._\text{$-replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).rem)))
[Take goal term]
[1.0] $heap<sub>724,1:745,8</sub>.b2 \leq maxof(int)
\rightarrow [from term 59.19, $heap_{724,1;745,8}$ is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p1, 177).rem}
[1.1] \text{heap}_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).quot) + (171 * div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).rem)).b2 \leq \max f(\text{int})
\rightarrow [const member of object with modified fields]
[1.2] $\text{heap}_{funcstart_724,1}.\text{b2} \leq \text{maxof(int)}
\rightarrow [const static or extern object]
```

```
[1.3] $heap<sub>init</sub>.b2 \leq maxof(int)
\rightarrow [expand definition of constant 'b2' at prang.c (22,20)]
[1.4] asType<short int>((int)35) \le maxof(int)
\rightarrow [simplify]
[1.8] true
Proof of verification condition: Arithmetic result of operator '*' is within
limit of type 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (63,38)
Condition defined at:
To prove: minof(int) \le (asType<int>(asType<short int>(div2.quot)) *
asType < int > (\$heap_{724,1;745,8}.b2))
Given:
heap_{init}.LIMIT == (int)80
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
\theta
\theta
heap_{init}.M2 == asType < short int > ((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart\_724,1})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) /
```

```
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}))~\%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}))) = =
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{div1.rem})
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p1) = =
asType<integer>(div1.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathtt{a1}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724.1}.p2),
asType < int > (\$heap_{funcstart\_724.1}.a2))
(asType<integer>(asType<int>($heap_{funcstart\_724.1}.p2)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = = 
asType<integer>(div2.quot)
(\mathbf{asType} {<} \mathbf{integer} {>} (\mathbf{asType} {<} \mathbf{int} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2})) \ \%
asType < integer > (asType < int > (\$heap_{funcstart\_724.1}.a2))) = =
asType<integer>(div2.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p2) ==
asType<integer>(div2.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a2) \le
asType < integer > (\$heap_{funcstart\_724,1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724.1},
\mathbf{asType} < \mathbf{int} > (\$ heap_{funcstart\_724,1}.p3),
asType < int > (\$heap_{funcstart\_724,1}.a3))
(asType<int>(asType<int>($heap_{tuncstart\_724.1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
```

```
asType<integer>(div3.rem)
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}) ==
asType<integer>(div3.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a3}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
heap_{724,1:745,8} == heap_{funcstart,724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1.quot})) \ * \ \mathbf{asType}{<} \mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
-asType<integer const>($heap<sub>724.1:745.8</sub>.M1) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{p1})
!(0 == asType < integer > (\$heap_{724,1;745,8}.p1))
asType<integer>($heap<sub>724.1:745.8</sub>.p1) <
asType<integer>($heap<sub>724,1:745,8</sub>.M1)
Proof:
[Take given term]
[5.0] invariant1(heapIs heap_{funcstart\_724,1})
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
[5.1] ((((((0 < asType < integer > ($heap_{funcstart\_724,1}.p1)) &&
(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 
asType < integer > (\$heap_{tuncstart\_724.1}.M1))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p2) <
as
Type<integer>(\rho_{funcstart\_724,1}.M2))) & (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.3] (((((0 < $heap_{funcstart\_724,1}.p1) && ($heap_{funcstart\_724,1}.p1 < 
asType < integer > (\$heap_{funcstart\_724.1}.M1))) \&\& (0 <
asType < integer > (\$heap_{funcstart_{724,1}}.p2))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M2})))~\&\&~(0<
asType < integer > (\$heap_{funcstart_{-724,1}}.p3))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) <
```

```
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [const static or extern object]
[5.4] (((((0 < \text{heap}_{funcstart\_724,1}.p1) && (\text{heap}_{funcstart\_724,1}.p1 <
asType<integer>(heap_{init}.M1))) && (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2})))\ \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < $heap_{funcstart_{724,1}}.p1) && ($heap_{funcstart_{724,1}}.p1 < 
asType<integer>(asType<short int>((int)30269)))) && (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 < funcstart\_724,1)
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{tuncstart_{-724.1}}.M3))
\rightarrow [simplify]
[5.16] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < \text{$heap}_{funcstart\_724,1}.p2)) \&\& (\text{$heap}_{funcstart\_724,1}.p2 <
\mathbf{asType} \small{<} \mathbf{integer} \small{>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M2}))) \ \&\& \ (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p3) < 
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M3}))
\rightarrow [const static or extern object]
[5.17] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \; \land \; (0 < \$heap_{funcstart\_724,1}.p1) \; \land 
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType < integer > (\$heap_{init}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType<integer>($heap_{tuncstart\_724,1}.p3) <
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M3}))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < \text{$heap}_{funcstart\_724,1}.p2)) \&\& (\text{$heap}_{funcstart\_724,1}.p2 <
asType < integer > (asType < short int > ((int)30307)))) && (0 < integer) && (0 < integer
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart_{-724.1}}.M3))
\rightarrow [simplify]
```

```
[5.30] ((-30307 < -$heap_funcstart_724,1.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.p2) \land (0 < \text{Sheap}_{funcstart\_724,1}.p3)) \&\&
(\text{\$heap}_{funcstart\_724,1}.\text{p3} < \text{asType} < \text{integer} > (\text{\$heap}_{funcstart\_724,1}.\text{M3}))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -$heap<sub>funcstart_724,1</sub>.p2) \wedge (-30269 <
-\text{\$heap}_{funcstart\_724,1}.\text{p1}) \land (0 < \text{\$heap}_{funcstart\_724,1}.\text{p1}) \land (0 <
\text{Sheap}_{funcstart\_724,1.p2} \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.\text{p3} < \mathbf{asType} < \mathbf{integer} > (\text{\$heap}_{init}.\text{M3}))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap<sub>funcstart_724,1</sub>.p2) \wedge (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\theta_{funcstart\_724,1}.p2) \land (0 < \theta_{funcstart\_724,1}.p3)) \&\&
(\$heap_{funcstart\_724,1}.p3 < \mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{short}
int > ((int)30323)))
\rightarrow [simplify]
[5.40] (-30323 < -$heap<sub>funcstart_724,1.</sub>p3) \wedge (-30307 <
-\$heap_{funcstart\_724,1}.p2) \land (-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < -\$heap_{funcstart\_724,1}.p2)
\text{Sheap}_{funcstart\_724,1}.\text{p1}) \land (0 < \text{Sheap}_{funcstart\_724,1}.\text{p2}) \land (0 <
heap_{funcstart_{-724,1}.p3}
[Work on sub-term 5 of conjunction in term 5.40]
[9.0] 0 < \text{$heap}_{funcstart\_724,1}.p2
[Take given term]
[11.0] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
\rightarrow [simplify]
[11.1] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
\rightarrow [const static or extern object]
[11.2] div1 == div(heapIs \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}
asType < int > (\$heap_{init}.a1))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
[11.3] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType<int>(asType<short int>((int)177)))
\rightarrow [simplify]
[11.6] \text{ div1} == \text{div}(\mathbf{heapIs} \$ heap_{funcstart\_724,1}, \$ heap_{funcstart\_724,1}.p1, 177)
[Take given term]
```

```
[27.0] \operatorname{div2} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
\rightarrow [simplify]
[27.1] div2 == div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}.p2,
asType < int > (\$heap_{funcstart\_724,1}.a2))
\rightarrow [const static or extern object]
[27.2] div2 == div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p2,
asType < int > (\$heap_{init}.a2))
\rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
[27.3]~{\rm div2} == {\rm div}(\mathbf{heapIs}~\$ \mathrm{heap}_{funcstart\_724,1},\,\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2},
asType<int>(asType<short int>((int)176)))
\rightarrow [simplify]
[27.6] div2 == div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176)
[Assume known post-assertion, class invariant or type constraint for term 27.6]
[30.0] (asType<integer>($heap_{funcstart\_724,1}.p2) /
asType<integer>(176)) == asType<integer>(div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).quot
\rightarrow [simplify]
[30.2] ($heap_{funcstart\_724,1}.p2 / 176) == asType < integer > (div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot}
→ [expand definition of operator './' in class 'int' at built in declaration]
[30.3] ([asType<integer>(sheap_{funcstart\_724,1}.p2) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176), []:
asType < integer > (\$heap_{funcstart\_724.1}.p2) / 176) = =
asType<integer>(div(heapIs p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1})
176).quot)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[30.4] ([asType<integer>(sheap_{funcstart\_724,1.p2}) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176),
[!(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176) ==
\mathbf{asType} < \mathbf{integer} > (\mathbf{div}(\mathbf{heapIs} \ \$ \mathbf{heap}_{funcstart\_724,1}, \ \$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}, \\
176).quot)
\rightarrow [simplify]
[30.7] ([0 < -$heap<sub>funcstart_724,1.</sub>p2]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 0)]:
```

```
asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176) ==
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2,
176).quot)
\rightarrow [from term 9.0, literala < -$heap<sub>funcstart_724,1.</sub>p2 is false whenever -2 < (0
+ literala)]
   Proof of rule precondition:
   [30.7.0] - 2 < (0 + 0)
   \rightarrow [simplify]
    [30.7.2] true
[30.8] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176) ==
\mathbf{asType} < \mathbf{integer} > (\mathbf{div}(\mathbf{heapIs} \ \$ \mathbf{heap}_{funcstart\_724,1}, \ \$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}, \\
176).quot)
\rightarrow [simplify]
[30.11] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176), [!(0 <
-\$heap_{funcstart\_724,1}.p2)]: \ \mathbf{asType} < \mathbf{integer} > (\$heap_{funcstart\_724,1}.p2) \ / \ 176)
== asType < integer > (div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p2, 176}.quot)
\rightarrow [from term 9.0, literala < -$heap<sub>funcstart_724,1</sub>.p2 is false whenever -2 < (0
+ literala)
   Proof of rule precondition:
   [30.11.0] - 2 < (0 + 0)
   \rightarrow [simplify]
   [30.11.2] true
[30.12] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176),
[!false]: asType<integer>($heap<sub>funcstart_724,1.</sub>p2) / 176) ==
asType<integer>(div(heapIs p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1})
176).quot)
\rightarrow [simplify]
[30.17] 0 == (-div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2,
176).quot + (\theta_{176}).quot + (\theta_{176}).quot + (\theta_{176})
[Take given term]
[59.0] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
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heap_{funcstart_{-724,1}}.p1, 177
[59.1] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},
\rho_{uncstart\_724,1.p1, 177}.rem) * asType < int > (\rho_{uncstart\_724,1.r1}) - (\rho_{uncstart\_724,1.
(asType<int>(asType<short int>(div1.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [simplify]
[59.3] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>(heap_{funcstart\_724,1}.b1)))
\rightarrow [const static or extern object]
[59.4] \rho_{1745,8} == \rho_{1745,8} == \rho_{1745,8} == \rho_{1745,8}._replace(p1 \rightarrow \rho_{1745,8} == \rho_{1745,8}
int>((\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} *
asType < int > (\$heap_{init}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1.quot})) * \mathbf{asType}{<} \mathbf{int}{>} (\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
\rightarrow [expand definition of constant 'r1' at prang.c (15,20)]
[59.5] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType < int > (asType < short int > ((int)171))) -
(asType < int > (asType < short int > (div1.quot)) *
asType < int > (\$heap_{funcstart\_724,1}.b1)))
\rightarrow [simplify]
[59.8] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem * 171)
- (asType<int>(asType<short int>(div1.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177
[59.9] \text{sheap}_{724,1;745,8} == \text{sheap}_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).rem)
- (asType<int>(asType<short int>(div(heapIs $heap_{funcstart_724.1},
heap_{funcstart_{724,1},p1, 177}, quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [simplify]
[59.11] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
\mathbf{int} > ((171 * \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, 177).\operatorname{rem})
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [const static or extern object]
```

```
[59.12] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType < int > (\$heap_{init}.b1)))
\rightarrow [expand definition of constant 'b1' at prang.c (17,20)]
[59.13] \rho_{13} = \rho_
int>((171 * div(heapIs $heap_{funcstart_724,1}, $heap_{funcstart_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType<int>(asType<short int>((int)2))))
\rightarrow [simplify]
[59.19] $\text{heap}_{724.1:745.8} == $\text{heap}_{funcstart_724.1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, 177).rem)))
[Take goal term]
[1.0]  minof(int) \leq (asType<int>(asType<short int>(div2.quot)) *
asType < int > (\$heap_{724,1;745,8}.b2))
\rightarrow [simplify]
[1.1] -32768 \leq (asType<int>(asType<short int>(div2.quot)) *
asType < int > ($heap_{724,1;745,8}.b2))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{tuncstart\_724.1},
heap_{funcstart_{-724,1}}.p2, 176)
[1.2] -32768 \le (asType<int>(asType<short int>(div(heapIs
\label{eq:heap_funcstart_724,1} \$ heap_{funcstart\_724,1}.p2,\ 176).quot)) *
asType<int>($heap<sub>724,1:745,8</sub>.b2))
\rightarrow [simplify]
[1.4] -32768 \leq (div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p2,
176).quot * asType<int>($heap<sub>724.1:745.8</sub>.b2))
\rightarrow [from term 59.19, $heap<sub>724,1;745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1},p1, 177}, quot) + (171 * div(heapIs heap_{funcstart_{724,1},p1, 177})
heap_{funcstart_{-724,1}}.p1, 177).rem)
[1.5] \ -32768 \leq (\mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2},
176).quot * asType<int>($heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).rem))).b2))
\rightarrow [const member of object with modified fields]
[1.6] -32768 \leq (div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p2,
176).quot * asType<int>($heap<sub>funcstart_724.1</sub>.b2))
```

```
\rightarrow [const static or extern object]
[1.7] -32768 \leq (div(heapIs $heap_{funcstart\_724.1}, $heap_{funcstart\_724.1}.p2,
176).quot * asType < int > (\$heap_{init}.b2))
\rightarrow [expand definition of constant 'b2' at prang.c (22,20)]
\label{eq:constant_724,1} \text{-}32768 \leq (\text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p2},
176).quot * asType<int>(asType<short int>((int)35)))
[1.13] -32769 < (35 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p2,
176).quot)
\rightarrow [literal comparison of product]
[1.14] ([35 < 0]: (-32769 / -35) < -\text{div}(\text{heapIs } \text{\$heap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot}, [0 < 35]: (-32769 / 35) < \text{div}(\textbf{heapIs})
\$ heap_{funcstart\_724,1}, \$ heap_{funcstart\_724,1}.p2, \ 176).quot, \ [0 == 35]: \ -32769 < 0)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[1.15] ([35 < 0]: (-32769 / -35) < -\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724.1.p2}, 176).quot, [(0 < 35) \land !(35 < 0)]: (-32769 / 35) < 0
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p2, 176).\operatorname{quot}, \ [(0 == 35)]
\land !(0 < 35) \land !(35 < 0)]: -32769 < 0)
\rightarrow [simplify]
[1.23] -937 < div(heapIs $heap_{funcstart_{-724,1}}, $heap_{funcstart_{-724,1}}.p2,
176).quot
\rightarrow [negate goal and search for contradiction]
[1.24]!(-937 < \text{div}(\text{heapIs } \text{$heap}_{funcstart\_724,1}, \text{$heap}_{funcstart\_724,1}.\text{p2},
176).quot)
\rightarrow [simplify]
[1.26] 936 < -\text{div}(\text{heapIs } \text{$heap}_{funcstart\_724,1}, \text{$heap}_{funcstart\_724,1}.p2,
176).quot
[Create new term from terms 1.26, 30.17 using rule: transitivity 15]
[75.0] (0 + 936) < -($heap_{funcstart\_724,1}.p2 / 176)
\rightarrow [simplify]
[75.7] 164736 < -$heap<sub>funcstart_724,1</sub>.p2
\rightarrow [from term 9.0, literala < -$heap_{uncstart\_724,1}.p2 is false whenever -2 < (0
+ literala)]
    Proof of rule precondition:
    [75.7.0] - 2 < (0 + 164736)
    \rightarrow [simplify]
```

```
[75.8] false
Proof of verification condition: Arithmetic result of operator '*' is within
limit of type 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (63,38)
Condition defined at:
To prove: (asType<int>(asType<short int>(div2.quot)) *
asType < int > (\$heap_{724,1;745,8}.b2)) \le maxof(int)
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
heap_{init}.M2 == asType < short int > ((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta sheap<sub>init</sub>.b2 == asType<short int>((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart\_724,1})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1})) \ / \\
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(asType < integer > (asType < int > (\$heap_{tuncstart\_724.1}.p1)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
```

[75.7.2] **true**

```
asType<integer>(div1.rem)
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathtt{p1}) = =
asType<integer>(div1.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathtt{a1}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType < integer > (div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart_{-724.1}},
asType < int > (\$heap_{funcstart\_724.1}.p2),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}))\ /
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.quot)
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2})) \ \%
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(asType < integer > ($heap_{funcstart\_724.1}.p2) = =
asType<integer>(div2.rem))
(asType<integer>(sheap_{funcstart\_724,1}.a2) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p2)) => !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
\label{eq:div3} \text{div3} == \text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a3}))
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3})) \ / \\
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3})) \ \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.rem)
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(asType < integer > (\$heap_{funcstart\_724.1}.p3) = =
```

```
asType<integer>(div3.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a3) \le
asType < integer > (\$heap_{funcstart\_724,1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart-724,1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
-asType<integer const>($heap<sub>724.1:745.8</sub>.M1) <
asType<integer>($heap<sub>724,1:745,8</sub>.p1)
!(0 == asType < integer > (\$heap_{724,1;745,8}.p1))
asType<integer>($heap<sub>724.1:745.8</sub>.p1) <
asType<integer>($heap<sub>724,1:745,8</sub>.M1)
Proof:
[Take given term]
[5.0] invariant1(heapIs heap_{funcstart_724,1})
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
 \texttt{[5.1]} \left( \left( \left( \left( \left( 0 < \mathbf{asType} < \mathbf{integer} > \left( \$ \mathsf{heap}_{funcstart\_724,1}.\mathsf{p1} \right) \right) \right. \&\& \right. \right. 
(asType<integer>($heap_funcstart_724.1.p1) <
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2})))\ \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType<integer>($heap_{tuncstart\_724,1}.p3) <
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M3}))
\rightarrow [simplify]
[5.3] (((((0 < \text{heap}_{funcstart\_724,1}.p1) && (\text{heap}_{funcstart\_724,1}.p1 <
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 < function for the start of the start 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2})))\ \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType<integer>(heap_{funcstart\_724,1}.M2))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.4] (((((0 < $heap_{funcstart_{724,1}}.p1) && ($heap_{funcstart_{724,1}}.p1 <
```

```
asType < integer > (\$heap_{init}.M1))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType<integer>($heap_{tuncstart\_724,1}.p3) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < $heap_{funcstart_{724,1}}.p1) && ($heap_{funcstart_{724,1}}.p1 < 
asType<integer>(asType<short int>((int)30269)))) && (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [simplify]
[5.16] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \; \land \; (0 < \$heap_{funcstart\_724,1}.p1) \; \land 
(0 < \text{Sheap}_{funcstart_{-724,1},p2})) \&\& (\text{Sheap}_{funcstart_{-724,1},p2} <
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M2}))) \ \&\& \ (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [const static or extern object]
[5.17] \left( \left( \left( \left( -30269 < -\$ \text{heap}_{funcstart\_724,1}.\text{p1} \right) \right. \wedge \left. \left( 0 < \$ \text{heap}_{funcstart\_724,1}.\text{p1} \right) \right. \wedge \right. \right)
(0 < \text{\$heap}_{funcstart_{-724,1}.p2})) \&\& (\text{\$heap}_{funcstart_{-724,1}.p2} <
asType < integer > (\$heap_{init}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType<integer>($heap_funcstart_724,1.p3) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType<integer>(asType<short int>((int)30307)))) && (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})))\ \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M3}))
\rightarrow [simplify]
[5.30] ((-30307 < -$heap_{funcstart\_724,1}.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{-724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{-724,1}.p3})) \&\&
```

```
(\text{\$heap}_{funcstart\_724,1}.\text{p3} < \mathbf{asType} < \mathbf{integer} > (\text{\$heap}_{funcstart\_724,1}.\text{M3}))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \land (-30269 <
-\$ heap_{funcstart\_724,1}.p1) \land (0 < \$ heap_{funcstart\_724,1}.p1) \land (0 < \$ heap_{funcstart\_724,1}.p1) \land (0 < \$ heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1.p2}) \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.\text{p3} < \mathbf{asType} < \mathbf{integer} > (\text{\$heap}_{init}.\text{M3}))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap<sub>funcstart_724.1</sub>.p2) \wedge (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{-724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{-724,1}.p3})) \&\&
(\text{sheap}_{funcstart\_724.1}.p3 < asType < integer > (asType < short)
int > ((int)30323))
\rightarrow [simplify]
[5.40] (-30323 < -\$heap_{funcstart\_724,1}.p3) \land (-30307 < -30307)
-\$heap_{funcstart\_724,1}.p2) \land (-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < -\$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.\text{p1}) \land (0 < \text{Sheap}_{funcstart\_724,1}.\text{p2}) \land (0 <
heap_{funcstart_{-724,1}.p3}
[Work on sub-term 2 of conjunction in term 5.40]
[6.0] -30307 < -\$heap_{funcstart\_724,1}.p2
[Work on sub-term 5 of conjunction in term 5.40]
\textit{[9.0] 0} < \$ heap_{funcstart\_724,1}.p2
[Take given term]
[11.0] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
\rightarrow [simplify]
[11.1] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType < int > (\$heap_{funcstart\_724,1}.a1))
\rightarrow [const static or extern object]
[11.2] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType < int > (\$heap_{init}.a1))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
[11.3] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType<int>(asType<short int>((int)177)))
\rightarrow [simplify]
[11.6] div1 == div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1, 177)
[Take given term]
```

```
[27.0] \operatorname{div2} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
\rightarrow [simplify]
[27.1] div2 == div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}.p2,
asType < int > (\$heap_{funcstart\_724,1}.a2))
\rightarrow [const static or extern object]
[27.2] div2 == div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p2,
asType < int > (\$heap_{init}.a2))
\rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
[27.3]~{\rm div2} == {\rm div}(\mathbf{heapIs}~\$ \mathrm{heap}_{funcstart\_724,1},\,\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2},
asType<int>(asType<short int>((int)176)))
\rightarrow [simplify]
[27.6] div2 == div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176)
[Assume known post-assertion, class invariant or type constraint for term 27.6]
[30.0] (asType<integer>($heap_{funcstart\_724,1}.p2) /
asType<integer>(176)) == asType<integer>(div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).quot
\rightarrow [simplify]
[30.2] ($heap_{funcstart\_724,1}.p2 / 176) == asType < integer > (div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot}
→ [expand definition of operator './' in class 'int' at built in declaration]
[30.3] ([asType<integer>(sheap_{funcstart\_724,1}.p2) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176), []:
asType < integer > (\$heap_{funcstart\_724.1}.p2) / 176) = =
asType<integer>(div(heapIs p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1})
176).quot)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[30.4] ([asType<integer>(sheap_{funcstart\_724,1.p2}) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176),
[!(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176) ==
\mathbf{asType} < \mathbf{integer} > (\mathbf{div}(\mathbf{heapIs} \ \$ \mathbf{heap}_{funcstart\_724,1}, \ \$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}, \\
176).quot)
\rightarrow [simplify]
[30.7] ([0 < -$heap<sub>funcstart_724,1.</sub>p2]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 0)]:
```

```
asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176) ==
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2,
176).quot)
\rightarrow [from term 9.0, literala < -$heap<sub>funcstart_724,1.</sub>p2 is false whenever -2 < (0
+ literala)]
   Proof of rule precondition:
   [30.7.0] - 2 < (0 + 0)
   \rightarrow [simplify]
    [30.7.2] true
[30.8] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176) ==
\mathbf{asType} < \mathbf{integer} > (\mathbf{div}(\mathbf{heapIs} \ \$ \mathbf{heap}_{funcstart\_724,1}, \ \$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}, \\
176).quot)
\rightarrow [simplify]
[30.11] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176), [!(0 <
-\$heap_{funcstart\_724,1}.p2)]: \ \mathbf{asType} < \mathbf{integer} > (\$heap_{funcstart\_724,1}.p2) \ / \ 176)
== asType < integer > (div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p2, 176}.quot)
\rightarrow [from term 9.0, literala < -$heap<sub>funcstart_724,1</sub>.p2 is false whenever -2 < (0
+ literala)
   Proof of rule precondition:
   [30.11.0] - 2 < (0 + 0)
   \rightarrow [simplify]
   [30.11.2] true
[30.12] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176),
[!false]: asType<integer>($heap<sub>funcstart_724,1.</sub>p2) / 176) ==
asType<integer>(div(heapIs p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1})
176).quot)
\rightarrow [simplify]
[30.17] 0 == (-div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2,
176).quot + (\theta_{176}).quot + (\theta_{176}).quot + (\theta_{176})
[Take given term]
[59.0] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
```

```
heap_{funcstart_{-724,1}}.p1, 177
[59.1] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},
\rho_{uncstart\_724,1.p1, 177}.rem) * asType < int > (\rho_{uncstart\_724,1.r1}) - (\rho_{uncstart\_724,1.
(asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724.1}.b1))))
\rightarrow [simplify]
[59.3] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>(heap_{funcstart\_724,1}.b1)))
\rightarrow [const static or extern object]
[59.4] \rho_{1745,8} == \rho_{1745,8} == \rho_{1745,8} == \rho_{1745,8}._replace(p1 \rightarrow \rho_{1745,8} == \rho_{1745,8}
int>((\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} *
asType < int > (\$heap_{init}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1.quot})) * \mathbf{asType}{<} \mathbf{int}{>} (\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
\rightarrow [expand definition of constant 'r1' at prang.c (15,20)]
[59.5] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType < int > (asType < short int > ((int)171))) -
(asType < int > (asType < short int > (div1.quot)) *
asType < int > (\$heap_{funcstart\_724,1}.b1)))
\rightarrow [simplify]
[59.8] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem * 171)
- (asType<int>(asType<short int>(div1.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177
[59.9] \text{sheap}_{724,1;745,8} == \text{sheap}_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).rem)
- (asType<int>(asType<short int>(div(heapIs $heap_{funcstart_724.1},
heap_{funcstart_{724,1},p1, 177}, quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [simplify]
[59.11] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
\mathbf{int} > ((171 * \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, 177).\operatorname{rem})
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [const static or extern object]
```

```
[59.12] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).rem)
 - (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType < int > (\$heap_{init}.b1)))
\rightarrow [expand definition of constant 'b1' at prang.c (17,20)]
[59.13] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((171 * div(heapIs $heap_{funcstart_724,1}, $heap_{funcstart_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType<int>(asType<short int>((int)2))))
\rightarrow [simplify]
[59.19] $\text{heap}_{724.1:745.8} == $\text{heap}_{funcstart_724.1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, 177).rem)))
[Take goal term]
[1.0] (asType<int>(asType<short int>(div2.quot)) *
asType < int > (\$heap_{724,1;745,8}.b2)) \le maxof(int)
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1}}.p2, 176
[1.1] (asType<int>(asType<short int>(div(heapIs $heap_{tuncstart\_724.1},
\text{sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot}) * asType<int>(\text{sheap}_{724,1;745,8}.\text{b2})) \leq
maxof(int)
\rightarrow [simplify]
[1.3] (div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot *
asType < int > (\$heap_{724.1:745.8}.b2)) \le maxof(int)
\rightarrow [from term 59.19, $heap<sub>724,1:745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs p_{funcstart\_724,1}),
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1}, 177).quot) + (171 * div(heapIs $heap_{funcstart\_724,1}, 17
$heap_{funcstart\_724,1}.p1, 177).rem))]
[1.4] (div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot *
asType < int > (\$heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * div(heapIs))))))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1, 177).quot) + (171 * div(heapIs)
\{\text{heap}_{funcstart\_724,1}, \{\text{heap}_{funcstart\_724,1}.p1, 177).rem\}\}).b2)) \leq \max(\text{int})
\rightarrow [const member of object with modified fields]
[1.5] (div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b2})) \leq \mathbf{maxof}(\mathbf{int})
\rightarrow [const static or extern object]
[1.6] (div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
asType < int > (\$heap_{init}.b2)) < maxof(int)
```

```
\rightarrow [expand definition of constant 'b2' at prang.c (22,20)]
[1.7] (div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot *
asType < int > (asType < short int > ((int)35))) \le maxof(int)
\rightarrow [simplify]
 \label{eq:continuous} \mbox{[1.20] -32768} < \mbox{(-35 * div($\mathbf{heapIs}$ \$heap$_{funcstart\_724,1}$, $\$heap$_{funcstart\_724,1}$.p2}, 
176).quot)
\rightarrow [literal comparison of product]
[1.21] ([-35 < 0]: (-32768 / 35) < -\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1},
\rho_{tuncstart_{-724,1},p2,176} equot, \rho_{tuncstart_{-724,1},p2,176} equot, \rho_{tuncstart_{-724,1},p2,176} equot, \rho_{tuncstart_{-724,1},p2,176}
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot}, [-35 == 0]: -32768 < 0)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[1.22] ([-35 < 0]: (-32768 / 35) < -\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot}, [(0 < -35) \land !(-35 < 0)]: (-32768 / -35) < 0
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p2, \ 176).quot, \ [(-35 == 0)]
\wedge !(-35 < 0) \wedge !(0 < -35)]: -32768 < 0)
\rightarrow [simplify]
[1.26] -937 < -\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p2},
176).quot
\rightarrow [negate goal and search for contradiction]
 [1.27] ! (-937 < -\text{div}(\textbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p2}, 
176).quot)
\rightarrow [simplify]
[1.30] 936 < div(heapIs $heap_{funcstart_{-724,1}}, $heap_{funcstart_{-724,1}}.p2, 176).quot
[Create new term from terms 1.30, 30.17 using rule: transitivity 16]
[75.0] (0 + 936) < (\text{$heap}_{funcstart\_724.1}.p2 / 176)
\rightarrow [simplify]
[75.8] 164911 < \text{$heap}_{funcstart\_724,1}.p2
\rightarrow [from term 6.0, literala < $heap_{tuncstart\_724,1}.p2 is false whenever -2 <
(-30307 + literala)
    Proof of rule precondition:
    [75.8.0] - 2 < (-30307 + 164911)
    \rightarrow [simplify]
    [75.8.2] true
[75.9] false
```

Proof of verification condition: Type constraint satisfied in implicit

```
Condition generated at: C:\Escher\Customers\prang\prang.c (63,33)
Condition defined at:
To prove: minof(short int) \le ((asType < int > (asType < short in
\mathbf{int}{>}(\mathrm{div2.rem})) \ * \ \mathbf{asType}{<} \mathbf{int}{>} (\$\mathrm{heap}_{724,1;745,8}.\mathrm{r2})) \ - \\
(asType<int>(asType<short int>(div2.quot)) *
asType < int > (\$heap_{724,1:745,8}.b2)))
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
heap_{init}.M2 == asType < short int > ((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
\theta_{init}.a2 == asType<short int>((int)176)
\theta == asType<short int>((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs $heap_{tuncstart_724.1})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ / \\
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(\mathbf{asType} {<} \mathbf{int} {>} (\mathbf{asType} {<} \mathbf{int} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}) <
```

conversion from 'int' to 'short int'

```
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a1})) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) ==
asType<integer>(div1.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a1}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart_{-724,1}}.a2))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.quot)
(asType<int>(asType<int>($heap_{tuncstart\_724.1}.p2)) %
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p2) = =
asType<integer>(div2.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a2) \le
asType < integer > (\$heap_{funcstart\_724,1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724.1}.p3),
asType < int > (\$heap_{funcstart\_724,1}.a3))
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})) \ / \\
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a3}))) ==
asType<integer>(div3.quot)
(asType<integer>(asType<int>($heap_{tuncstart\_724.1}.p3)) %
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a3}))) = =
asType<integer>(div3.rem)
(asType<integer>($heap_{tuncstart\_724,1}.p3) <
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(asType < integer > ($heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a3}) \leq
```

```
asType < integer > (\$heap_{funcstart\_724,1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
heap_{724,1;745,8} == heap_{funcstart\_724,1}.\_replace(p1 \rightarrow asType < short)
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724.1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
-asType<integer const>($heap<sub>724,1:745,8</sub>.M1) <
asType<integer>($heap<sub>724.1:745.8</sub>.p1)
!(0 == asType < integer > (\$heap_{724,1:745.8}.p1))
asType < integer > (\$heap_{724,1;745,8}.p1) <
asType<integer>($heap<sub>724,1:745,8</sub>.M1)
Proof:
[Take given term]
[5.0] invariant1(heapIs heapIs 
\rightarrow [expand definition of function 'invariant1' at prang.c (34.1)]
[5.1] ((((((0 < asType < integer > ($heap_{funcstart\_724,1}.p1)) &&
(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 
as
Type<integer>(\rho_{funcstart\_724,1}.M1))) & (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
as
Type<integer>(\rho_{funcstart\_724,1}.M2))) & (0 <
asType < integer > (\$heap_{funcstart_{-724,1}}.p3))) \&\&
(asType<integer>($heap_funcstart_724,1.p3) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.3] (((((0 < $heap_{funcstart_{724,1}}.p1) && ($heap_{funcstart_{724,1}}.p1 < ])
as
Type<integer>(\rho_{funcstart\_724,1}.M1))) & (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2})))\ \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p3) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M3}))
\rightarrow [const static or extern object]
[5.4] \ (((((0 < \$heap_{funcstart\_724,1}.p1) \&\& \ (\$heap_{funcstart\_724,1}.p1 < (
asType < integer > (\$heap_{init}.M1))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p2) <
```

```
asType<integer>(heap_{funcstart\_724,1}.M2))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < $heap_{funcstart_{724,1}}.p1) && ($heap_{funcstart_{724,1}}.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
(asType<integer>($heap_{tuncstart\_724,1}.p3) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
|5.16| \left( \left( \left( \left( -30269 < -\$ \text{heap}_{funcstart\_724,1}.\text{p1} \right) \right. \wedge \left. \left( 0 < \$ \text{heap}_{funcstart\_724,1}.\text{p1} \right) \right. \wedge \right. |
(0 < \mathrm{\$heap}_{funcstart\_724,1}.\mathrm{p2})) && (\mathrm{\$heap}_{funcstart\_724,1}.\mathrm{p2} <
asType<integer>($heap_{funcstart\_724,1}.M2))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > (\$heap_{tuncstart_{-724,1}}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.17] ((((-30269 < -$heap_{funcstart\_724,1}.p1) \lambda (0 < $heap_{funcstart\_724,1}.p1) \lambda
(0 < \$ heap_{funcstart\_724,1}.p2)) && (\$ heap_{funcstart\_724,1}.p2 <
asType < integer > (\$heap_{init}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \; \land \; (0 < \$heap_{funcstart\_724,1}.p1) \; \land 
(0 < \text{$heap}_{funcstart\_724,1}.p2)) \&\& (\text{$heap}_{funcstart\_724,1}.p2 <
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724.1}.M3))
\rightarrow [simplify]
[5.30] ((-30307 < -$heap_{funcstart\_724,1}.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.p2) \land (0 < \text{Sheap}_{funcstart\_724,1}.p3)) \&\&
(\text{\$heap}_{funcstart\_724,1}.\text{p3} < \text{asType} < \text{integer} > (\text{\$heap}_{funcstart\_724,1}.\text{M3}))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -$heap_{tuncstart\_724,1}.p2) \land (-30269 <
```

```
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.p2) \land (0 < \text{Sheap}_{funcstart\_724,1}.p3)) \&\&
(\text{\$heap}_{funcstart\_724,1}.p3 < asType < integer > (\text{\$heap}_{init}.M3))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{724,1}.p3})) \&\&
(\text{sheap}_{funcstart\_724,1}.\text{p3} < \text{asType} < \text{integer} > (\text{asType} < \text{short})
int > ((int)30323)))
\rightarrow [simplify]
[5.40] (-30323 < -$heap<sub>funcstart_724,1.</sub>p3) \wedge (-30307 <
-\$heap_{funcstart\_724,1}.p2) \land (-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < -\$heap_{funcstart\_724,1}.p1)
\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p2) \land (0 <
heap_{funcstart_{-724,1}.p3}
[Work on sub-term 2 of conjunction in term 5.40]
\textit{[6.0]} \ -30307 < -\$ \text{heap}_{funcstart\_724,1}.\text{p2}
[Work on sub-term 5 of conjunction in term 5.40]
\textit{[9.0] 0} < \$ heap_{funcstart\_724,1}.p2
[Take given term]
[11.0] div1 == div(heapIs heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
\rightarrow [simplify]
[11.1]~{\rm div1} == {\rm div}(\mathbf{heapIs}~\$ \mathrm{heap}_{funcstart\_724,1},\,\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType < int > (\$heap_{funcstart\_724,1}.a1))
\rightarrow [const static or extern object]
[11.2] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType < int > (\$heap_{init}.a1))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
[11.3] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
asType<int>(asType<short int>((int)177)))
\rightarrow [simplify]
[11.6] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}, \ 177)
[Take given term]
[27.0] div2 == div(heapIs heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
```

```
\rightarrow [simplify]
[27.1] div2 == div(heapIs $heap_{funcstart\_724.1}, $heap_{funcstart\_724.1}.p2,
asType < int > (\$heap_{funcstart\_724,1}.a2))
\rightarrow [const static or extern object]
[27.2] div2 == div(heapIs $heap_{funcstart\_724.1}, $heap_{funcstart\_724.1}.p2,
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{init}.\mathrm{a2}))
\rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
[27.3] div2 == div(heapIs $heap_{funcstart\_724.1}, $heap_{funcstart\_724.1}.p2,
asType<int>(asType<short int>((int)176)))
\rightarrow [simplify]
[27.6] \text{ div2} == \text{div}(\mathbf{heapIs} \$ heap_{funcstart\_724,1}, \$ heap_{funcstart\_724,1}.p2, 176)
[Assume known post-assertion, class invariant or type constraint for term 27.6]
\textit{[30.0]} \; (\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) \; / \\
asType<integer>(176)) == asType<integer>(div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).quot
\rightarrow [simplify]
[30.2] ($heap<sub>funcstart_724.1</sub>.p2 / 176) == asType<integer>(div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).quot
→ [expand definition of operator './' in class 'int' at built in declaration]
[30.3] ([asType<integer>(\ensuremath{\text{sheap}}_{funcstart\_724,1}.p2) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176), []:
asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176) ==
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2,
176).quot)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[30.4] \; ([\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p2) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176) ==
\mathbf{asType} < \mathbf{integer} > (\mathbf{div}(\mathbf{heapIs} \ \$ \mathbf{heap}_{funcstart\_724,1}, \ \$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}, \\
176).quot)
\rightarrow [simplify]
[30.7] ([0 < -$heap<sub>funcstart_724,1</sub>.p2]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176) = =
\mathbf{asType} < \mathbf{integer} > (\mathbf{div}(\mathbf{heapIs} \ \$ \mathbf{heap}_{funcstart\_724,1}, \ \$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}, \\
176).quot)
```

```
\rightarrow [from term 9.0, literala < -$heap<sub>funcstart_724,1</sub>.p2 is false whenever -2 < (0
+ literala)]
       Proof of rule precondition:
       [30.7.0] - 2 < (0 + 0)
       \rightarrow [simplify]
       [30.7.2] true
[30.8] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176),
[!(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176) = =
\mathbf{asType} \small{<} \mathbf{integer} \small{>} ( \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}, \\
176).quot)
\rightarrow [simplify]
[30.11] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176), [!(0 <
-\$heap_{funcstart\_724,1}.p2)]: asType<integer>(\$heap_{funcstart\_724,1}.p2) / 176)
== asType < integer > (div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p2, 176).quot
\rightarrow [from term 9.0, literala < -$heap<sub>funcstart_724,1.</sub>p2 is false whenever -2 < (0
+ literala)]
       Proof of rule precondition:
       [30.11.0] - 2 < (0 + 0)
       \rightarrow [simplify]
       [30.11.2] true
[30.12] ([false]: -(-asType < integer > (\$heap_{funcstart\_724.1}.p2) / 176),
[!false]: asType<integer>(heap_{funcstart\_724,1}.p2) / 176) ==
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2,
176).quot)
\rightarrow [simplify]
[30.17] 0 == (-\operatorname{div}(\mathbf{heapIs} \ \hat{\mathbf{s}}_{funcstart\_724,1}, \ \hat{\mathbf{s}}_{funcstart\_724,1}.p2,
176).quot + (\text{$heap}_{funcstart\_724,1}.p2 / 176))
[Assume known post-assertion, class invariant or type constraint for term 27.6]
[31.0] (asType<integer>(peqtention = 1.0) (as
asType<integer>(176)) == asType<integer>(div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem
\rightarrow [simplify]
[31.2] (heap_{funcstart\_724,1}.p2 \% 176) == asType<integer>(div(heapIs
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem
→ [expand definition of operator '.%' in class 'int' at built in declaration]
```

```
[31.3] ([asType<integer>(peq_{tange}) (peq_{tange}) ([asType<integer)) (peq_{tange}) ([asType<integer)) (peq_{tange}) (peq_{tange}) (peq_{tange}) (peq_{tange})
-(-asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176), []:
asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176) ==
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2,
176).rem)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[31.4] \; ([\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) < 0]:
-(-\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}) \% \ 176),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176) ==
asType<integer>(div(heapIs $heap_{tuncstart\_724.1}, $heap_{tuncstart\_724.1}.p2,
176).rem)
\rightarrow [simplify]
[31.7] ([0 < -$heap<sub>funcstart_724,1</sub>.p2]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176),
[!(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176) ==
asType<integer>(div(heapIs p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1})
176).rem)
\rightarrow [from term 9.0, literala < -$heap<sub>funcstart_724.1</sub>.p2 is false whenever -2 < (0
+ literala)]
    Proof of rule precondition:
    [31.7.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [31.7.2] true
[31.8] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 0)]:
asType < integer > (\$heap_{funcstart\_724.1}.p2) \% 176) = =
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2,
176).rem)
\rightarrow [simplify]
[31.11] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176), [!(0
< -$heap<sub>funcstart_724.1.p2</sub>)]: asType<integer>($heap<sub>funcstart_724.1.p2</sub>) %
176) == asType<integer>(div(heapIs heap_{funcstart\_724,1}),
heap_{funcstart_{724,1}.p2, 176}.rem
\rightarrow [from term 9.0, literala < -$heap<sub>funcstart_724,1</sub>.p2 is false whenever -2 < (0
+ literala)]
    Proof of rule precondition:
    [31.11.0] - 2 < (0 + 0)
```

```
\rightarrow [simplify]
   [31.11.2] true
[31.12] ([false]: -(-asType < integer > (\$heap_{funcstart\_724.1}.p2) \% 176),
[!false]: asType<integer>(sheap_{funcstart\_724,1.p2}) \% 176 ==
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2,
176).rem)
\rightarrow [simplify]
[31.17] 0 == (-\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p2,
176).rem + (\text{$heap}_{funcstart\_724,1}.p2 \% 176))
[Take given term]
[59.0] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{tuncstart\_724.1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{tuncstart\_724.1}.b1))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177
[59.1] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}) * asType<int>(\text{Sheap}_{funcstart\_724,1}.\text{r1})) -
(asType<int>(asType<short int>(div1.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [simplify]
[59.3] \text{sheap}_{724,1;745,8} == \text{sheap}_{funcstart\_724,1}.\_\text{replace}(\text{p1} \rightarrow \text{asType} < \text{short})
int>((div(heapIs \$heap_{funcstart\_724.1}, \$heap_{funcstart\_724.1}, p1, 177).rem *
asType < int > (\$heap_{tuncstart\_724.1}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1.quot})) \ * \ \mathbf{asType}{<} \mathbf{int}{>} (\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
\rightarrow [const static or extern object]
[59.4] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType < int > (\$heap_{init}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType<int>($heap_{funcstart\_724,1}.b1)))
\rightarrow [expand definition of constant 'r1' at prang.c (15,20)]
[59.5] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType < int > (asType < short int > ((int)171))) -
(asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [simplify]
[59.8] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
```

```
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem * 171)
- (asType<int>(asType<short int>(div1.quot))
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177
[59.9] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).rem)
- (asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177).quot) *
asType < int > (\$heap_{funcstart\_724,1}.b1)))
\rightarrow [simplify]
[59.11] \theta == 
int > ((171 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [const static or extern object]
[59.12] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType < int > (\$heap_{init}.b1)))
\rightarrow [expand definition of constant 'b1' at prang.c (17,20)]
[59.13] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((171 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType < int > (asType < short int > ((int)2))))
\rightarrow [simplify]
[59.19] $\text{heap}_{724,1;745,8} == \text{$heap}_{funcstart\_724,1}._\text{$replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, \ 177).\operatorname{rem})))
[Take goal term]
[1.0] minof(short int) \leq ((asType<int>(asType<short int>(div2.rem)) *
\mathbf{asType} < \mathbf{int} > (\$ heap_{724,1;745,8}.r2)) - (\mathbf{asType} < \mathbf{int} > (\mathbf{asType} < \mathbf{short})
int>(div2.quot)) * asType< int>($heap_{724.1:745.8}.b2)))
\rightarrow [simplify]
[1.1] -32768 \leq ((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724,1.745,8}.r2)) - (asType < int > (asType < short)
int > (div2.quot)) * asType < int > ($heap_{724,1;745,8}.b2)))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{funcstart_724,1},
heap_{funcstart_{-724,1}}.p2, 176)
```

```
[1.2] -32768 < ((asType<int>(asType<short int>(div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 176).rem)
asType < int > (\$heap_{724,1:745,8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724,1:745.8</sub>.b2)))
\rightarrow [simplify]
[1.4] -32768 \leq ((div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p2,
176).rem * asType < int > (\$heap_{724,1:745.8}.r2)) -
(asType<int>(asType<short int>(div2.quot)) *
asType<int>($heap<sub>724.1:745.8</sub>.b2)))
\rightarrow [from term 59.19, $heap_{724,1;745,8}$ is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1}}.p1, 177).rem)
 [1.5] \ -32768 \leq ((\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p2},
176).rem * asType<int>(heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).rem))).r2)) -
(asType<int>(asType<short int>(div2.quot)) *
asType<int>($heap<sub>724.1:745.8</sub>.b2)))
\rightarrow [const member of object with modified fields]
[1.6] -32768 \le ((\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p2},
176).rem * asType < int > (\$heap_{funcstart\_724,1}.r2)) -
(asType<int>(asType<short int>(div2.quot)) *
asType < int > (\$heap_{724,1:745,8}.b2)))
\rightarrow [const static or extern object]
[1.7] -32768 \leq ((div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p2,
176).rem * asType < int > (\$heap_{init}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724,1:745.8</sub>.b2)))
\rightarrow [expand definition of constant 'r2' at prang.c (20,20)]
[1.8] -32768 \leq ((div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p2,
176).rem * asType<int>(asType<short int>((int)172))) -
(asType<int>(asType<short int>(div2.quot)) *
asType<int>($heap<sub>724.1:745.8</sub>.b2)))
\rightarrow [simplify]
 \label{eq:continuous} \textit{[1.11] -32768} \leq ((\text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p2},
176).rem * 172) - (asType<int>(asType<short int>(div2.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{b2})))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1}}.p2, 176
[1.12] -32768 \leq ((172 * div(heapIs $heap_{funcstart\_724,1},
```

```
\rho_{tuncstart=724,1}.p2, 176).rem - (asType < int > (asType < short)
int>(div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p2, 176).quot)) *
asType<int>($heap<sub>724,1:745,8</sub>.b2)))
\rightarrow [simplify]
[1.14] -32768 \leq ((172 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem}) - (\text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} * asType < int > (\text{Sheap}_{724,1;745,8}.\text{b2})))
\rightarrow [from term 59.19, heap_{724,1;745,8} is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724,1}),
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177).rem)
[1.15] - 32768 \leq ((172 * \text{div}(\textbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p2},
176).rem) – (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p2},
176).quot * asType<int>($heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, \ 177).\operatorname{rem}))).\operatorname{b2})))
→ [const member of object with modified fields]
[1.16] -32768 \leq ((172 * div(heapIs $heap_{funcstart\_724,1},)
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem}) - (\text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho = \frac{176}{100} $\text{heap}_{funcstart_724,1} \text{.p2}, 176$).quot * asType<int>(\left\text{heap}_{funcstart_724,1} \text{.b2}))
\rightarrow [const static or extern object]
[1.17] -32768 \leq ((172 * div(heapIs $heap_{funcstart\_724,1},)
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem} - (div(heapIs \text{Sheap}_{funcstart\_724,1},
\label{eq:continuous_function} $\operatorname{heap}_{funcstart\_724,1}.p2,\ 176).quot * \mathbf{asType} < \mathbf{int} > (\$\operatorname{heap}_{init}.b2)))$
\rightarrow [expand definition of constant 'b2' at prang.c (22,20)]
\label{eq:continuous} \mbox{[1.18] -32768} \leq ((172 * \mbox{div}(\mathbf{heapIs} \; \$ \mbox{heap}_{funcstart\_724,1}, \; \$ \mbox{heap}_{funcstart\_724,1}.\mbox{p2},
176).rem) – (div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2,
176).quot * asType<int>(asType<short int>((int)35))))
\rightarrow [simplify]
 [1.25] -32769 < ((-35 * div(\mathbf{heapIs} \$ heap_{funcstart\_724,1}, \$ heap_{funcstart\_724,1}.p2,
176).quot) + (172 * div(heapIs heapIs = f_{uncstart_{-724,1}}, heap_{funcstart_{-724,1}}.p2,
176).rem))
\rightarrow [negate goal and search for contradiction]
[1.26]!(-32769 < ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724.1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724.1},
heap_{funcstart_{-724,1}.p2, 176).rem}
\rightarrow [simplify]
[1.31] 32768 < ((35 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p2,
176).quot) + (-172 * \text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p2},
```

```
176).rem))
[Copy term 1.31]
[86.0] 32768 < ((-172 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem} + (35 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p2, 176}, quot))
\rightarrow [from term 31.17, div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p2,
176).rem is equal to heap_{funcstart\_724,1}.p2 \% 176
[86.1] 32768 < ((-172 * ($heap_{funcstart\_724,1}.p2 % 176)) + (35 * div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot})
[Create new term from term 30.17 using rule: condition for equality of division]
[113.0] ((176 * (0 + -(-\text{div}(\mathbf{heapIs} \$\text{heap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724.1.p2}, 176).\text{quot}))) < (1 + \text{Sheap}_{funcstart\_724.1.p2})) \land
(\text{\$heap}_{funcstart\_724.1}.\text{p2} < (176 * (0 + 1 + -(-\text{div}(\text{heapIs}))))
\text{Sheap}_{funcstart_{-724,1}}, \text{Sheap}_{funcstart_{-724,1}}.p2, 176).quot))))
\rightarrow [simplify]
[113.15] (-1 < ((-176 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p2,
(-176).quot) + \text{heap}_{funcstart\_724,1}.p2)) \land (-176 < (-\text{heap}_{funcstart\_724,1}.p2 +
(176 * \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p2}, 176).\operatorname{quot})))
[Work on sub-term 2 of conjunction in term 113.15]
[114.0] -1 < ((-176 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p2,
176).quot) + $heap_{funcstart\_724,1}.p2)
[Create new term from terms 114.0, 6.0 using rule: transitivity 2]
[152.0] (-30307 + -1 + 1) < (-176 * div(heapIs $heap_{tuncstart, 724.1},
heap_{funcstart_{-724,1}}.p2, 176).quot
\rightarrow [simplify]
[152.1] -30307 < (-176 * div(heapIs $heap<sub>funcstart_724,1</sub>,
heap_{funcstart_{-724,1}}.p2, 176).quot
\rightarrow [literal comparison of product]
[152.2] ([-176 < 0]: (-30307 / 176) < -\text{div}(\text{heapIs } \text{\$heap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot}, [0 < -176]: (-30307 / -176) < \text{div}(\textbf{heapIs})
0)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[152.3] ([-176 < 0]: (-30307 / 176) < -\text{div}(\text{heapIs } \text{$heap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot}, [(0 < -176) \land !(-176 < 0)]: (-30307 / -176)
< \text{div}(\text{heapIs } \text{\$heap}_{funcstart\_724,1}, \text{\$heap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot}, [(-176)]
==0) \land !(-176 < 0) \land !(0 < -176)]: -30307 < 0)
\rightarrow [simplify]
```

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[152.7] -173 < -\text{div}(\text{heapIs } \text{$heap}_{funcstart\_724,1}, \text{$heap}_{funcstart\_724,1}.\text{p2},
176).quot
[Create new term from terms 152.7, 86.1 using rule: transitivity 5]
[159.0] 32768 < ((-172 * (\$heap_{funcstart\_724,1}.p2 \% 176)) + (35 * -(-173 + 1)))
\rightarrow [simplify]
[159.5] 26748 < (-172 * (\$heap_{funcstart\_724,1}.p2 \% 176))
\rightarrow [literal comparison of product]
[159.6] ([-172 < 0]: (26748 / 172) < -($heap_{funcstart\_724,1}.p2 % 176), [0 <
-172]: (26748 / -172) < (\text{\$heap}_{funcstart\_724,1}.p2 \% 176), [-172 == 0]: 26748 <
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[159.7] ([-172 < 0]: (26748 / 172) < -(\text{\$heap}_{funcstart\_724,1}.\text{p2 \% } 176), [(0 < 10.00)]
-172) \wedge !(-172 < 0)]: (26748 / -172) < ($heap_{funcstart_724,1}.p2 % 176), [(-172)]
==0) \land !(-172 < 0) \land !(0 < -172)]: 26748 < 0)
\rightarrow [simplify]
[159.12] false
Proof of verification condition: Type constraint satisfied in implicit
conversion from 'int' to 'short int'
Condition generated at: C:\Escher\Customers\prang\prang.c (63,33)
Condition defined at:
To prove: ((asType<int>(asType<short int>(div2.rem)) *
\mathbf{asType}{<}\mathbf{int}{>}(\${heap}_{724,1;745,8}.r2)) - (\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{short}
int>(div2.quot)) * asType< int>($heap_{724.1:745.8}.b2))) \le maxof(short int)
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta = asType < short int > ((int)2)
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta
heap_{init}.M3 == asType < short int > ((int)30323)
```

```
\rho_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType<short int>((int)178)
heap_{init}.b3 == asType < short int > ((int)63)
\theta
\theta
heap_{init}.p3 == asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart_724,1})
div1 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ / \ 
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))) = =
asType<integer>(div1.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p1) = =
asType<integer>(div1.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a1) \le
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}))\ /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heap_{funcstart\_724.1}.p2)) %
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p2) = =
asType<integer>(div2.rem))
```

```
(asType < integer > (\$heap_{funcstart_{-724,1}}.a2) \le
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2})) = > !(0 = =
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1} \cdot \mathbf{p3})) \ / \\
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(asType<integer>(asType<int>($heap_{tuncstart\_724.1}.p3)) %
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(asType < integer > (\$heap_{funcstart\_724.1}.p3) = =
asType<integer>(div3.rem))
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a3}) \leq
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})) => !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
heap_{724,1;745,8} == heap_{funcstart\_724,1}.\_replace(p1 \rightarrow asType < short)
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
-asType<integer const>($heap<sub>724 1.745 8</sub>.M1) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{p1})
!(0 == asType < integer > (\$heap_{724,1:745.8} \cdot p1))
asType<integer>($heap<sub>724,1:745,8</sub>.p1) <
asType<integer>($heap<sub>724,1:745,8</sub>.M1)
Proof:
[Take given term]
[5.0] invariant1(heapIs $heap_{tuncstart_724.1})
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
[5.1] (((((0 < asType < integer > ($heap_{funcstart_724,1}.p1)) &&
(asType<integer>($heap_funcstart_724.1.p1) <
as
Type<integer>(\rho_{funcstart\_724,1}.M1))) & (0 <
```

```
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M2}))) \ \&\& \ (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType<integer>($heap_funcstart_724,1.M3))
\rightarrow [simplify]
[5.3] (((((0 < \theta_{funcstart\_724,1.p1}) && (\theta_{funcstart\_724,1.p1})
\mathbf{asType} \small{<} \mathbf{integer} \small{>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M1}))) \ \&\& \ (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M2})))~\&\&~(0<
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.4] (((((0 < $heap_{funcstart\_724,1}.p1) && ($heap_{funcstart\_724,1}.p1 < ])
asType < integer > (\$heap_{init}.M1))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) <
as
Type<integer>($heap_{funcstart\_724,1}.M2))) && (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})))\ \&\&
(asType < integer > (\$heap_{funcstart_{-724.1}}.p3) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < $heap_{funcstart_{-724,1}}.p1) && ($heap_{funcstart_{-724,1}}.p1 < 
asType<integer>(asType<short int>((int)30269)))) && (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p2) <
asType<integer>(heap_{funcstart\_724,1}.M2))) && (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})))\ \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724.1}.M3))
\rightarrow [simplify]
[5.16] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \; \land \; (0 < \$heap_{funcstart\_724,1}.p1) \; \land 
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
as
Type<integer>($heap_{funcstart\_724,1}.M2))) && (0 <
asType < integer > (\$heap_{tuncstart\_724.1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M3}))
\rightarrow [const static or extern object]
```

```
[5.17] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{init}.\mathrm{M2})))~\&\&~(0<
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType<integer>($heap_funcstart_724,1.M3))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < \text{$heap}_{funcstart\_724,1}.p2)) \&\& (\text{$heap}_{funcstart\_724,1}.p2 <
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.30] ((-30307 < -$heap_{tuncstart_724,1}.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1.p2}) \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.\text{p3} < \text{asType} < \text{integer} > (\text{\$heap}_{funcstart\_724,1}.\text{M3}))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \wedge (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{-724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{-724,1}.p3})) \&\&
(\$heap_{funcstart\_724,1}.p3 < \mathbf{asType} < \mathbf{integer} > (\$heap_{init}.M3))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{724,1}.p3})) \&\&
(\text{sheap}_{funcstart\_724,1}.p3 < asType < integer > (asType < short)
int > ((int)30323))
\rightarrow [simplify]
[5.40] (-30323 < -\$heap_{funcstart\_724,1}.p3) \land (-30307 < -30307)
-\$heap_{funcstart\_724,1}.p2) \wedge (-30269 < -\$heap_{funcstart\_724,1}.p1) \wedge (0 <
\text{Sheap}_{funcstart\_724,1}.\text{p1}) \land (0 < \text{Sheap}_{funcstart\_724,1}.\text{p2}) \land (0 <
heap_{funcstart_{-724,1}.p3}
[Work on sub-term 5 of conjunction in term 5.40]
\textit{[9.0] 0} < \$ heap_{funcstart\_724,1}.p2
[Take given term]
[11.0] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
```

```
\rightarrow [simplify]
[11.1] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType < int > (\$heap_{funcstart\_724,1}.a1))
\rightarrow [const static or extern object]
\textit{[11.2]} \ \text{div1} == \text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
asType < int > (\$heap_{init}.a1))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
[11.3] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
asType<int>(asType<short int>((int)177)))
\rightarrow [simplify]
[11.6] div1 == div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1, 177)
[Take given term]
[27.0] \operatorname{div2} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
\rightarrow [simplify]
[27.1] \operatorname{div2} == \operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p2,
asType < int > (\$heap_{funcstart\_724,1}.a2))
\rightarrow [const static or extern object]
[27.2] \operatorname{div2} == \operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p2,
asType < int > (\$heap_{init}.a2))
\rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
[27.3] \operatorname{div2} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p2},
asType<int>(asType<short int>((int)176)))
\rightarrow [simplify]
[27.6] \text{ div2} == \text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p2}, 176)
[Assume known post-assertion, class invariant or type constraint for term 27.6]
[30.0] (asType<integer>(heap_{funcstart\_724,1}.p2) /
\mathbf{asType}{<}\mathbf{integer}{>}(176)) == \mathbf{asType}{<}\mathbf{integer}{>}(\mathrm{div}(\mathbf{heapIs}
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot}
\rightarrow [simplify]
[30.2] ($heap<sub>funcstart_724.1</sub>.p2 / 176) == asType<integer>(div(heapIs)
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p2, 176).quot
→ [expand definition of operator './' in class 'int' at built in declaration]
[30.3] ([asType<integer>(heap_{funcstart}_724.1.p2) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176), []:
```

```
asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176) ==
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2,
176).quot)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[30.4] \; ([\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p2) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176),
[!(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176) = =
\mathbf{asType} {<} \mathbf{integer} {>} ( \mathbf{div} (\mathbf{heapIs} \ \$ \mathbf{heap}_{funcstart\_724,1}, \ \$ \mathbf{heap}_{funcstart\_724,1}. \mathbf{p2}, \\
176).quot)
\rightarrow [simplify]
[30.7] ([0 < -$heap<sub>funcstart_724,1</sub>.p2]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176),
[!(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p2) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176) ==
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2,
176).quot)
\rightarrow [from term 9.0, literala < -$heap<sub>funcstart_724.1</sub>.p2 is false whenever -2 < (0
+ literala)]
    Proof of rule precondition:
    [30.7.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [30.7.2] true
[30.8] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176) ==
\mathbf{asType} < \mathbf{integer} > (\mathbf{div}(\mathbf{heapIs} \ \$ \mathbf{heap}_{funcstart\_724,1}, \ \$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}, \\
176).quot)
\rightarrow [simplify]
[30.11] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176), [!(0 <
-\$heap_{funcstart\_724,1}.p2)]: \ \mathbf{asType} < \mathbf{integer} > (\$heap_{funcstart\_724,1}.p2) \ / \ 176)
== asType < integer > (div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724.1}}.p2, 176).quot
\rightarrow [from term 9.0, literala < -$heap<sub>funcstart_724,1</sub>.p2 is false whenever -2 < (0
+ literala)
    Proof of rule precondition:
    [30.11.0] - 2 < (0 + 0)
    \rightarrow [simplify]
```

```
[30.11.2] true
[30.12] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176),
[!false]: asType<integer>($heap<sub>funcstart_724,1.</sub>p2) / 176) ==
\mathbf{asType} < \mathbf{integer} > (\mathbf{div}(\mathbf{heapIs} \ \$ \mathbf{heap}_{funcstart\_724,1}, \ \$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}, \\
176).quot)
\rightarrow [simplify]
[30.17] 0 == (-div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2,
176).quot + (\text{$heap}_{funcstart\_724,1}.p2 / 176))
[Assume known post-assertion, class invariant or type constraint for term 27.6]
[31.0] (asType<integer>(sheap_{funcstart\_724,1}.p2) %
asType<integer>(176)) == asType<integer>(div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem
\rightarrow [simplify]
[31.2] ($heap<sub>funcstart_724,1.</sub>p2 % 176) == asType<integer>(div(heapIs)
\text{Sheap}_{funcstart\_724.1}, \text{Sheap}_{funcstart\_724.1}.p2, 176).rem
→ [expand definition of operator '.%' in class 'int' at built in declaration]
[31.3] \; ([\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) < 0] :
-(-asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176), []:
asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176) ==
asType<integer>(div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p2,
176).rem)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[31.4] \; ([\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) < 0] :
-(-asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176) ==
asType<integer>(div(heapIs $heap_{tuncstart\_724.1}, $heap_{tuncstart\_724.1}.p2,
176).rem)
\rightarrow [simplify]
[31.7] ([0 < -$heap<sub>funcstart_724,1</sub>.p2]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176),
[!(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2})<0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176) ==
asType<integer>(div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p2,
\rightarrow [from term 9.0, literala < -$heap<sub>funcstart_724.1</sub>.p2 is false whenever -2 < (0
+ literala)]
    Proof of rule precondition:
    [31.7.0] - 2 < (0 + 0)
```

```
\rightarrow [simplify]
    [31.7.2] true
[31.8] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176) ==
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2,
176).rem)
\rightarrow [simplify]
[31.11] ([false]: -(-asType < integer > ($heap_{funcstart\_724,1}.p2) \% 176), [!(0
<-$heap<sub>funcstart_724,1.</sub>p2)]: asType<integer>($heap<sub>funcstart_724,1.</sub>p2) %
176) == asType<integer>(div(heapIs $heap_{tuncstart_724.1},
heap_{funcstart_{-724,1}.p2, 176}.rem)
\rightarrow [from term 9.0, literala < -$heap<sub>funcstart_724,1.</sub>p2 is false whenever -2 < (0
+ literala)]
    Proof of rule precondition:
    [31.11.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [31.11.2] true
[31.12] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176),
[!false]: asType<integer>(sheap_{funcstart\_724,1.p2}) \% 176 ==
\mathbf{asType} < \mathbf{integer} > (\mathbf{div}(\mathbf{heapIs} \ \$ \mathbf{heap}_{funcstart\_724,1}, \ \$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}, \\
176).rem)
\rightarrow [simplify]
[31.17] \ 0 == (-\text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p2},
176).rem + (\text{$heap}_{funcstart\_724,1}.p2 \% 176))
[Take given term]
[40.0] (asType<integer>($heap_{funcstart\_724,1}.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}) ==
asType<integer>(div2.rem))
\rightarrow [simplify]
[40.1] (\text{$heap_{funcstart\_724,1}.p2 < asType < integer > (\text{$heap_{funcstart\_724,1}.a2}))}
=> (asType < integer > (\$heap_{funcstart\_724,1}.p2) ==
asType<integer>(div2.rem))
\rightarrow [const static or extern object]
[40.2] ($heap<sub>funcstart_724,1.</sub>p2 < asType<integer>($heap<sub>init.</sub>a2)) =>
(asType < integer > (\$heap_{funcstart\_724,1}.p2) = =
asType<integer>(div2.rem))
```

```
\rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
[40.3] \ (\$heap_{funcstart\_724,1}.p2 < \mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{short})
\mathbf{int}{>}((\mathbf{int})176))) => (\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) ==
asType<integer>(div2.rem))
\rightarrow [simplify]
[40.10] (-176 < -\$heap_{funcstart\_724,1}.p2) => (\$heap_{funcstart\_724,1}.p2) ==
asType<integer>(div2.rem))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1},p2,176}
[40.11] \; (\text{-}176 < -\$ \text{heap}_{funcstart\_724,1}.\text{p2}) => (\$ \text{heap}_{funcstart\_724,1}.\text{p2} ==
\mathbf{asType} < \mathbf{integer} > (\mathbf{div}(\mathbf{heapIs} \ \$\mathbf{heap}_{funcstart\_724,1}, \ \$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p2},
176).rem))
\rightarrow [simplify]
[40.17] (0 == (-$heap_{funcstart_{724,1}}.p2 + div(heapIs $heap_{funcstart_{724,1}},
\text{Sheap}_{funcstart\_724,1.p2}, 176).rem)) \lor (175 < \text{Sheap}_{funcstart\_724,1.p2})
[Take given term]
[59.0] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177
[59.1] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}) * asType < int > (\text{Sheap}_{funcstart\_724,1}.\text{r1})) -
(asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [simplify]
[59.3] \rho_{1745,8} == \rho_{1745
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
\rightarrow [const static or extern object]
\text{[59.4] \$heap}_{724,1;745,8} == \$heap_{funcstart\_724,1}.\_\textbf{replace}(p1 \rightarrow \textbf{asType} < \textbf{short}
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
\mathbf{asType} {<} \mathbf{int} {>} (\$ \mathbf{heap}_{init}.\mathbf{r1})) - (\mathbf{asType} {<} \mathbf{int} {>} (\mathbf{asType} {<} \mathbf{short}
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
\rightarrow [expand definition of constant 'r1' at prang.c (15,20)]
```

```
[59.5] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType<int>(asType<short int>((int)171))) -
(asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [simplify]
[59.8] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem * 171)
- (asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\ 724.1}.b1))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177)
\text{[59.9] \$heap}_{724,1;745,8} == \$heap_{funcstart\_724,1}.\_\textbf{replace}(p1 \rightarrow \textbf{asType} < \textbf{short}
\mathbf{int} > ((171 * \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, 177).\operatorname{rem})
- (asType<int>(asType<short int>(div(heapIs $heap_{funcstart_724,1},))
heap_{funcstart_{-724,1}}.p1, 177).quot)
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [simplify]
[59.11] \theta_{13} = \theta_
int>((171 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [const static or extern object]
[59.12] \theta_{12} = \theta_{124,1;745,8} = \theta_{124,1;74
\mathbf{int} > ((171 * \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, 177).\operatorname{rem})
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType < int > (\$heap_{init}.b1)))
\rightarrow [expand definition of constant 'b1' at prang.c (17,20)]
[59.13] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType<int>(asType<short int>((int)2))))
\rightarrow [simplify]
[59.19] $\text{heap}_{724,1:745,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).rem)))
[Take goal term]
[1.0] ((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724.1:745.8}.r2)) - (asType < int > (asType < short)
int>(div2.quot) * asType<int>(heap_{724.1:745.8}.b2)) \leq maxof(short int)
```

```
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1}}.p2, 176
[1.1] ((asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},
\text{sheap}_{funcstart\_724,1.p2, 176}.\text{rem}) * asType < int > (\text{sheap}_{724,1.745,8.r2})) -
(asType<int>(asType<short int>(div2.quot)) *
asType < int > (\$heap_{724.1:745.8}.b2))) \le maxof(short int)
\rightarrow [simplify]
[1.3] ((div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, p_2, 176).rem *
\mathbf{asType}{<}\mathbf{int}{>}(\$\text{heap}_{724,1;745,8}.\text{r2})) - (\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{short}
\mathbf{int}{>}(\mathrm{div2.quot})) \ * \ \mathbf{asType}{<} \mathbf{int}{>} (\$\mathrm{heap}_{724,1;745,8}.\mathrm{b2}))) \leq \mathbf{maxof}(\mathbf{short} \ \mathbf{int})
\rightarrow [from term 59.19, $heap<sub>724.1:745.8</sub> is equal to
heap_{funcstart_{-724,1}}.-replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart_{-724,1}})
heap_{funcstart_{724,1},p1, 177}, quot) + (171 * div(heapIs p_{funcstart_{724,1},p1, 177}), quot)
\$heap_{funcstart\_724,1}.p1,\ 177).rem))]
[1.4] ((div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, p_2, 176).rem *
asType < int > (\$heap_{funcstart\_724.1}.\_replace(p1 \rightarrow ((-2 * div(heapIs))))))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs})
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).rem))).r2)) -
(asType<int>(asType<short int>(div2.quot)) *
asType < int > (\$heap_{724.1:745.8}.b2))) \le maxof(short int)
→ [const member of object with modified fields]
[1.5] ((div(heapIs heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p_2, 176).rem *
asType < int > (\$heap_{funcstart\_724,1}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType< int>($heap_{724,1;745,8}.b2))) \le maxof(short int)
\rightarrow [const static or extern object]
[1.6] ((div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, p_2, 176).rem *
asType < int > (\$heap_{init}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType< int>($heap_{724,1;745,8}.b2))) \le maxof(short int)
\rightarrow [expand definition of constant 'r2' at prang.c (20,20)]
[1.7] ((div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, p_2, 176).rem *
asType<int>(asType<short int>((int)172))) -
(asType<int>(asType<short int>(div2.quot)) *
asType < int > (\$heap_{724.1:745.8}.b2))) \le maxof(short int)
\rightarrow [simplify]
[1.10] ((div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p2, 176).rem *
172) - (asType<int>(asType<short int>(div2.quot))
asType < int > (\$heap_{724,1;745,8}.b2))) \le maxof(short int)
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1},p2,176}
```

```
[1.11] ((172 * div(heapIs heap_{funcstart-724,1}, heap_{funcstart-724,1.p2},
176).rem) - (asType<int>(asType<short int>(div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 176).quot)
asType < int > (\$heap_{724,1;745,8}.b2))) \le maxof(short int)
\rightarrow [simplify]
[1.13] ((172 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2,
176).rem) – (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.p2,
176).quot * asType<int>($heap<sub>724.1:745.8</sub>.b2))) \leq maxof(short int)
\rightarrow [from term 59.19, $heap<sub>724,1;745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1}.p1, 177).rem}
[1.14] ((172 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p2,
176).rem) – (\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p2,
176).quot * asType<int>($heap_{tuncstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).rem))).b2))) \le
maxof(short int)
\rightarrow [const member of object with modified fields]
[1.15] ((172 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p2,
176).rem) – (div(heapIs heap_{funcstart, 724,1}, heap_{funcstart, 724,1}, p_{funcstart, 724,1}
176).quot * asType<int>($heap<sub>funcstart_724,1</sub>.b2))) \leq maxof(short int)
\rightarrow [const static or extern object]
[1.16] ((172 * div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1})
176).rem) – (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p2},
176).quot * asType < int > (\$heap_{init}.b2))) \le maxof(short int)
\rightarrow [expand definition of constant 'b2' at prang.c (22,20)]
[1.17] ((172 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2,
176).rem) – (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p2},
176).quot * asType<int>(asType<short int>((int)35)))) \leq maxof(short
int)
\rightarrow [simplify]
[1.36] -32768 < ((-172 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724.1.p2}, 176).\text{rem} + (35 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724.1},
heap_{funcstart_{-724,1}.p2, 176}, quot))
\rightarrow [negate goal and search for contradiction]
[1.37]!(-32768 < ((-172 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem} + (35 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724.1}}.p2, 176).quot))
```

```
\rightarrow [simplify]
[1.42] \ 32767 < ((172 * \text{div}(\textbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p2},
176).rem) + (-35 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart\_724,1}, \text{\$heap}_{funcstart\_724,1}.p2,
176).quot))
[Branch on disjunction or conditional in term 40.17]
[69.0] (0 == (-$heap<sub>funcstart_724,1</sub>.p2 + div(heapIs $heap<sub>funcstart_724,1</sub>,
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem})) \lor (175 < \text{Sheap}_{funcstart\_724,1}.\text{p2}) \lor !(0 ==
(-\text{\$heap}_{funcstart\_724,1}.\text{p2} + \text{div}(\text{\textbf{heapIs}} \text{\$heap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p2, 176).rem
[Copy term 1.42]
[70.0] (32767 < ((-35 * div(heapIs heap_{funcstart\_724,1}),
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).rem))) \lor (175 < \text{Sheap}_{funcstart\_724,1.p2}) \lor !(0 ==
(-\text{\$heap}_{funcstart\_724,1}.\text{p2} + \text{div}(\text{\textbf{heapIs}} \, \text{\$heap}_{funcstart\_724,1},
heap_{funcstart_{724,1}}.p2, 176).rem
\rightarrow [from term 69.0, div(heapIs $heap_{funcstart\_724,1}$, $heap_{funcstart\_724,1}$.p2,
176).rem is equal to $heap_funcstart_724,1.p2]
[70.1] (32767 < ((-35 * div(heapIs $heap_{funcstart\_724,1},
\$ heap_{funcstart\_724,1}.p2,\ 176).quot) + (172 * \$ heap_{funcstart\_724,1}.p2))) \lor \dots
[Copy term 31.17]
[71.0] (0 == (-div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2,
176).rem + (\text{$heap_{funcstart\_724,1.p2} \% 176})) \lor (175 < \text{$heap_{funcstart\_724,1.p2}})
\vee !(0 == (-\$heap_{funcstart\_724,1}.p2 + div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p2, 176).rem
\rightarrow [from\ term\ 69.0,\ div(\mathbf{heapIs}\ \$heap_{funcstart\_724,1},\ \$heap_{funcstart\_724,1}.p2,
176).rem is equal to heap_{funcstart\_724,1.p2}
[71.1] (0 == (-\$heap_{funcstart\_724,1}.p2 + (\$heap_{funcstart\_724,1}.p2 \% 176))) \lor ...
[Assume known post-assertion, class invariant or type constraint for term 71.1]
[78.0] (\text{heap}_{funcstart\_724,1}.p2 < 176) \vee (175 < \text{heap}_{funcstart\_724,1}.p2) \vee!(0
== (-\$heap_{funcstart\_724,1}.p2 + div(heapIs \$heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p2, 176).rem}
\rightarrow [simplify]
[78.3] (-176 < -\$heap_{funcstart\_724,1}.p2) \lor ...
[Copy term 1.42]
[80.0] 32767 < ((-35 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p2,
176).quot) + (172 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2,
176).rem))
\rightarrow [from term 31.17, div(heapIs $heap_{funcstart\_724,1}$, $heap_{funcstart\_724,1}$,p2,
```

```
176).rem is equal to heap_{funcstart_{-724,1}}.p2 \% 176
[80.1] \ 32767 < ((-35 \ * \ \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2},
176).quot) + (172 * (\text{$heap}_{funcstart\_724,1.p2} \% 176)))
[Copy term 70.1]
[81.0] (32767 < ((-35 * div(heapIs $heap_{funcstart\_724,1},
\rho_{uncstart_{-724,1},p2,176} = (172 * \rho_{uncstart_{-724,1},p2}) + (175 < \rho_{uncstart_{-724,1},p2}) 
\$heap_{funcstart\_724,1}.p2) \lor !(0 == (-\$heap_{funcstart\_724,1}.p2 + div(\mathbf{heapIs}))]
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem))
\rightarrow [from\ term\ 30.17,\ div(\mathbf{heapIs}\ \$heap_{funcstart\_724,1},\ \$heap_{funcstart\_724,1}.p2,
176).quot is equal to heap_{funcstart\_724,1}.p2 / 176
[81.1] (32767 < ((-35 * ($heap_{funcstart\_724,1}.p2 / 176)) + (172 *
heap_{funcstart_{-724,1}.p2})) \vee ...
\rightarrow [division by larger divisor]
    Proof of rule precondition 1:
    [81.1.0.0] literald < -$heap_{funcstart\_724,1}.p2
    \rightarrow [unify with term 78.3]
    [81.1.0.1] true
    Proof of rule precondition 2:
    [81.1.1.0] literalc < $heap<sub>funcstart_724,1</sub>.p2
    \rightarrow [unify with term 9.0]
    [81.1.1.1] true
    Proof of rule precondition 3:
    [81.1.2.0] --176 \le 176
    \rightarrow [simplify]
    [81.1.2.2] true
    Proof of rule precondition 4:
    [81.1.3.0] - 2 < 0
    \rightarrow [simplify]
    [81.1.3.1] true
[81.2] (32767 < ((-35 * $heap_{funcstart\_724,1}.p2) + (172 *
heap_{funcstart_{-724,1},p2})) \vee ...
\rightarrow [simplify]
[81.4] (32767 < (137 * \text{$heap}_{funcstart\_724,1}.p2)) \lor \dots
\rightarrow [literal comparison of product]
```

```
[81.5] ([137 < 0]: (32767 / -137) < -\$heap_{funcstart\_724,1}.p2, [0 < 137]: (32767 / -137)
/137) < $heap_{funcstart_724,1}.p2, [0 == 137]: 32767 < 0) \vee ...
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[81.6] ([137 < 0]: (32767 / -137) < -$heap_{funcstart\_724,1}.p2, [(0 < 137) \land !(137
< 0)]: (32767 / 137) < \text{$heap}_{funcstart, 724, 1}.p2, [(0 == 137) \land !(0 < 137) \land ]
!(137 < 0)]: 32767 < 0) \lor ...
\rightarrow [simplify]
[81.13] (true \land (239 < $heap_{funcstart_{724,1}}.p2)) \lor ...
\rightarrow [from term 78.3, literala < $heap_{funcstart\_724,1}.p2 is false whenever -2 <
(-176 + literala)
    Proof of rule precondition:
    [81.13.0] - 2 < (-176 + 239)
    \rightarrow [simplify]
    [81.13.2] true
[81.14] (true \wedge false) \vee \dots
\rightarrow [simplify]
[81.15] false \vee ...
[Remove 'false' term 81.15 and fetch new term from containing clause]
[82.0] 175 < \text{$heap}_{funcstart\_724,1}.p2
[Create new term from term 30.17 using rule: condition for equality of division]
[114.0] ((176 * (0 + -(-\text{div}(\mathbf{heapIs} \$heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot}))) < (1 + \text{Sheap}_{funcstart\_724,1}.\text{p2})) \land
(\text{$heap}_{funcstart\_724,1}.\text{p2} < (176 * (0 + 1 + -(-\text{div}(\textbf{heapIs}))))
\$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p2, 176).quot))))
\rightarrow [simplify]
[114.15] \ (-1 < ((-176 * {\rm div}(\mathbf{heapIs} \ \$ {\rm heap}_{funcstart\_724,1}, \ \$ {\rm heap}_{funcstart\_724,1}.{\rm p2},
176).quot) + \text{$heap}_{funcstart\_724.1.p2}) \land (-176 < (-\text{$heap}_{funcstart\_724.1.p2} +
(176 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p2, 176).quot)))
\rightarrow [separate conjunction and work on first sub-term]
[114.16] -176 < (-\text{\$heap}_{funcstart\_724,1}.\text{p2} + (176 * \text{div}(\text{heapIs})))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).quot)
[Create new term from terms 114.16, 82.0 using rule: transitivity 2]
[148.0] (-176 + 1 + 175) < (176 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p2, 176).quot
\rightarrow [simplify]
[148.1] 0 < (176 * div(heapIs $heap_{funcstart\_724.1}, $heap_{funcstart\_724.1}.p2,
```

```
176).quot)
\rightarrow [product is positive]
[148.2] ((0 < 176) \wedge (0 < div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot})) \lor ((176 < 0) \land (\text{div}(\textbf{heapIs})))
\text{Sheap}_{funcstart_{-724,1}}, \text{Sheap}_{funcstart_{-724,1}}.p2, 176).quot < 0)
\rightarrow [simplify]
[148.7] 0 < \text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot}
[Create new term from terms 148.7, 80.1 using rule: transitivity 11]
[151.0] (1 + 32767 + (0 * 35)) < (172 * (\$heap_{funcstart\_724,1}.p2 \% 176))
\rightarrow [simplify]
[151.2] 32768 < (172 * (\$heap_{funcstart_{724,1}}.p2 \% 176))
\rightarrow [literal comparison of product]
[151.3] ([172 < 0]: (32768 / -172) < -($heap_{funcstart\_724,1}.p2 % 176), [0 < -0.5]
172]: (32768 / 172) < (\$heap_{funcstart\_724,1}.p2 \% 176), [0 == 172]: 32768 < 0)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[151.4] ([172 < 0]: (32768 / -172) < -(\text{$heap}_{funcstart\_724,1}.p2 \% 176), [(0 <
172) \land!(172 < 0)]: (32768 / 172) < ($heap_{funcstart\_724,1}.p2 % 176), [(0 ==
172) \land !(0 < 172) \land !(172 < 0)]: 32768 < 0)
\rightarrow [simplify]
[151.13] false
Proof of verification condition: Assertion valid
Condition generated at: C:\Escher\Customers\prang\prang.c (64,31)
To prove: asType<integer>($heap<sub>724,1:747,8</sub>.p2) <
asType<integer>($heap<sub>724,1:747,8</sub>.M2)
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
heap_{init}.M2 == asType < short int > ((int)30307)
\rho_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
```

```
\theta sheap<sub>init</sub>.b2 == asType<short int>((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
heap_{init}.b3 == asType < short int > ((int)63)
\theta
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart\_724,1})
div1 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ / \ 
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(asType < integer > ($heap_{funcstart\_724,1}.p1) < 
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) ==
asType<integer>(div1.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathtt{a1}) \leq
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1})) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p2})) \ / \\
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))) ==
asType<integer>(div2.quot)
(asType < integer > (asType < int > (\$heap_{tuncstart\_724.1}.p2)) \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.rem)
(asType<integer>($heap_{tuncstart\_724,1}.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
```

```
(asType < integer > (\$heap_{funcstart_{-724,1}}.p2) = =
asType<integer>(div2.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a2) \le
asType < integer > (\$heap_{funcstart\_724,1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
(asType<int>(asType<int>($heap_{tuncstart\_724.1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) \%
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a3}))) = =
asType<integer>(div3.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3})) =>
(asType < integer > ($heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a3) \le
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})) => !(0 ==
asType<integer>(div3.quot))
!(0 == asTvpe < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
\$heap_{724,1;745,8} == \$heap_{funcstart\_724,1}.\_\textbf{replace}(p1 \rightarrow \textbf{asType} < \textbf{short}
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{tuncstart\_724.1}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1}.\mathbf{quot})) * \mathbf{asType}{<} \mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
-{\bf asType}{<} {\bf integer~const}{>} (\${\rm heap}_{724,1;745,8}.{\rm M1}) <
asType<integer>($heap<sub>724,1:745,8</sub>.p1)
!(0 == asType < integer > (\$heap_{724,1:745.8}.p1))
asType<integer>($heap<sub>724.1:745.8</sub>.p1) <
asType<integer>($heap<sub>724.1:745.8</sub>.M1)
\text{sheap}_{724,1;747,8} == \text{sheap}_{724,1;745,8}.\text{-replace}(p2 \to asType < short)
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724,1;745,8}.r2)) - (asType < int > (asType < short)
int > (div2.quot)) * asType < int > ($heap_{724,1;745,8}.b2))))
-asType < integer const > (\$heap_{724,1:747.8}.M2) < 
asType<integer>($heap<sub>724.1:747.8</sub>.p2)
```

```
!(0 == asType < integer > (\$heap_{724.1:747.8}.p2))
Proof:
[Take given term]
[5.0] invariant1(heapIs heap_{funcstart\_724,1})
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
[5.1] ((((((0 < asType < integer > ($heap_{funcstart\_724,1}.p1)) &&
(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 
asType<integer>(heap_{funcstart\_724,1}.M1))) && (0 <
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 
as
Type<integer>($heap_{funcstart\_724,1}.M2))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.3] (((((0 < $heap_{funcstart_724,1}.p1) && ($heap_{funcstart_724,1}.p1 < function for the content of the 
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType<integer>(sheap_{funcstart-724,1}.M2)) && (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})))\ \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M3}))
\rightarrow [const static or extern object]
[5.4] (((((0 < $heap_{funcstart\_724,1}.p1) && ($heap_{funcstart\_724,1}.p1 < 
asType < integer > (\$heap_{init}.M1))) \&\& (0 <
asType < integer > (\$heap_{funcstart_{-724,1}}.p2))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType<integer>($heap_funcstart_724.1.p3) <
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M3}))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < $heap_{funcstart_{724,1}}.p1) && ($heap_{funcstart_{724,1}}.p1 < 
asType<integer>(asType<short int>((int)30269)))) && (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2})))\ \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p2) <
asType<integer>(heap_{funcstart\_724,1}.M2))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
```

```
\rightarrow [simplify]
[5.16] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType<integer>($heap_{funcstart\_724,1}.M2))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.17] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \; \land \; (0 < \$heap_{funcstart\_724,1}.p1) \; \land 
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType < integer > (\$heap_{init}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType<integer>($heap_funcstart_724.1.p3) <
asType < integer > (\$heap_{funcstart\_724.1}.M3))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] \left( \left( \left( \left( -30269 < -\$ \text{heap}_{funcstart\_724,1}.\text{p1} \right) \right. \wedge \left. \left( 0 < \$ \text{heap}_{funcstart\_724,1}.\text{p1} \right) \right. \wedge \right. \right)
(0 < \text{$heap}_{funcstart_{724,1}.p2})) \&\& (\text{$heap}_{funcstart_{724,1}.p2} <
asType < integer > (asType < short int > ((int)30307)))) && (0 < integer) && (0 < integer
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})))\ \&\&
(asType < integer > (\$heap_{funcstart\_724.1}.p3) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [simplify]
[5.30] ((-30307 < -$heap_{funcstart\_724,1}.p2) \land (-30269 <
-\$ heap_{funcstart\_724,1}.p1) \land (0 < \$ heap_{funcstart\_724,1}.p1) \land (0 < \$ heap_{funcstart\_724,1}.p1) \land (0 < \$ heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.p2) \land (0 < \text{Sheap}_{funcstart\_724,1}.p3)) \&\&
(\$heap_{funcstart\_724,1}.p3 < \mathbf{asType} < \mathbf{integer} > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -$heap_{tuncstart_724.1}.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1.p2}) \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\text{\$heap}_{funcstart\_724.1}.p3 < asType < integer > (\text{\$heap}_{init}.M3))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap_{funcstart_724,1}.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{-724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{-724,1}.p3})) \&\&
(\text{sheap}_{funcstart\_724,1}.\text{p3} < \text{asType} < \text{integer} > (\text{asType} < \text{short})
int > ((int)30323)))
\rightarrow [simplify]
[5.40] (-30323 < -$heap_{funcstart\_724,1}.p3) \land (-30307 <
 -\$heap_{funcstart\_724,1}.p2) \land (-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < -\$heap_{funcstart\_724,1}.p1)
```

```
\text{Sheap}_{funcstart\_724,1}.\text{p1}) \land (0 < \text{Sheap}_{funcstart\_724,1}.\text{p2}) \land (0 <
\$heap_{funcstart\_724,1}.p3)
[Work on sub-term 5 of conjunction in term 5.40]
\textit{[9.0] 0} < \$ heap_{funcstart\_724,1}.p2
[Take given term]
[11.0] div1 == div(heapIs heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
\rightarrow [simplify]
[11.1] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \operatorname{\$heap}_{funcstart\_724,1}, \operatorname{\$heap}_{funcstart\_724,1}.p1,
asType < int > (\$heap_{funcstart\_724,1}.a1))
\rightarrow [const static or extern object]
[11.2] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType < int > (\$heap_{init}.a1))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
[11.3] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
asType<int>(asType<short int>((int)177)))
\rightarrow [simplify]
[11.6] div1 == div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p1, 177)
[Take given term]
[27.0] \operatorname{div2} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > ($heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
\rightarrow [simplify]
[27.1] div2 == div(heapIs $heap_{tuncstart\_724.1}, $heap_{tuncstart\_724.1}.p2,
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
\rightarrow [const static or extern object]
\label{eq:continuous} \mbox{[27.2] div2} == \mbox{div}(\mathbf{heapIs} \ \mbox{\$heap}_{funcstart\_724,1}, \ \mbox{\$heap}_{funcstart\_724,1}.p2,
asType < int > (\$heap_{init}.a2))
\rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
[27.3]~{\rm div2} == {\rm div}(\mathbf{heapIs}~\$ \mathrm{heap}_{funcstart\_724,1},\,\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2},
asType<int>(asType<short int>((int)176)))
\rightarrow [simplify]
[27.6] div2 == div(heapIs $heap_{funcstart\_724,1}$, $heap_{funcstart\_724,1}.p2, 176)
[Assume known post-assertion, class invariant or type constraint for term 27.6]
[30.0] (asType<integer>($heap_{tuncstart\_724,1}.p2) /
```

```
asType<integer>(176)) == asType<integer>(div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).quot
\rightarrow [simplify]
[30.2] ($heap<sub>funcstart_724,1.</sub>p2 / 176) == asType<integer>(div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).quot)
→ [expand definition of operator './' in class 'int' at built in declaration]
[30.3] ([asType<integer>(peq_{tange}) (peq_{tange}) ([asType<integer)) (peq_{tange}) ([asType<integer)) (peq_{tange}) (peq_{tange}) (peq_{tange}) (peq_{tange}) (peq_{tange})
-(-asType < integer > (\$heap_{funcstart\_724.1}.p2) / 176), []:
asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176) ==
\mathbf{asType} \small{<} \mathbf{integer} \small{>} ( \mathrm{div} (\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}, \\
176).quot)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[30.4] ([asType<integer>($heap_{funcstart\_724,1}.p2) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176) = =
\mathbf{asType} < \mathbf{integer} > (\mathbf{div}(\mathbf{heapIs} \ \$ \mathbf{heap}_{funcstart\_724,1}, \ \$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}, \\
176).quot)
\rightarrow [simplify]
[30.7] ([0 < -$heap<sub>funcstart_724,1.</sub>p2]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176),
[!(asType < integer > (\$heap_{funcstart\_724.1}.p2) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176) = =
asType<integer>(div(heapIs $heap_{tuncstart\_724.1}, $heap_{tuncstart\_724.1}.p2,
176).quot)
\rightarrow [from term 9.0, literala < -$heap<sub>funcstart_724,1.</sub>p2 is false whenever -2 < (0
+ literala)]
    Proof of rule precondition:
    [30.7.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [30.7.2] true
[30.8] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 0)]:
\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p2) \ / \ 176) = =
asType<integer>(div(heapIs $heap_{tuncstart\_724.1}, $heap_{tuncstart\_724.1}.p2,
176).quot)
\rightarrow [simplify]
[30.11] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176), [!(0 < integer > (\$heap_{funcstart\_724,1}.p2) / 176)]
-\$heap_{funcstart\_724,1}.p2): asType<integer>(\$heap_{funcstart\_724,1}.p2) / 176)
```

```
== asType<integer>(div(heapIs $heap_{funcstart_724.1},
heap_{funcstart_{-724,1}}.p2, 176).quot
\rightarrow [from term 9.0, literala < -$heap<sub>funcstart_724,1.</sub>p2 is false whenever -2 < (0
+ literala)]
   Proof of rule precondition:
   [30.11.0] - 2 < (0 + 0)
   \rightarrow [simplify]
   [30.11.2] true
[30.12] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}) \; / \; 176),
[!false]: asType<integer>($heap<sub>funcstart_724,1.</sub>p2) / 176) ==
asType < integer > (div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p2,
176).quot)
\rightarrow [simplify]
[30.17] 0 == (-div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2,
176).quot + (\text{$heap}_{funcstart\_724,1}.p2 / 176))
[Assume known post-assertion, class invariant or type constraint for term 27.6]
[31.0] (asType<integer>(\ensuremath{\text{sheap}}_{funcstart\_724,1}.p2) %
asType<integer>(176)) == asType<integer>(div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem
\rightarrow [simplify]
[31.2] (\theta_{funcstart\_724,1}.p2 \% 176) == asType<integer>(div(heapIs
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, p2, 176).rem
\rightarrow [expand definition of operator '.%' in class 'int' at built in declaration]
[31.3] ([asType<integer>(sheap_{funcstart\_724.1}.p2) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176), []:
asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176) ==
asType<integer>(div(heapIs $heap_{tuncstart\_724.1}, $heap_{tuncstart\_724.1}.p2,
176).rem)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[31.4] ([asType<integer>($heap_{funcstart\_724,1}.p2) < 0]:
-(-\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}) \% \ 176),
[!(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176) = =
asType<integer>(div(heapIs p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1})
176).rem)
\rightarrow [simplify]
[31.7] ([0 < -$heap<sub>funcstart_724,1</sub>.p2]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176),
```

```
[!(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176) ==
\mathbf{asType} {<} \mathbf{integer} {>} ( \mathbf{div} (\mathbf{heapIs} \ \$ \mathbf{heap}_{funcstart\_724,1}, \ \$ \mathbf{heap}_{funcstart\_724,1}. \mathbf{p2}, \\
176).rem)
\rightarrow [from term 9.0, literala < -$heap<sub>funcstart_724.1</sub>.p2 is false whenever -2 < (0
+ literala)]
         Proof of rule precondition:
         [31.7.0] - 2 < (0 + 0)
         \rightarrow [simplify]
         [31.7.2] true
[31.8] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176) = =
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2,
176).rem)
\rightarrow [simplify]
[31.11] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}) \; \% \; 176), \; [!(0.11)] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}) \; \% \; 176), \; [!(0.11)] \; ([\mathbf{false}]: \; -(-\mathbf{false}): \; -
<-$heap<sub>funcstart_724,1.p2</sub>)]: asType<integer>($heap<sub>funcstart_724,1.p2</sub>) %
176) == asType < integer > (div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p2, 176}.rem
\rightarrow [from term 9.0, literala < -$heap<sub>funcstart_724,1</sub>.p2 is false whenever -2 < (0
+ literala)]
         Proof of rule precondition:
         [31.11.0] - 2 < (0 + 0)
         \rightarrow [simplify]
         [31.11.2] true
[31.12] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176),
[!false]: asType<integer>($heap<sub>funcstart_724,1.</sub>p2) % 176) ==
\mathbf{asType} \small{<} \mathbf{integer} \small{>} ( \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}, \\
176).rem)
\rightarrow [simplify]
\label{eq:continuous} \textit{[31.17] }0 == (-\text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p2},
176).rem + (\text{$heap}_{funcstart\_724,1}.p2 % 176))
[Take given term]
[40.0] (asType<integer>($heap_{funcstart\_724,1}.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p2) = =
asType<integer>(div2.rem))
```

```
\rightarrow [simplify]
[40.1] ($\text{heap}_{funcstart_724,1}.p2 < \text{asType} < \text{integer} > ($\text{heap}_{funcstart_724,1}.a2))
=> (asType<integer>($heap_{funcstart\_724,1}.p2) ==
asType<integer>(div2.rem))
\rightarrow [const static or extern object]
[40.2] ($heap<sub>funcstart_724,1.</sub>p2 < asType<integer>($heap<sub>init.</sub>a2)) =>
(asType < integer > (\$heap_{funcstart\_724,1}.p2) = =
asType<integer>(div2.rem))
\rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
[40.3] \; (\$heap_{funcstart\_724,1}.p2 < \mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{short})
int>((int)176))) => (asType < integer>($heap_{funcstart\_724,1}.p2) ==
asType<integer>(div2.rem))
\rightarrow [simplify]
[40.10] (-176 < -$\text{heap}_{funcstart_724,1}.p2) => ($\text{heap}_{funcstart_724,1}.p2 == $\text{
asType<integer>(div2.rem))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1}}.p2, 176)
[40.11] (-176 < -$\text{heap}_{funcstart_724,1}.p2) => ($\text{heap}_{funcstart_724,1}.p2 == $\text{ }
\mathbf{asType} \small{<} \mathbf{integer} \small{>} ( \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}, \\
176).rem))
\rightarrow [simplify]
[40.17] (0 == (-\$heap<sub>funcstart_724,1</sub>.p2 + div(heapIs \$heap<sub>funcstart_724,1</sub>,
\text{Sheap}_{funcstart\_724,1.p2}, 176).rem)) \lor (175 < \text{Sheap}_{funcstart\_724,1.p2})
[Take given term]
[59.0] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart_724,1},
heap_{funcstart_{724,1}}.p1, 177
[59.1] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div(heapIs $heap_{tuncstart\_724.1},
\theta_{funcstart\_724,1}.p1, 177).rem ** asType<int>($\text{heap}_{funcstart\_724,1}.r1)) -
(asType<int>(asType<short int>(div1.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [simplify]
[59.3] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
```

```
asType < int > (\$heap_{tuncstart-724.1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
\rightarrow [const static or extern object]
[59.4] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType < int > (\$heap_{init}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
\rightarrow [expand definition of constant 'r1' at prang.c (15,20)]
[59.5] \rho_{1745,8} == \rho_{1745
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType < int > (asType < short int > ((int)171))) -
(asType<int>(asType<short int>(div1.quot)) *
\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
\rightarrow [simplify]
[59.8] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem * 171)
- (asType<int>(asType<short int>(div1.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart_{724,1}},
heap_{funcstart_{-724,1}}.p1, 177
[59.9] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((171 * div(heapIs \$heap_{funcstart\_724.1}, \$heap_{funcstart\_724.1}, p1, 177).rem)
- (asType<int>(asType<short int>(div(heapIs $heap_{tuncstart}, 724.1),
heap_{funcstart_{-724,1}}.p1, 177).quot) *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [simplify]
[59.11] \theta == 
int>((171 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{b1}))))
\rightarrow [const static or extern object]
[59.12] \$ \text{heap}_{724,1;745,8} == \$ \text{heap}_{funcstart\_724,1}.\_\textbf{replace} (\text{p1} \rightarrow \textbf{asType} < \textbf{short}
int>((171 * div(heapIs \$heap_{tuncstart\_724.1}, \$heap_{tuncstart\_724.1}, p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType < int > (\$heap_{init}.b1)))
\rightarrow [expand definition of constant 'b1' at prang.c (17,20)]
[59.13] \$ heap_{724,1;745,8} == \$ heap_{funcstart\_724,1}.\_\mathbf{replace} (p1 \to \mathbf{asType} < \mathbf{short})
int>((171 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724.1}, \$ \text{heap}_{funcstart\_724.1}.\text{p1}, 177).\text{quot} *
asType<int>(asType<short int>((int)2))))
```

```
\rightarrow [simplify]
[59.19] $\text{heap}_{724,1:745,8} == \text{$heap}_{funcstart\_724,1}._\text{$replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{$heap}_{funcstart\_724,1}, \ \text{$heap}_{funcstart\_724,1}.p1, \ 177).rem)))
[Take given term]
[63.0] $\text{heap}_{724,1:747,8} == $\text{heap}_{724,1:745,8}._\text{replace}(p2 \to \text{asType} < \text{short}
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724,1:745,8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724,1:745,8</sub>.b2))))
\rightarrow [from term 59.19, $heap<sub>724.1:745.8</sub> is equal to
heap_{funcstart\_724.1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724.1}),
\text{Sheap}_{funcstart_{-724,1},p1, 177}.\text{quot}) + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart_{-724,1}}),
heap_{funcstart_{724,1}.p1, 177).rem}
[63.1] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\text{heap}_{724,1;745,8}.\text{r2})) - (\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{short}
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{tuncstart} 724.1,
heap_{funcstart_{-724,1},p2,176}
[63.2] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},
\text{sheap}_{funcstart=724.1}.\text{p2}, 176).\text{rem}) * asType < int > (\text{sheap}_{724.1:745.8}.\text{r2})) -
(asType<int>(asType<short int>(div2.quot)) *
asType < int > (\$heap_{724,1:745,8}.b2))))
[63.4] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
(177).rem))._replace(p2 \rightarrow asType<short int>((div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem} *
\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{724,1;745,8}.\mathrm{r2})) - (\mathbf{asType} < \mathbf{int} > (\mathbf{asType} < \mathbf{short}))
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [from term 59.19, $heap<sub>724,1;745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724,1}),
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1}, 177).quot) + (171 * div(heapIs $heap_{funcstart\_724,1}, 17
```

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heap_{funcstart_{-724,1}}.p1, 177).rem)
[63.5] $heap<sub>724,1:747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathbf{\_replace}(\mathrm{p1} \rightarrow ((-2 * \mathrm{div}(\mathbf{heapIs}
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
\text{Sheap}_{funcstart_{724,1}}, \text{Sheap}_{funcstart_{724,1},p1, 177}.\text{rem})).r2)) -
(asType<int>(asType<short int>(div2.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{b2}))))
\rightarrow [const member of object with modified fields]
[63.6] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((\operatorname{div}(\mathbf{heapIs}))))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem *
asType < int > (\$heap_{funcstart\_724,1}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType< int>($heap_{724.1:745.8}.b2))))
\rightarrow [const static or extern object]
[63.7] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((\operatorname{div}(\mathbf{heapIs}))))
\rho_{funcstart\_724,1}, \rho_{funcstart\_724,1.p2, 176}.rem *
asType < int > (\$heap_{init}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [expand definition of constant 'r2' at prang.c (20,20)]
[63.8] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\label{eq:div_heap} \text{div}(\textbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
(177).rem))._replace(p2 \rightarrow asType<short int>((div(heapIs)
\text{Sheap}_{funcstart_{-724,1}}, \text{Sheap}_{funcstart_{-724,1}}.p2, 176).rem *
asType < int > (asType < short int > ((int)172)))
(asType<int>(asType<short int>(div2.quot)) *
asType<int>($heap<sub>724,1;745,8</sub>.b2))))
\rightarrow [simplify]
[63.11] $\text{heap}_{724,1:747,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}. p1, \ 177). \operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((\operatorname{div}(\mathbf{heapIs}))))
\text{Sheap}_{funcstart_{724,1}}, \text{Sheap}_{funcstart_{724,1}}.\text{p2}, 176).\text{rem} * 172) -
```

```
(asType<int>(asType<short int>(div2.quot)) *
asType < int > (\$heap_{724,1:745,8}.b2))))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1}}.p2, 176
[63.12] $\text{heap}_{724,1;747,8} == $\text{heap}_{funcstart_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 2, 176).rem –
(asType<int>(asType<short int>(div(heapIs $heap_{tuncstart\_724.1},
\text{sheap}_{funcstart\_724,1.p2}, 176).\text{quot}) * asType < int > (\text{sheap}_{724,1;745,8}.b2))))
\rightarrow [simplify]
[63.14] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem}) - (\text{div}(\text{heapIs})
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 2, 176).quot *
asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [from term 59.19, $heap<sub>724.1:745.8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\$heap_{funcstart\_724,1}.p1,\ 177).rem))]
[63.15] $\text{heap}_{724,1:747,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem}) - (\text{div}(\text{heapIs}))
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1},p2,176}.quot *
asType < int > (\$heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * div(heapIs)))))))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\textbf{heapIs}))
\text{Sheap}_{funcstart_{724,1}}, \text{Sheap}_{funcstart_{724,1}}, \text{p1}, 177).rem))).b2))))
\rightarrow [const member of object with modified fields]
[63.16] $heap<sub>724.1:747.8</sub> == $heap<sub>funcstart_724.1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}. p1, \ 177). \operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem}) - (\text{div}(\text{heapIs})
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}.p2, 176).quot *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b2}))))
\rightarrow [const static or extern object]
```

```
[63.17] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\label{eq:div_heap} \text{div}(\textbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1},p2,176}, quot *
asType < int > (\$heap_{init}.b2))))
\rightarrow [expand definition of constant 'b2' at prang.c (22,20)]
[63.18] $\text{heap}_{724,1:747,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\label{eq:div_heap} \text{div}(\textbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 2, 176).quot *
asType<int>(asType<short int>((int)35)))))
\rightarrow [simplify]
[63.24] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart} \ 724.1, \ \$ \operatorname{heap}_{funcstart} \ 724.1, \ p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p2, 176).rem))
[Take goal term]
[1.0] asType<integer>($heap_{724,1;747,8}.p2) <
asType<integer>($heap<sub>724.1:747.8</sub>.M2)
\rightarrow [from term 63.24, $heap<sub>724,1;747,8</sub> is equal to
heap_{funcstart\_724.1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724.1},
heap_{funcstart_{724,1},p1, 177}, quot) + (171 * div(heapIs p_{funcstart_{724,1},p1, 177}), quot)
\theta_{funcstart_{724,1},p1,177,rem})._replace\theta_{funcstart_{724,1},p1,177,rem})._replace
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 2, 176).rem
[1.1] asType<integer>(heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{funcstart_{-724,1}.p2, 176).rem})).p2) <
asType<integer>($heap<sub>724.1:747.8</sub>.M2)
\rightarrow [simplify]
[1.3] ((-35 * div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}.p2,
176).quot) + (172 * div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
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(176).rem) < asType < integer > ($heap_{724,1.747,8}.M2)
\rightarrow [from term 63.24, $heap<sub>724.1:747.8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1},p1,177}, quot) + (171 * div(heapIs p_{funcstart_{724,1},p1,177}).
\rho_{funcstart\_724,1}.p1, 177).rem))._replace\rho_{funcstart\_724,1}.p1, 177).rem)
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p2, 176).rem)
[1.4] ((-35 * div(heapIs $heap_{funcstart_{724,1}}, $heap_{funcstart_{724,1}}.p2, 176).quot)
+ (172 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart\_724,1}, \text{\$heap}_{funcstart\_724,1.p2}, 176).\text{rem})) <
asType<integer>(p1 \rightarrow (-2 * div(heapIs))
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p1, 177).quot) + (171 * div(heapIs
\rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}
* div(heapIs heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 176).quot) + (172 *
\operatorname{div}(\mathbf{heapIs} \ \text{$heap}_{funcstart\_724,1}, \ \text{$heap}_{funcstart\_724,1}.p2, \ 176).rem))).M2)
→ [const member of object with modified fields]
[1.6] ((-35 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2,
176).quot) + (172 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2,
176).rem)) < \mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.M2)
\rightarrow [const static or extern object]
[1.7] ((-35 * div(heapIs heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p_2,
176).quot) + (172 * \text{div}(\textbf{heapIs} \$ \text{heap}_{funcstart}, 724.1, \$ \text{heap}_{funcstart}, 724.1.p2,
(176).rem) < asType < integer > (\$heap_{init}.M2)
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
\textit{[1.8]} \ ((-35 \ ^* \ \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2},
176).quot) + (172 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart\_724,1}, \text{\$heap}_{funcstart\_724,1}.p2,
176).rem)) < asType<integer>(asType<short int>((int)30307))
\rightarrow [simplify]
[1.18] -30307 < ((-172 * div(heapIs $heap_{funcstart_724.1}))
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{rem} + (35 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p2, 176).quot)
\rightarrow [negate goal and search for contradiction]
[1.19] ! (-30307 < ((-172 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart_{-724,1},p2, 176}.rem) + (35 * div(heapIs \text{Sheap}_{funcstart_{-724,1},p2})
heap_{funcstart_{724,1},p2, 176}, quot)))
\rightarrow [simplify]
[1.24] 30306 < ((172 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p2,
176).rem) + (-35 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2,
176).quot))
[Branch on disjunction or conditional in term 40.17]
```

```
[73.0] (0 == (-$heap_{funcstart_{-724,1}}.p2 + div(heapIs $heap_{funcstart_{-724,1}},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem})) \lor (175 < \text{Sheap}_{funcstart\_724,1}.\text{p2}) \lor !(0 ==
(-\$heap_{funcstart\_724,1}.p2 + div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p2, 176).rem
[Copy term 1.24]
[76.0] (30306 < ((-35 * div(heapIs $heap_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2}, 176).quot) + (172 * div(heapIs \rho_{funcstart\_724,1},
\{\text{heap}_{funcstart\_724,1.p2}, 176\}.\text{rem}\} \lor (175 < \{\text{heap}_{funcstart\_724,1.p2}\} \lor !(0 = = 176).\text{rem}\}
(-\text{\$heap}_{funcstart\_724,1}.\text{p2} + \text{div}(\text{heapIs }\text{\$heap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p2, 176).rem}
\rightarrow [from term 73.0, div(heapIs $heap_{funcstart\_724,1}$, $heap_{funcstart\_724,1}$.p2,
176).rem is equal to heap_{funcstart\_724,1}.p2
[76.1] (30306 < ((-35 * div(heapIs $heap_{funcstart\_724,1},
\$ heap_{funcstart\_724,1}.p2,\ 176).quot) + (172 * \$ heap_{funcstart\_724,1}.p2))) \lor \dots
[Copy term 31.17]
[77.0] (0 == (-\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p2},
176).rem + (\text{$heap}_{funcstart\_724,1}.p2 \% 176))) \vee (175 < \text{$heap}_{funcstart\_724,1}.p2)
\vee !(0 == (-\$heap_{funcstart\_724,1}.p2 + div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p2, 176).rem}
\rightarrow [from\ term\ 73.0,\ div(\mathbf{heapIs}\ \$heap_{funcstart\_724,1},\ \$heap_{funcstart\_724,1}.p2,
176).rem is equal to heap_{funcstart\_724,1}.p2
[77.1] (0 == (-\$heap_{funcstart\_724,1}.p2 + (\$heap_{funcstart\_724,1}.p2 \% 176))) \lor ...
[Assume known post-assertion, class invariant or type constraint for term 77.1]
[84.0] ($\text{heap}_{funcstart_724.1}.p2 < 176) \vee (175 < $\text{heap}_{funcstart_724.1}.p2) \vee !(0
== (-\$heap_{funcstart\_724.1}.p2 + div(heapIs \$heap_{funcstart\_724.1},
heap_{funcstart_{-724,1}.p2, 176).rem}
\rightarrow [simplify]
[84.3] (-176 < -\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}) \ \lor \ \dots
[Copy term 1.24]
[86.0] 30306 < ((-35 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p2,
176).quot) + (172 * div(heapIs \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, p2,
176).rem))
\rightarrow [from term 31.17, div(heapIs $heap_{funcstart\_724,1}$, $heap_{funcstart\_724,1}$.p2,
176).rem is equal to heap_{funcstart\_724,1}.p2 \% 176
[86.1] \ 30306 < ((-35 * div(\mathbf{heapIs} \$ heap_{funcstart\_724,1}, \$ heap_{funcstart\_724,1}.p2,
(176).quot + (172 * (\text{$heap}_{funcstart\_724,1.p2 \% 176})))
[Copy term 76.1]
[87.0] (30306 < ((-35 * div(heapIs heapIs = f_{uncstart_724,1}, f_{uncstart_724,1})
```

```
\text{Sheap}_{funcstart_{-724,1}.p2, 176}.\text{quot}) + (172 * \text{Sheap}_{funcstart_{-724,1}.p2}))) \lor (175 <
\theta_{funcstart\_724,1.p2} \lor \theta_{funcstart\_724,1.p2} + \theta_{funcstart\_724,1.
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, 176).rem
\rightarrow [from term 30.17, div(heapIs $heap_{funcstart\_724,1}$, $heap_{funcstart\_724,1}$.p2,
176).quot is equal to heap_{funcstart\_724,1}.p2 / 176
[87.1] (30306 < ((-35 * (\$heap_{funcstart\_724,1}.p2 / 176)) + (172 * (-35 * (\$heap_{funcstart\_724,1}.p2 / 176)))
heap_{funcstart_{724,1}.p2)} \lor ...
\rightarrow [division by larger divisor]
         Proof of rule precondition 1:
         [87.1.0.0]~\mathrm{literald} < -\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}
         \rightarrow [unify with term 84.3]
         [87.1.0.1] true
         Proof of rule precondition 2:
         [87.1.1.0]~\mathrm{literalc} < \$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}
         \rightarrow [unify with term 9.0]
         [87.1.1.1] true
         Proof of rule precondition 3:
         [87.1.2.0] --176 \le 176
         \rightarrow [simplify]
         [87.1.2.2] true
         Proof of rule precondition 4:
         [87.1.3.0] - 2 < 0
         \rightarrow [simplify]
         [87.1.3.1] true
[87.2] (30306 < ((-35 * $heap_{funcstart\_724,1}.p2) + (172 *
heap_{funcstart_{-724,1}.p2})) \vee ...
\rightarrow [simplify]
[87.4] (30306 < (137 * $heap_{funcstart\_724,1}.p2)) \vee ...
\rightarrow [literal comparison of product]
[87.5] ([137 < 0]: (30306 / -137) < -\$heap_{funcstart\_724,1}.p2, [0 < 137]: (30306
/137) < $\text{heap}_{funcstart_724,1}.p2, [0 == 137]: 30306 < 0) \lor \dots
\rightarrow [explicitly assert falsehood of skipped guards in subsequent guards]
[87.6] ([137 < 0]: (30306 / -137) < -$heap_{funcstart\_724,1}.p2, [(0 < 137) \land !(137
< 0)]: (30306 / 137) < $heap_{funcstart_724,1}.p2, [(0 == 137) \land!(0 < 137) \land
```

 $!(137 < 0)]: 30306 < 0) \lor ...$

```
\rightarrow [simplify]
[87.13] (true \land (221 < $heap_{funcstart_724,1}.p2)) \lor ...
\rightarrow [from term 84.3, literala < $heap_{funcstart_724,1}.p2 is false whenever -2 <
(-176 + literala)
    Proof of rule precondition:
    [87.13.0] - 2 < (-176 + 221)
    \rightarrow [simplify]
    [87.13.2] true
[87.14] (true \wedge false) \vee \dots
\rightarrow [simplify]
[87.15] false \lor ...
[Remove 'false' term 87.15 and fetch new term from containing clause]
[88.0] 175 < \text{$heap}_{funcstart\_724,1}.p2
[Create new term from term 30.17 using rule: condition for equality of division]
[120.0] ((176 * (0 + -(-\text{div}(\mathbf{heapIs} \ \text{$heap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot}))) < (1 + \text{Sheap}_{funcstart\_724,1.p2})) \land
(\text{$heap}_{funcstart\_724,1}.\text{p2} < (176 * (0 + 1 + -(-div(\textbf{heapIs}))))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).quot))))
\rightarrow [simplify]
 [120.15] \ (-1 < ((-176 * {\rm div}(\mathbf{heapIs} \ \$ {\rm heap}_{funcstart\_724,1}, \ \$ {\rm heap}_{funcstart\_724,1}.{\rm p2}, 
(-176).quot) + \text{heap}_{funcstart\_724,1}.p2)) \land (-176 < (-\text{heap}_{funcstart\_724,1}.p2 +
(176 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart\_724,1}, \text{\$heap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot})))
\rightarrow [separate conjunction and work on first sub-term]
[120.16] -176 < (-\$heap_{funcstart\_724,1}.p2 + (176 * div(heapIs))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).quot)
[Create new term from terms 120.16, 88.0 using rule: transitivity 2]
[155.0] (-176 + 1 + 175) < (176 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p2, 176).quot
\rightarrow [simplify]
[155.1] 0 < (176 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart\_724,1}, \text{\$heap}_{funcstart\_724,1}.\text{p2},
176).quot)
\rightarrow [product is positive]
[155.2] ((0 < 176) \land (0 < \text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724.1},
\text{heap}_{funcstart_724.1.p2, 176}, quot)) \vee ((176 < 0) \wedge (div(heapIs
\$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p2, 176).quot < 0))
\rightarrow [simplify]
```

```
[155.7] 0 < \text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.p2, 176).quot
[Create new term from terms 155.7, 86.1 using rule: transitivity 11]
[160.0] (1 + 30306 + (0 * 35)) < (172 * (\$heap_{tuncstart\_724.1}.p2 \% 176))
\rightarrow [simplify]
[160.2] 30307 < (172 * (\$heap_{funcstart\_724,1}.p2 \% 176))
\rightarrow [literal comparison of product]
[160.3] ([172 < 0]: (30307 / -172) < -($heap_{funcstart\_724,1}.p2 % 176), [0 < 176]
172]: (30307 / 172) < (\text{$heap}_{funcstart\_724,1}.p2 \% 176), [0 == 172]: 30307 < 0)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[160.4] ([172 < 0]: (30307 / -172) < -($heap_{funcstart\_724,1}.p2 % 176), [(0 < 0.4])
172) \land!(172 < 0)]: (30307 / 172) < ($heap_{funcstart\_724,1}.p2 % 176), [(0 ==
172) \land !(0 < 172) \land !(172 < 0)]: 30307 < 0)
\rightarrow [simplify]
[160.13] false
Proof of verification condition: Assertion valid
Condition generated at: C:\Escher\Customers\prang\prang.c (64,12)
To prove: -asType<integer const>($heap<sub>724.1:747.8</sub>.M2) <
asType<integer>($heap<sub>724.1:747.8</sub>.p2)
Given:
heap_{init}.LIMIT == (int)80
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta = asType < short int > ((int)2)
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\theta_{init}.r2 == asType<short int>((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
heap_{init}.b2 == asType < short int > ((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
heap_{init}.a3 == asType<short int>((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
```

```
\rho_{init}.p2 == asType < short int > ((int)2)
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart\_724,1})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}))~\%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(asType<integer>($heap_funcstart_724.1.p1) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p1) = =
asType<integer>(div1.rem))
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.quot)
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2})) \ \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2})) =>
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}) ==
asType<integer>(div2.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a2) \le
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})) => !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
```

```
div3 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
(asType<int>(asType<int>($heap_{tuncstart\_724.1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(\mathbf{asType} {<} \mathbf{integer} {>} (\mathbf{asType} {<} \mathbf{int} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3})) \ \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))) ==
asType<integer>(div3.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724.1}.a3)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a3}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
heap_{724,1;745,8} == heap_{funcstart\_724,1}.\_replace(p1 \rightarrow asType < short)
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_tuncstart_724.1.r1)) - (asType<int>(asType<short
\mathbf{int}{>}(\mathbf{div1.quot})) * \mathbf{asType}{<} \mathbf{int}{>} (\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
-{\bf asType}{<}{\bf integer~const}{>}(\${\rm heap}_{724,1;745,8}.{\rm M1})<
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{p1})
!(0 == asType < integer > (\$heap_{724,1;745,8}.p1))
asType < integer > (\$heap_{724,1;745,8}.p1) <
asType<integer>($heap<sub>724.1:745.8</sub>.M1)
\text{heap}_{724.1:747.8} == \text{heap}_{724.1:745.8}._replace(p2 \rightarrow asType<short)
int>((asType<int>(asType<short int>(div2.rem))
asType < int > (\$heap_{724,1;745,8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724,1:745,8</sub>.b2))))
Proof:
[Take given term]
[5.0] invariant1(heapIs heap_{funcstart_{-724,1}})
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
[5.1] (((((0 < asType < integer > ($heap_{funcstart\_724,1}.p1)) &&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}) <
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 < funcstart\_724,1)
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
```

```
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p3) < 
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M3}))
\rightarrow [simplify]
[5.3] (((((0 < $heap_{funcstart_724,1}.p1) && ($heap_{funcstart_724,1}.p1 < function for the content of the 
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p2) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M2})))~\&\&~(0<
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.4] (((((0 < $heap_{funcstart\_724,1}.p1) && ($heap_{funcstart\_724,1}.p1 < ])
asType < integer > (\$heap_{init}.M1))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < $heap_{funcstart_{724,1}}.p1) && ($heap_{funcstart_{724,1}}.p1 < ]
\mathbf{asType} \small{<} \mathbf{integer} \small{>} (\mathbf{asType} \small{<} \mathbf{short} \ \mathbf{int} \small{>} ((\mathbf{int})30269)))) \ \&\& \ (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2})))\ \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p2) < 
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType<integer>($heap_funcstart_724.1.p3) <
asType < integer > (\$heap_{funcstart\_724.1}.M3))
\rightarrow [simplify]
[5.16] \left( \left( \left( \left( -30269 < -\$ \text{heap}_{funcstart\_724,1}.\text{p1} \right) \right. \wedge \left. \left( 0 < \$ \text{heap}_{funcstart\_724,1}.\text{p1} \right) \right. \wedge \right. \right)
(0 < \mathrm{\$heap}_{funcstart\_724,1}.\mathrm{p2})) && (\mathrm{\$heap}_{funcstart\_724,1}.\mathrm{p2} <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})))\ \&\&
(asType < integer > (\$heap_{funcstart\_724.1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.17] ((((-30269 < -$heap_{funcstart\_724,1}.p1) \lambda (0 < $heap_{funcstart\_724,1}.p1) \lambda
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(0 < \text{\$heap}_{funcstart_{-724,1}.p2})) \&\& (\text{\$heap}_{funcstart_{-724,1}.p2} <
asType < integer > (\$heap_{init}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathtt{heap}_{funcstart\_724,1}.\mathtt{p3})))\ \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p3) < 
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M3}))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType < integer > (asType < short int > ((int)30307)))) && (0 < integer) && (0 < integer
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.30] ((-30307 < -\$heap_{funcstart\_724,1}.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1.p2}) \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.\text{p3} < \text{asType} < \text{integer} > (\text{\$heap}_{funcstart\_724,1}.\text{M3}))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -$heap_funcstart_724,1.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\ 724.1.p2} \land (0 < \text{Sheap}_{funcstart\ 724.1.p3})) \&\&
(\$heap_{funcstart\_724,1}.p3 < \mathbf{asType} < \mathbf{integer} > (\$heap_{init}.M3))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap_funcstart_724,1.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{724,1}.p3})) \&\&
(\text{sheap}_{funcstart\_724,1}.p3 < asType < integer > (asType < short)
int > ((int)30323)))
\rightarrow [simplify]
[5.40] (-30323 < -\$heap_{funcstart\_724,1}.p3) \land (-30307 < -30307)
 -\$heap_{funcstart\_724,1}.p2) \land (-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < -\$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{-724,1}.p1} \land (0 < \text{Sheap}_{funcstart_{-724,1}.p2}) \land (0 <
heap_{funcstart_{724,1}.p3}
[Work on sub-term 2 of conjunction in term 5.40]
\textit{[6.0] -30307} < -\$ heap_{funcstart\_724,1}.p2
[Work on sub-term 5 of conjunction in term 5.40]
\textit{[9.0] 0} < \$ heap_{funcstart\_724,1}.p2
[Take given term]
[11.0] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
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```
\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
\rightarrow [simplify]
[11.1]~{\rm div1} == {\rm div}(\mathbf{heapIs}~\$ \mathrm{heap}_{funcstart\_724,1},\,\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType < int > (\$heap_{funcstart\_724,1}.a1))
\rightarrow [const static or extern object]
[11.2] div1 == div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p1,
asType < int > (\$heap_{init}.a1))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
[11.3] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \operatorname{\$heap}_{funcstart\_724,1}, \operatorname{\$heap}_{funcstart\_724,1}.p1,
asType<int>(asType<short int>((int)177)))
\rightarrow [simplify]
[11.6] \text{ div1} == \text{div}(\mathbf{heapIs} \$ heap_{funcstart\_724,1}, \$ heap_{funcstart\_724,1}.p1, 177)
[Take given term]
[27.0] \operatorname{div2} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
\rightarrow [simplify]
[27.1] \ \mathrm{div2} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2},
asType < int > (\$heap_{funcstart\_724,1}.a2))
\rightarrow [const static or extern object]
[27.2] \operatorname{div2} == \operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p2,
\mathbf{asType}{<}\mathbf{int}{>}(\$\text{heap}_{init}.\text{a2}))
\rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
[27.3] div2 == div(heapIs $heap_{funcstart\_724.1}, $heap_{funcstart\_724.1}.p2,
asType<int>(asType<short int>((int)176)))
\rightarrow [simplify]
[27.6] div2 == div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p2, 176)
[Assume known post-assertion, class invariant or type constraint for term 27.6]
[30.0] (asType<integer>($heap_{funcstart\_724,1}.p2) /
asType < integer > (176)) == asType < integer > (div(heapIs))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot
\rightarrow [simplify]
[30.2] ($heap<sub>funcstart_724,1.</sub>p2 / 176) == asType<integer>(div(heapIs)
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot
→ [expand definition of operator './' in class 'int' at built in declaration]
```

```
[30.3] ([asType<integer>($heap_{funcstart\_724,1}.p2) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176), []:
asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176) = =
asType<integer>(div(heapIs p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1})
176).quot)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[30.4] ([asType<integer>($heap_{funcstart\_724,1}.p2) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176) = =
asType<integer>(div(heapIs $heap_{tuncstart\_724.1}, $heap_{tuncstart\_724.1}.p2,
176).quot)
\rightarrow [simplify]
[30.7] ([0 < -$heap<sub>funcstart_724,1</sub>.p2]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176),
[!(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p2) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176) ==
asType<integer>(div(heapIs p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1})
176).quot)
\rightarrow [from term 9.0, literala < -$heap<sub>funcstart_724.1</sub>.p2 is false whenever -2 < (0
+ literala)]
   Proof of rule precondition:
   [30.7.0] - 2 < (0 + 0)
   \rightarrow [simplify]
   [30.7.2] true
[30.8] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 0)]:
asType < integer > (\$heap_{funcstart\_724.1}.p2) / 176) = =
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2,
176).quot)
\rightarrow [simplify]
[30.11] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p2) / 176), [!(0 < integer > (\$heap_{funcstart\_724,1}.p2) / 176)]
-\text{\$heap}_{funcstart\_724.1}.\text{p2}): asType<integer>(\text{\$heap}_{funcstart\_724.1}.\text{p2}) / 176)
== asType<integer>(div(heapIs $heap_funcstart_724,1,
\theta
\rightarrow [from term 9.0, literala < –$heap_{uncstart\_724,1}.p2 is false whenever -2 < (0
+ literala)]
   Proof of rule precondition:
   [30.11.0] - 2 < (0 + 0)
```

```
\rightarrow [simplify]
       [30.11.2] true
[30.12] ([\mathbf{false}]: -(-\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) \ / \ 176),
[!false]: asType<integer>(\theta) = ==
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2,
176).quot)
\rightarrow [simplify]
[30.17] 0 == (-\operatorname{div}(\mathbf{heapIs} \ \hat{\mathbf{s}}_{\operatorname{heap}_{\operatorname{funcstart}},724,1}, \ \hat{\mathbf{s}}_{\operatorname{heap}_{\operatorname{funcstart}},724,1}.p2,
176).quot + (\text{$heap}_{funcstart\_724,1}.p2 / 176))
[Assume known post-assertion, class invariant or type constraint for term 27.6]
[31.0] (asType<integer>(heap_{funcstart\_724,1}.p2) %
asType<integer>(176)) == asType<integer>(div(heapIs
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem
\rightarrow [simplify]
[31.2] ($heap<sub>funcstart_724,1.</sub>p2 % 176) == asType<integer>(div(heapIs)
\text{$heap}_{funcstart\_724,1}, \text{$heap}_{funcstart\_724,1}.p2, 176).rem
→ [expand definition of operator '.%' in class 'int' at built in declaration]
[31.3] ([asType<integer>(sheap_{funcstart_{-724,1}.p2}) < 0]:
-(-\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}) \% 176), \ []:
asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176) = =
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2,
176).rem)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[31.4] ([asType<integer>(peqtention = 1.4] ([asType<integer)(peqtention = 1.4) ([asType<integer)(peqte
-(-asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176),
[!(asType < integer > (\$heap_{funcstart\_724.1}.p2) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176) ==
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2,
176).rem)
\rightarrow [simplify]
[31.7] ([0 < -$heap<sub>funcstart_724,1.</sub>p2]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176) ==
asType<integer>(div(heapIs $heap_{tuncstart\_724.1}, $heap_{tuncstart\_724.1}.p2,
\rightarrow [from term 9.0, literala < -$heap<sub>funcstart_724,1</sub>.p2 is false whenever -2 < (0
+ literala)
```

Proof of rule precondition:

```
[31.7.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [31.7.2] true
[31.8] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176),
[!(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176) ==
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2,
176).rem)
\rightarrow [simplify]
[31.11] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p2) \% 176), [!(0
<-$heap<sub>funcstart_724,1.</sub>p2)]: asType<integer>($heap<sub>funcstart_724,1.</sub>p2) %
176) == asType<integer>(div(heapIs $heap_{funcstart\_724,1},)
heap_{funcstart_{-724,1}.p2, 176}.rem
\rightarrow [from term 9.0, literala < -$heap<sub>funcstart_724,1.</sub>p2 is false whenever -2 < (0
+ literala)]
    Proof of rule precondition:
    [31.11.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [31.11.2] true
[31.12] \; ([\mathbf{false}]: \; -(\mathbf{-asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}) \; \% \; 176),
[!false]: asType<integer>($heap<sub>funcstart_724.1.</sub>p2) % 176) ==
\mathbf{asType} < \mathbf{integer} > (\mathbf{div}(\mathbf{heapIs} \ \$ \mathbf{heap}_{funcstart\_724,1}, \ \$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}, \\
176).rem)
\rightarrow [simplify]
[31.17] 0 == (-\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p2},
176).rem + (heap_{funcstart\_724,1}.p2 \% 176)
[Take given term]
[59.0] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1.quot})) \ * \ \mathbf{asType}{<} \mathbf{int}{>} (\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177
[59.1] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}) * asType<int>(\text{Sheap}_{funcstart\_724,1}.\text{r1})) -
(asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
```

```
\rightarrow [simplify]
[59.3] \rho_{1745,8} == \rho_{1745
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
\mathbf{asType} {<} \mathbf{int} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{r1})) - (\mathbf{asType} {<} \mathbf{int} {>} (\mathbf{asType} {<} \mathbf{short}
int>(div1.quot)) * asType<int>($heap_{funcstart\_724,1}.b1)))
\rightarrow [const static or extern object]
[59.4] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
\mathbf{int}{>}((\mathrm{div}(\mathbf{heapIs}\ \$\mathrm{heap}_{funcstart\_724,1},\ \$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},\ 177).\mathrm{rem}\ *
asType < int > (\$heap_{init}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType<int>($heap_{funcstart\_724,1}.b1)))
\rightarrow [expand definition of constant 'r1' at prang.c (15,20)]
[59.5] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType<int>(asType<short int>((int)171))) -
(asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724.1}.b1))))
\rightarrow [simplify]
[59.8] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem * 171)
- (asType<int>(asType<short int>(div1.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1},p1,177}
[59.9] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
\mathbf{int} > ((171 * \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, 177).\operatorname{rem})
- (asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},)
heap_{funcstart_{724,1}}.p1, 177).quot) *
asType < int > (\$heap_{funcstart\_724.1}.b1))))
\rightarrow [simplify]
[59.11] \theta_{13} = \theta_
int>((171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [const static or extern object]
[59.12] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType < int > (\$heap_{init}.b1)))
\rightarrow [expand definition of constant 'b1' at prang.c (17,20)]
```

```
[59.13] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int > ((171 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{short}\ \mathbf{int}{>}((\mathbf{int})2)))))
\rightarrow [simplify]
[59.19] $heap<sub>724,1;745,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
div(\mathbf{heapIs} \ \text{$heap}_{funcstart\_724,1}, \ \text{$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, \ 177).\operatorname{rem})))
[Take given term]
[63.0] $\text{heap}_{724,1:747.8} == $\text{heap}_{724,1:745.8}._\text{replace}(p2 \to \text{asType} < \text{short}
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724,1.745,8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724,1:745,8</sub>.b2))))
\rightarrow [from term 59.19, $heap<sub>724,1;745,8</sub> is equal to
heap_{funcstart_{-724,1}} replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart_{-724,1}}),
heap_{funcstart_{724,1},p1,177}, quot) + (171 * div(heapIs $heap_{funcstart_{724,1}})
heap_{funcstart_{724,1}}.p1, 177).rem)
[63.1] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
(177).rem))._replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724,1:745,8}.r2)) - (asType < int > (asType < short)
\mathbf{int}{>}(\text{div2.quot})) * \mathbf{asType}{<} \mathbf{int}{>} (\$\text{heap}_{724,1;745,8}.\text{b2}))))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1},p2,176}
\mathrm{div}(\mathbf{heapIs}\ \$\mathrm{heap}_{funcstart\_724,1},\ \$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},\ 177).\mathrm{quot}) + (171\ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
(177).rem))).\_replace(p2 \rightarrow asType < short)
int>((asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724.1},
\text{sheap}_{funcstart\_724,1.p2, 176}.\text{rem}) * asType < int > (\text{sheap}_{724,1:745,8}.\text{r2})) -
(asType<int>(asType<short int>(div2.quot)) *
asType < int > (\$heap_{724,1:745.8}.b2))))
\rightarrow [simplify]
[63.4] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem *
asType < int > (\$heap_{724.1:745.8}.r2)) - (asType < int > (asType < short)
```

```
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [from term 59.19, $heap<sub>724,1:745.8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1}, 177).quot) + (171 * div(heapIs $heap_{funcstart\_724,1}, 17
heap_{funcstart_{-724,1}}.p1, 177).rem)
[63.5] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
\rho_{funcstart_{724,1}}, \rho_{funcstart_{724,1}}, \rho_{funcstart_{724,1}}
asType < int > (\$heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * div(heapIs)))))))
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
\$ heap_{funcstart\_724,1}, \$ heap_{funcstart\_724,1}.p1, 177).rem))).r2)) \ -
(asType<int>(asType<short int>(div2.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\${\rm heap}_{724,1;745,8}.{\rm b2}))))
→ [const member of object with modified fields]
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem))).replace(p2 \rightarrow asType < short int > ((div(heapIs)))
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}.p2, 176).rem *
asType < int > (\$heap_{funcstart\_724,1}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType< int>($heap_{724.1:745.8}.b2))))
\rightarrow [const static or extern object]
[63.7] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem *
asType < int > (\$heap_{init}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [expand definition of constant 'r2' at prang.c (20,20)]
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((\operatorname{div}(\mathbf{heapIs}))))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem *
asType<int>(asType<short int>((int)172))) -
(asType<int>(asType<short int>(div2.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{b2}))))
\rightarrow [simplify]
```

```
[63.11] $\text{heap}_{724,1;747,8} == \text{$heap}_{funcstart_724,1}._\text{$\mathbf{replace}$}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\label{eq:div_heap} \text{div}(\textbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
(177).rem))._replace(p2 \rightarrow asType<short int>((div(heapIs)))._replace(p2)
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p2, 176).rem * 172) -
(asType<int>(asType<short int>(div2.quot)) *
asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{tuncstart_{724.1}},
heap_{funcstart_{-724,1}}.p2, 176
[63.12] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem}) -
(asType < int > (asType < short int > (div(heapIs $heap_{funcstart\_724,1}, 
\text{sheap}_{funcstart\_724,1.p2}, 176).\text{quot}) * asType<int>(\text{sheap}_{724,1:745,8}.\text{b2}))))
\rightarrow [simplify]
[63.14] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}. \operatorname{pl},
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p2, 176).quot *
asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [from term 59.19, $heap<sub>724,1;745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1},p1, 177}, quot) + (171 * div(heapIs heap_{funcstart_{724,1},p1, 177})
heap_{funcstart} 724.1.p1, 177).rem))]
[63.15] $\text{heap}_{724,1;747,8} == \text{$heap}_{funcstart\_724,1}._\text{$replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((172 * div(\mathbf{heapIs}
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}.p2, 176).quot
\mathbf{asType}{<}\mathbf{int}{>}(\$\text{heap}_{funcstart\_724,1}.\mathbf{\_replace}(\text{p1} \rightarrow ((\text{-}2 * \text{div}(\mathbf{heapIs}
\text{Sheap}_{funcstart_{-724,1}}, \text{Sheap}_{funcstart_{-724,1}}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\textbf{heapIs})
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 177).rem)).b2))))
\rightarrow [const member of object with modified fields]
[63.16] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
```

```
\theta_{funcstart_{-724,1}}, \theta_{funcstart_{-724,1},p2, 176}.rem) - (div(heapIs)
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}.p2, 176).quot *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b2}))))
\rightarrow [const static or extern object]
[63.17] $\text{heap}_{724,1;747,8} == \text{$heap}_{funcstart\_724,1}._\text{$replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 2, 176).quot *
asType < int > (\$heap_{init}.b2))))
\rightarrow [expand definition of constant 'b2' at prang.c (22,20)]
[63.18] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 2, 176).quot *
asType<int>(asType<short int>((int)35)))))
\rightarrow [simplify]
[63.24] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p2, 176).rem}
[Take goal term]
[1.0] -asType<integer const>($heap_{724,1:747.8}.M2) <
asType<integer>($heap<sub>724,1;747,8</sub>.p2)
\rightarrow [from term 63.24, $heap<sub>724.1:747.8</sub> is equal to
\text{Sheap}_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1}), the sheap funcstart\_724,1).
\text{Sheap}_{funcstart_{724,1},p1, 177}.\text{quot}) + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart_{724,1}})
heap_{funcstart\_724,1}.p1, 177).rem))._replace(p2 \rightarrow (-35 * div(heapIs)))._
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, p2, 176).rem)
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\theta_{funcstart\_724,1}.p2, 176.quot) + (172 * div(heapIs \theta_{funcstart\_724,1},
heap_{funcstart_{724,1}.p2, 176}.rem)).M2) <
```

```
asType<integer>($heap<sub>724.1:747.8</sub>.p2)
\rightarrow [const member of object with modified fields]
[1.3] -asType<integer const>(heap_{funcstart\_724,1}.M2) <
asType<integer>($heap<sub>724,1;747,8</sub>.p2)
\rightarrow [const static or extern object]
[1.4] -asType<integer const>($heap_{init}.M2) <
asType<integer>($heap<sub>724,1;747,8</sub>.p2)
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[1.5] - \mathbf{asType} < \mathbf{integer\ const} > (\mathbf{asType} < \mathbf{short\ int} > ((\mathbf{int})30307)) < \mathbf{asType} < \mathbf{onst} > (\mathbf{onst}) < \mathbf{onst} 
asType < integer > (\$heap_{724,1;747,8}.p2)
\rightarrow [simplify]
[1.9] -30307 < asType < integer > ($heap_{724,1:747.8}.p2)
\rightarrow [from term 63.24, $heap<sub>724,1;747,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs *heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs p_{funcstart\_724,1}),
heap_{funcstart\_724.1}.p1, 177).rem)._replace(p2 \rightarrow (-35 * div(heapIs)))._
heap_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p_{176,rem})
[1.10] -30307 < asType<integer>($heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724.1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724.1},
heap_{funcstart_{724,1},p2, 176}.rem)).p2
\rightarrow [simplify]
[1.12] -30307 < ((-35 * div(heapIs $heap_{funcstart_724.1}, $heap_{funcstart_724.1}.p2,
176).quot) + (172 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart\_724,1}, \text{\$heap}_{funcstart\_724,1}.\text{p2},
176).rem))
\rightarrow [negate goal and search for contradiction]
[1.13] ! (-30307 < ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p2, 176).rem)
\rightarrow [simplify]
[1.18] 30306 < ((35 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p2,
176).quot) + (-172 * \text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p2},
176).rem))
[Copy term 1.18]
[90.0] 30306 < ((-172 * div(heapIs $heap_{funcstart\_724,1},
```

```
\text{Sheap}_{funcstart_{-724,1},p2, 176}.rem) + (35 * div(heapIs \text{Sheap}_{funcstart_{-724,1},p2})
heap_{funcstart_{-724,1},p2, 176}, quot))
\rightarrow [from term 31.17, div(heapIs $heap_{funcstart_724,1}$, $heap_{funcstart_724,1}$,p2,
176).rem is equal to heap_{funcstart\_724,1}.p2 \% 176
[90.1] 30306 < ((-172 * (pap_{funcstart\_724,1}.p2 % 176)) + (35 * div(pap_{funcstart\_724,1}.p2 % 176))
\text{Sheap}_{funcstart_{-724,1}}, \text{Sheap}_{funcstart_{-724,1}}.p2, 176).quot)
[Create new term from term 30.17 using rule: condition for equality of division]
[117.0] ((176 * (0 + -(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1},
\label{eq:heap_funcstart_724,1.p2} \$ \operatorname{heap}_{funcstart_724,1.p2}, \ 176).\operatorname{quot}))) < (1 + \$ \operatorname{heap}_{funcstart_724,1.p2})) \wedge \\
(\text{\$heap}_{funcstart\_724.1}.\text{p2} < (176 * (0 + 1 + -(-\text{div}(\text{heapIs}))))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).quot))))
\rightarrow [simplify]
[117.15] (-1 < ((-176 * div(heapIs \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}})
(-176).quot) + \text{heap}_{funcstart\_724,1}.p2)) \land (-176 < (-\text{heap}_{funcstart\_724,1}.p2 +
(176 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p2, 176).quot)))
[Work on sub-term 2 of conjunction in term 117.15]
[118.0] -1 < ((-176 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p2,
176).quot) + $heap_{funcstart_{-724,1}}.p2)
[Create new term from terms 118.0, 6.0 using rule: transitivity 2]
[157.0] (-30307 + -1 + 1) < (-176 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p2, 176}, quot
\rightarrow [simplify]
[157.1] -30307 < (-176 * div(heapIs $heap<sub>funcstart_724,1</sub>,
heap_{funcstart_{-724,1}}.p2, 176).quot
\rightarrow [literal comparison of product]
[157.2] ([-176 < 0]: (-30307 / 176) < -\text{div}(\text{heapIs } \text{\$heap}_{funcstart\_724,1},
\rho_{tuncstart_{-724,1},p2,176}, quot, \rho_{tuncstart_{-724,1},p2,176}, quot, \rho_{tuncstart_{-724,1},p2,176}
\text{Sheap}_{funcstart_{724,1}}, \text{Sheap}_{funcstart_{724,1}}, \text{p2}, 176).\text{quot}, [-176 == 0]: -30307 <
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[157.3] ([-176 < 0]: (-30307 / 176) < -\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot}, [(0 < -176) \land !(-176 < 0)]: (-30307 / -176)
< \text{div}(\text{heapIs } \text{$heap}_{funcstart\_724,1}, \text{$heap}_{funcstart\_724,1}.p2, 176).quot, [(-176)]
==0) \land !(-176 < 0) \land !(0 < -176)]: -30307 < 0)
\rightarrow [simplify]
[157.7] - 173 < -\text{div}(\textbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p2},
176).quot
[Create new term from terms 157.7, 90.1 using rule: transitivity 5]
```

```
[164.0] 30306 < ((-172 * (\$heap_{funcstart}, 724.1.p2 \% 176)) + (35 * -(-173 + 1)))
\rightarrow [simplify]
[164.5] 24286 < (-172 * ($heap_{funcstart\_724,1}.p2 % 176))
\rightarrow [literal comparison of product]
[164.6] ([-172 < 0]: (24286 / 172) < -(\text{\$heap}_{funcstart\_724,1}.\text{p2} \% 176), [0 < 164.6]
-172]: (24286 / -172) < ($heap_{funcstart\_724,1}.p2 % 176), [-172 == 0]: 24286 <
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[164.7] ([-172 < 0]: (24286 / 172) < -($heap_{funcstart\_724,1}.p2 % 176), [(0 <
-172) \land !(-172 < 0)]: (24286 / -172) < ($heap_{tuncstart_724,1}.p2 % 176), [(-172)]
==0) \land !(-172 < 0) \land !(0 < -172)]: 24286 < 0)
\rightarrow [simplify]
[164.12] false
Proof of verification condition: Type constraint satisfied in explicit
conversion from 'int' to 'short int'
Condition generated at: C:\Escher\Customers\prang\prang.c (65,15)
Condition defined at:
To prove: minof(short int) \le div3.rem
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta
heap_{init}.M2 == asType < short int > ((int)30307)
heap_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
heap_{init}.b2 == asType<short int>((int)35)
\theta = asType < short int > ((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
```

 $\hat{s}_{init}.b3 == asType < short int > ((int)63)$ $\hat{s}_{init}.p1 == asType < short int > ((int)1)$

```
\rho_{init}.p2 == asType < short int > ((int)2)
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart\_724,1})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}))~\%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(asType<integer>($heap_funcstart_724.1.p1) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p1) = =
asType<integer>(div1.rem))
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.quot)
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2})) \ \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.rem)
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2})) =>
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}) ==
asType<integer>(div2.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a2) \le
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})) => !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
```

```
div3 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
(asType<int>(asType<int>($heap_{tuncstart\_724.1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(\mathbf{asType} {<} \mathbf{integer} {>} (\mathbf{asType} {<} \mathbf{int} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3})) \ \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))) ==
asType<integer>(div3.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724.1}.a3)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a3}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType < integer > (div3.quot))
heap_{724,1;745,8} == heap_{funcstart\_724,1}.\_replace(p1 \rightarrow asType < short)
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_tuncstart_724.1.r1)) - (asType<int>(asType<short
\mathbf{int}{>}(\mathbf{div1.quot})) * \mathbf{asType}{<} \mathbf{int}{>} (\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
-asType < integer const > (\$heap_{724,1;745,8}.M1) < 100
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{p1})
!(0 == \mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathrm{heap}_{724,1;745,8}.\mathrm{p1}))
asType < integer > (\$heap_{724,1;745,8}.p1) <
asType<integer>($heap<sub>724.1:745.8</sub>.M1)
\text{heap}_{724.1:747.8} == \text{heap}_{724.1:745.8}._replace(p2 \rightarrow asType<short)
int>((asType<int>(asType<short int>(div2.rem))
asType < int > (\$heap_{724,1;745,8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724,1:745,8</sub>.b2))))
-asType<integer const>($heap<sub>724.1:747.8</sub>.M2) <
asType<integer>($heap<sub>724.1:747.8</sub>.p2)
!(0 == asType < integer > (\$heap_{724,1:747.8}, p2))
asType<integer>($heap<sub>724.1:747.8</sub>.p2) <
asType<integer>($heap<sub>724,1;747,8</sub>.M2)
Proof:
[Take given term]
[5.0] invariant1(heapIs heap_{funcstart\_724,1})
```

```
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
[5.1] ((((((0 < asType < integer > ($heap_{funcstart\_724,1}.p1)) &&
(asType < integer > (\$heap_{funcstart\_724,1}.p1) <
as
Type<integer>(\rho_{funcstart\_724,1}.M1))) & (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
(asType < integer > (\$heap_{funcstart\_724.1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.3] \ (((((0 < \$heap_{funcstart\_724,1}.p1) \&\& \ (\$heap_{funcstart\_724,1}.p1 < (
as
Type<integer>(\rho_{funcstart\_724,1}.M1))) & (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 < funcstart\_724,1.M2))
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})))\ \&\&
(asType<integer>($heap_funcstart_724.1.p3) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.4] (((((0 < $heap_{funcstart_{724,1}}.p1) && ($heap_{funcstart_{724,1}}.p1 < 
asType < integer > (\$heap_{init}.M1))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < \text{heap}_{funcstart\_724,1}.p1) && (\text{heap}_{funcstart\_724,1}.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2})))\ \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p2) < 
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{tuncstart_{-724.1}}.M3))
\rightarrow [simplify]
|5.16| \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \; \land \; (0 < \$heap_{funcstart\_724,1}.p1) \; \land 
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M2})))~\&\&~(0<
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
```

```
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.17] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \; \land \; (0 < \$heap_{funcstart\_724,1}.p1) \; \land 
(0 < \text{\$heap}_{funcstart\_724,1}.\text{p2})) && (\text{\$heap}_{funcstart\_724,1}.\text{p2} <
asType < integer > ($heap_{init}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})))\ \&\&
(asType<integer>($heap_{tuncstart\_724,1}.p3) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -\$heap_{tuncstart\_724.1}.p1) \land (0 < \$heap_{tuncstart\_724.1}.p1) 
(0 < \mathrm{\$heap}_{funcstart\_724,1}.\mathrm{p2})) && ( \mathrm{\$heap}_{funcstart\_724,1}.\mathrm{p2} <
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.30] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{724,1}.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.p3 < asType < integer > (\text{\$heap}_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\theta_{funcstart\_724,1}.p2) \land (0 < \theta_{funcstart\_724,1}.p3)) \&\&
(\text{\$heap}_{funcstart\_724,1}.\text{p3} < \text{asType} < \text{integer} > (\text{\$heap}_{init}.\text{M3}))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \land (-30269 <
 -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1.p2}) \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\$heap_{funcstart\_724,1}.p3 < \mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{short}
int > ((int)30323))
\rightarrow [simplify]
[5.40] (-30323 < -\$heap_{funcstart\_724,1.p3}) \land (-30307 <
-\$heap_{funcstart\_724,1}.p2) \wedge (-30269 < -\$heap_{funcstart\_724,1}.p1) \wedge (0 <
\text{Sheap}_{funcstart\_724,1}.\text{p1}) \land (0 < \text{Sheap}_{funcstart\_724,1}.\text{p2}) \land (0 <
heap_{funcstart_{724,1}.p3}
[Work on sub-term 6 of conjunction in term 5.40]
[10.0] 0 < \text{$heap}_{funcstart\_724,1}.p3
```

```
[Take given term]
[43.0] div3 == div(heapIs $heap<sub>funcstart_724,1</sub>,
asType < int > (\$heap_{funcstart\_724,1}.p3),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
\rightarrow [simplify]
[43.1] div3 == div(heapIs $heap_{funcstart\_724.1}, $heap_{funcstart\_724.1}.p3,
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
\rightarrow [const static or extern object]
[43.2] div3 == div(heapIs $heap_{funcstart\_724.1}, $heap_{funcstart\_724.1}.p3,
asType < int > (\$heap_{init}.a3))
\rightarrow [expand definition of constant 'a3' at prang.c (26,20)]
[43.3] \ \mathrm{div3} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3},
asType<int>(asType<short int>((int)178)))
\rightarrow [simplify]
[43.6] \text{ div3} == \text{div}(\text{heapIs } \text{$heap}_{funcstart\_724,1}, \text{$heap}_{funcstart\_724,1}.p3, 178)
[Assume known post-assertion, class invariant or type constraint for term 43.6]
[47.0] (asType<integer>($heap_{tuncstart\_724.1}.p3) %
asType<integer>(178)) == asType<integer>(div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{rem}
\rightarrow [simplify]
[47.2] (heap_{funcstart\_724,1}.p3 \% 178) == asType<integer>(div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{rem}
→ [expand definition of operator '.%' in class 'int' at built in declaration]
[47.3] ([asType<integer>(sheap_{funcstart\_724,1.p3}) < 0]:
-(-asType < integer > (\$heap_{tuncstart\_724.1}.p3) \% 178), []:
asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178) ==
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3,
178).rem)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[47.4] ([asType<integer>($heap_{funcstart\_724,1}.p3) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724.1}.p3) \% 178),
[!(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178) ==
\mathbf{asType} < \mathbf{integer} > (\mathbf{div}(\mathbf{heapIs} \ \$ \mathbf{heap}_{funcstart\_724,1}, \ \$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}, \\
178).rem)
\rightarrow [simplify]
[47.7] ([0 < -\$heap_{funcstart\_724,1.p3}]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178),
```

```
[!(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178) ==
asType<integer>(div(heapIs p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}),
178).rem)
\rightarrow [from term 10.0, literala < -$heap<sub>funcstart_724.1</sub>.p3 is false whenever -2 <
(0 + literala)
        Proof of rule precondition:
        [47.7.0] - 2 < (0 + 0)
        \rightarrow [simplify]
        [47.7.2] true
[47.8] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178),
[!(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178) = =
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3,
178).rem)
\rightarrow [simplify]
[47.11] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) \; \% \; 178), \; [!(0.12)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.
<-$heap<sub>funcstart_724,1.</sub>p3)]: asType<integer>($heap<sub>funcstart_724,1.</sub>p3) %
178) == asType < integer > (div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p3, 178}.rem
\rightarrow [from term 10.0, literala < -$heap<sub>funcstart_724,1</sub>.p3 is false whenever -2 <
(0 + literala)
        Proof of rule precondition:
        [47.11.0] - 2 < (0 + 0)
        \rightarrow [simplify]
        [47.11.2] true
[47.12] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178),
[!false]: asType<integer>($heap<sub>funcstart_724,1.</sub>p3) % 178) ==
\mathbf{asType} \small{<} \mathbf{integer} \small{>} ( \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}, \\
178).rem)
\rightarrow [simplify]
[47.17] \ 0 == (-\text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p3},
178).rem + (\text{$heap}_{funcstart\_724,1}.p3 \% 178))
[Assume known post-assertion, class invariant or type constraint for term
[54.0] minof(int) \leq div(heapIs \text{$heap}_{funcstart\_724,1}, \text{$heap}_{funcstart\_724,1}.p3,
178).rem
\rightarrow [simplify]
```

```
178).rem
[Take goal term]
[1.0] minof(short int) \leq div3.rem
\rightarrow [simplify]
[1.1] -32768 \le \text{div}3.\text{rem}
\rightarrow [from term 43.6, div3 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p3, 178
[1.2] \ -32768 \le \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3},
178).rem
\rightarrow [simplify]
[1.4] -32769 < div(heapIs $heap_{funcstart_{-724,1}}, $heap_{funcstart_{-724,1}}.p3,
178).rem
\rightarrow [from term 54.3, literala < div(heapIs $heap_{funcstart\_724,1},
\rho_{funcstart_{724,1}.p3, 178}.rem is true whenever (-1 + literala) < -32769
   Proof of rule precondition:
   [1.4.0](-32769 + -1) < -32769
   \rightarrow [simplify]
   [1.4.2] true
[1.5] true
Proof of verification condition: Type constraint satisfied in explicit
conversion from 'int' to 'short int'
Condition generated at: C:\Escher\Customers\prang\prang.c (65,15)
Condition defined at:
To prove: div3.rem \le maxof(short int)
Given:
heap_{init}.LIMIT == (int)80
\theta
\theta
\theta
\theta
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\rho_{init}.r2 == asType < short int > ((int)172)
```

[54.3] -32769 < div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3,

```
\theta_{init}.a2 == asType<short int>((int)176)
\theta
\theta sheap<sub>init</sub>.M3 == asType<short int>((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
heap_{init}.b3 == asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
invariant
1<br/>( \mathbf{heapIs}\ \$ \mathbf{heap}_{funcstart\_724,1})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \ \operatorname{\$heap}_{funcstart\_724,1},
\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(asType<int>(asType<int>($heap_{tuncstart\_724.1}.p1)) /
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}))) = =
asType<integer>(div1.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) ==
asType<integer>(div1.rem))
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) /
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))) ==
asType<integer>(div2.rem)
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) <
```

```
asType < integer > (\$heap_{funcstart_{-724,1}}.a2)) = >
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) ==
asType<integer>(div2.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a2}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
asType < int > (\$heap_{funcstart_{-724,1}}.a3))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(asType<int>(sheap<sub>funcstart_724,1.</sub>p3)) %
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))) ==
asType<integer>(div3.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) ==
asType<integer>(div3.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a3) \le
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})) => !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
\mathbf{asType} \hspace{-0.1em}<\hspace{-0.1em} \mathbf{int} \hspace{-0.1em}> \hspace{-0.1em} (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{r1})) - (\mathbf{asType} \hspace{-0.1em}<\hspace{-0.1em} \mathbf{int} \hspace{-0.1em}> \hspace{-0.1em} (\mathbf{asType} \hspace{-0.1em}<\hspace{-0.1em} \mathbf{short})
int>(div1.quot)) * asType<int>($heap_{funcstart\_724,1}.b1)))
-asType<integer const>($heap<sub>724,1:745,8</sub>.M1) <
asType<integer>($heap<sub>724,1:745,8</sub>.p1)
!(0 == asType < integer > (\$heap_{724,1:745.8}.p1))
asType<integer>($heap<sub>724.1:745.8</sub>.p1) <
asType<integer>($heap<sub>724,1:745,8</sub>.M1)
\$heap_{724,1;747,8} == \$heap_{724,1;745,8}. \textbf{\_replace}(p2 \rightarrow \textbf{asType} < \textbf{short}
int>((asType<int>(asType<short int>(div2.rem)) *
\mathbf{asType} < \mathbf{int} > (\$ heap_{724,1;745,8}.r2)) - (\mathbf{asType} < \mathbf{int} > (\mathbf{asType} < \mathbf{short})
int>(div2.quot)) * asType< int>($heap_{724,1:745,8}.b2))))
-asType<integer const>($heap<sub>724.1:747.8</sub>.M2) <
```

```
asType<integer>($heap<sub>724.1:747.8</sub>.p2)
!(0 == asType < integer > (\$heap_{724,1:747.8} \cdot p2))
asType<integer>($heap<sub>724.1:747.8</sub>.p2) <
asType<integer>($heap<sub>724,1;747,8</sub>.M2)
Proof:
[Take given term]
[5.0] invariant1(heapIs heap_{funcstart\_724,1})
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
 \texttt{[5.1]} \left( \left( \left( \left( (0 < \mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p1) \right) \right. \&\& \right. \right. 
(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 < funcstart\_724,1)
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [simplify]
[5.3] (((((0 < $heap_{funcstart_724,1}.p1) && ($heap_{funcstart_724,1}.p1 < function for the content of the 
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M3}))
\rightarrow [const static or extern object]
asType < integer > (\$heap_{init}.M1))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < $heap_{funcstart_{724,1}}.p1) && ($heap_{funcstart_{724,1}}.p1 < 
\mathbf{asType} \small{<} \mathbf{integer} \small{>} (\mathbf{asType} \small{<} \mathbf{short} \ \mathbf{int} \small{>} ((\mathbf{int})30269)))) \ \&\& \ (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(asType<integer>($heap_{tuncstart\_724.1}.p2) <
```

```
asType<integer>(heap_{funcstart\_724,1}.M2))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.16] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1
(0 < \text{$heap}_{funcstart\_724,1}.p2)) \&\& (\text{$heap}_{funcstart\_724,1}.p2 <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.17] ((((-30269 < -$heap_{funcstart\_724,1}.p1) \lambda (0 < $heap_{funcstart\_724,1}.p1) \lambda
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType < integer > (\$heap_{init}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M3}))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < \text{$heap}_{funcstart\_724,1}.p2)) \&\& (\text{$heap}_{funcstart\_724,1}.p2 <
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.30] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\$heap_{funcstart\_724,1}.p2) \land (0 < \$heap_{funcstart\_724,1}.p3)) \&\&
(\text{\$heap}_{funcstart\_724,1}.\text{p3} < \text{asType} < \text{integer} > (\text{\$heap}_{funcstart\_724,1}.\text{M3}))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -$heap_funcstart_724,1.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1.p2} \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.\text{p3} < \text{asType} < \text{integer} > (\text{\$heap}_{init}.\text{M3}))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \wedge (-30269 <
 -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.p2) \land (0 < \text{Sheap}_{funcstart\_724,1}.p3)) \&\&
(\text{sheap}_{funcstart\_724,1}.\text{p3} < \text{asType} < \text{integer} > (\text{asType} < \text{short})
int > ((int)30323)))
```

```
\rightarrow [simplify]
[5.40] (-30323 < -$heap<sub>funcstart_724,1.</sub>p3) \land (-30307 <
-\$heap_{funcstart\_724,1}.p2) \wedge (-30269 < -\$heap_{funcstart\_724,1}.p1) \wedge (0 <
\text{Sheap}_{funcstart\_724,1}.\text{p1}) \land (0 < \text{Sheap}_{funcstart\_724,1}.\text{p2}) \land (0 <
heap_{funcstart_{-724,1}.p3}
[Work on sub-term 6 of conjunction in term 5.40]
[10.0] \; 0 < \$ heap_{funcstart\_724,1}.p3
[Take given term]
[43.0] div3 == div(heapIs $heap_{funcstart\_724,1},
\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
\rightarrow [simplify]
[43.1] \ \mathrm{div3} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3},
asType < int > (\$heap_{funcstart\_724,1}.a3))
\rightarrow [const static or extern object]
[43.2] \operatorname{div3} == \operatorname{div}(\mathbf{heapIs} \ \operatorname{\$heap}_{funcstart\_724,1}, \ \operatorname{\$heap}_{funcstart\_724,1}.p3,
asType < int > (\$heap_{init}.a3))
\rightarrow [expand definition of constant 'a3' at prang.c (26,20)]
[43.3] \ \mathrm{div3} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3},
asType<int>(asType<short int>((int)178)))
\rightarrow [simplify]
[43.6] div3 == div(heapIs $heap_{funcstart\_724,1}$, $heap_{funcstart\_724,1}.p3, 178)
[Assume known post-assertion, class invariant or type constraint for term 43.6]
[47.0] (asType<integer>(sheap_{funcstart\_724,1.p3}) %
asType<integer>(178)) == asType<integer>(div(heapIs
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem
\rightarrow [simplify]
[47.2] ($heap<sub>funcstart_724,1.</sub>p3 % 178) == asType<integer>(div(heapIs)
\text{$heap}_{funcstart\_724,1}, \text{$heap}_{funcstart\_724,1}.p3, 178).rem
→ [expand definition of operator '.%' in class 'int' at built in declaration]
[47.3] ([asType<integer>(sheap_{funcstart\_724.1}.p3) < 0]:
-(-asType < integer > (\$heap_{tuncstart\_724,1}.p3) \% 178), []:
asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178) ==
asType<integer>(div(heapIs p_{funcstart-724,1}, p_{funcstart-724,1}, p_{funcstart-724,1}),
178).rem)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[47.4] ([asType<integer>(sheap_{funcstart\_724.1}.p3) < 0]:
```

```
-(-asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178),
[!(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) < 0)]:
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})~\%~178) ==
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3,
178).rem)
\rightarrow [simplify]
[47.7] ([0 < -$heap<sub>funcstart_724,1</sub>.p3]:
-(-\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}) \% \ 178),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178) = =
\mathbf{asType} < \mathbf{integer} > (\mathbf{div}(\mathbf{heapIs} \$ \mathbf{heap}_{funcstart\_724,1}, \$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3},
178).rem)
\rightarrow [from term 10.0, literala < -$heap<sub>funcstart_724.1</sub>.p3 is false whenever -2 <
(0 + literala)
    Proof of rule precondition:
    [47.7.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [47.7.2] true
[47.8] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178) ==
\mathbf{asType} < \mathbf{integer} > (\mathbf{div}(\mathbf{heapIs} \ \$ \mathbf{heap}_{funcstart\_724,1}, \ \$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}, \\
178).rem)
\rightarrow [simplify]
[47.11] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178), [!(0)]
<-$heap<sub>funcstart_724,1.</sub>p3)]: asType<integer>($heap<sub>funcstart_724,1.</sub>p3) %
178) == asType<integer>(div(heapIs heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p3}, 178).rem
\rightarrow [from term 10.0, literala < -$heap<sub>funcstart_724,1</sub>.p3 is false whenever -2 <
(0 + literala)
    Proof of rule precondition:
    [47.11.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [47.11.2] true
\textit{[47.12] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178),}
[!false]: asType<integer>(sheap_{funcstart\_724,1.p3}) % 178) ==
\mathbf{asType} < \mathbf{integer} > (\mathbf{div}(\mathbf{heapIs} \ \$ \mathbf{heap}_{funcstart\_724,1}, \ \$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}, \\
178).rem)
```

```
\rightarrow [simplify]
[47.17] 0 == (-\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3},
178).rem + (\text{$heap}_{funcstart\_724,1}.p3 \% 178))
[Assume known post-assertion, class invariant or type constraint for term
47.17
[55.0] div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p3, 178).rem \theta_{funcstart\_724,1}
maxof(int)
\rightarrow [simplify]
[55.9] \ -32768 < -{\rm div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3},
178).rem
[Take goal term]
[1.0] div3.rem \leq maxof(short int)
\rightarrow [from term 43.6, div3 is equal to div(heapIs $heap_{tuncstart\_724.1},
$heap_{funcstart\_724,1}.p3, 178)]
[1.1] div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem \leq
maxof(short int)
\rightarrow [simplify]
 \label{eq:continuous} \mbox{[1.10] -32768} < -\mbox{div}(\mbox{\bf heapIs $$heap}_{funcstart\_724,1}, \mbox{$$sheap}_{funcstart\_724,1}.p3, 
178).rem
\rightarrow [from term 55.9, literala < -div(heapIs $heap_{funcstart\_724,1},
\rho_{funcstart\_724,1}.p3,\ 178).rem is true whenever (-1 + literala) < -32768
    Proof of rule precondition:
    [1.10.0](-32768 + -1) < -32768
    \rightarrow [simplify]
    [1.10.2] true
[1.11] true
Proof of verification condition: Type constraint satisfied in implicit
conversion from 'short int' to 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (65,15)
Condition defined at:
To prove: minof(int) \le asType < short int > (div3.rem)
Given:
heap_{init}.LIMIT == (int)80
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
```

```
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta = asType < short int > ((int)2)
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\theta_{init}.r2 == asType<short int>((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs $heap_{tuncstart_724.1})
div1 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1})) \ / \\
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(\mathbf{asType} {<} \mathbf{integer} {>} (\mathbf{asType} {<} \mathbf{int} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1})) =>
(asType < integer > (\$heap_{funcstart\_724.1}.p1) = =
asType<integer>(div1.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a1) \le
asType < integer > (\$heap_{funcstart\_724,1}.p1)) => !(0 ==
asType < integer > (div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
```

```
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}))\ /
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.quot)
(asType<int>(asType<int>($heap_{funcstart\_724,1}.p2)) %
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p2) = =
asType<integer>(div2.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a2) \le
asType < integer > (\$heap_{funcstart\_724,1}.p2)) => !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart_{-724.1}},
\mathbf{asType} < \mathbf{int} > (\$ heap_{funcstart\_724,1}.p3),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3})) \ / \\
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a3}))) = =
asType<integer>(div3.quot)
(asType<integer>(asType<int>($heap_{tuncstart\_724.1}.p3)) %
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a3}))) = =
asType<integer>(div3.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}) <
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a3})) = >
(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a3}) \leq
\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
heap_{724,1;745,8} == heap_{funcstart\_724,1}.\_replace(p1 \rightarrow asType < short)
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
-asType < integer const > (\$heap_{724,1:745.8}.M1) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{p1})
!(0 == asType < integer > (\$heap_{724,1;745,8}.p1))
```

```
asType<integer>($heap<sub>724.1:745.8</sub>.p1) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{M1})
heap_{724,1:747,8} == heap_{724,1:745,8}.replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724.1:745.8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType< int>($heap_{724,1;745,8}.b2))))
-asType < integer const > (\$heap_{724,1:747,8}.M2) < 
asType<integer>($heap<sub>724.1:747.8</sub>.p2)
!(0 == \mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathrm{heap}_{724,1;747,8}.\mathrm{p2}))
asType<integer>($heap<sub>724.1:747.8</sub>.p2) <
asType<integer>($heap<sub>724,1:747,8</sub>.M2)
Proof:
[Take given term]
[5.0] invariant1(heapIs heap_{funcstart\_724.1})
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
[5.1] ((((((0 < asType < integer > (heap_{funcstart_{-724,1}}.p1)) &&
(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 
as
Type<integer>($heap_{funcstart\_724,1}.M1))) && (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2})))\ \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p2) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M2})))~\&\&~(0<
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.3] (((((0 < \text{heap}_{funcstart\_724,1}.p1) && (\text{heap}_{funcstart\_724,1}.p1 <
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2})))\ \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p2) <
\mathbf{asType} \small{<} \mathbf{integer} \small{>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M2}))) \ \&\& \ (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M3}))
\rightarrow [const static or extern object]
[5.4] \ (((((0 < \text{\$heap}_{funcstart\_724,1}.\text{p1}) \&\& \ (\text{\$heap}_{funcstart\_724,1}.\text{p1} <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{init}.\mathrm{M1})))~\&\&~(0<
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})))\ \&\&
```

```
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < $heap_{funcstart_{724,1}}.p1) && ($heap_{funcstart_{724,1}}.p1 < 
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [simplify]
[5.16] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \; \land \; (0 < \$heap_{funcstart\_724,1}.p1) \; \land 
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M3}))
\rightarrow [const static or extern object]
\label{eq:final_start_724,1.p1} [(((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$he
(0 < \text{$heap}_{funcstart\_724,1}.p2)) \&\& (\text{$heap}_{funcstart\_724,1}.p2 < 
asType < integer > (\$heap_{init}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType < integer > (asType < short int > ((int)30307)))) && (0 < integer) && (0 < integer
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M3}))
\rightarrow [simplify]
[5.30] ((-30307 < -$heap_{funcstart\_724,1}.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{-724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{-724,1}.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.\text{p3} < \text{asType} < \text{integer} > (\text{\$heap}_{funcstart\_724,1}.\text{M3}))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -\$heap_{funcstart\_724,1}.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{724,1}.p3})) \&\&
```

```
(\text{\$heap}_{funcstart\_724,1}.p3 < asType < integer > (\text{\$heap}_{init}.M3))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap_funcstart_724,1.p2) \land (-30269 <
-\$ heap_{funcstart\_724,1}.p1) \land (0 < \$ heap_{funcstart\_724,1}.p1) \land (0 < \$ heap_{funcstart\_724,1}.p1) \land (0 < \$ heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1.p2}) \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\text{sheap}_{funcstart\_724.1}.p3 < asType < integer > (asType < short)
int > ((int)30323)))
\rightarrow [simplify]
[5.40] (-30323 < -$heap_{funcstart\_724,1}.p3) \land (-30307 <
-\$heap_{funcstart\_724,1}.p2) \land (-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < -\$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{-724,1},p1} \land (0 < \text{Sheap}_{funcstart_{-724,1},p2}) \land (0 <
heap_{funcstart_{-724,1}.p3}
[Work on sub-term 6 of conjunction in term 5.40]
[10.0] 0 < $\text{heap}_{funcstart_724,1.p3}$
[Take given term]
[43.0] div3 == div(heapIs $heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
asType < int > (\$heap_{funcstart\_724,1}.a3))
\rightarrow [simplify]
[43.1] div3 == div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p3,
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
\rightarrow [const static or extern object]
[43.2] div3 == div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p3,
asType < int > (\$heap_{init}.a3))
\rightarrow [expand definition of constant 'a3' at prang.c (26,20)]
[43.3] \ \mathrm{div3} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3},
asType<int>(asType<short int>((int)178)))
\rightarrow [simplify]
[43.6] div3 == div(heapIs $heap_{funcstart\_724,1}$, $heap_{funcstart\_724,1}.p3, 178)
[Assume known post-assertion, class invariant or type constraint for term 43.6]
[47.0] (asType<integer>(sheap_{funcstart}_724.1.p3) %
asType < integer > (178)) == asType < integer > (div(heapIs))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{rem}
\rightarrow [simplify]
[47.2] (heap_{funcstart\_724,1}.p3 \% 178) == asType<integer>(div(heapIs
\text{$heap}_{funcstart\_724,1}, \text{$heap}_{funcstart\_724,1}.p3, 178).rem
→ [expand definition of operator '.%' in class 'int' at built in declaration]
```

```
[47.3] \; ([\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178), []:
asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178) ==
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3,
178).rem)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[47.4] \; ([\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) < 0] :
-(-\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}) \% \ 178),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178) ==
asType<integer>(div(heapIs $heap_{tuncstart\_724.1}, $heap_{tuncstart\_724.1}.p3,
178).rem)
\rightarrow [simplify]
[47.7] ([0 < -$heap<sub>funcstart_724,1</sub>.p3]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178),
[!(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178) = =
asType<integer>(div(heapIs p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}),
178).rem)
\rightarrow [from term 10.0, literala < -$heap<sub>funcstart_724.1</sub>.p3 is false whenever -2 <
(0 + literala)
   Proof of rule precondition:
   [47.7.0] - 2 < (0 + 0)
   \rightarrow [simplify]
   [47.7.2] true
[47.8] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 0)]:
asType < integer > (\$heap_{funcstart\_724.1}.p3) \% 178) = =
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3,
178).rem)
\rightarrow [simplify]
[47.11] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178), [!(0
< -$heap<sub>funcstart_724.1.</sub>p3)]: asType<integer>($heap<sub>funcstart_724.1.</sub>p3) %
178) == asType < integer > (div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p3, 178}.rem
\rightarrow [from term 10.0, literala < –$heap_funcstart_724,1.p3 is false whenever -2 <
(0 + literala)
   Proof of rule precondition:
   [47.11.0] - 2 < (0 + 0)
```

```
\rightarrow [simplify]
    [47.11.2] true
[47.12] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}) \; \% \; 178),
[!false]: asType<integer>($heap_{funcstart\_724,1}.p3) % 178) ==
asType < integer > (div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3,
178).rem)
\rightarrow [simplify]
[47.17] 0 == (-\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3},
178).rem + (\text{$heap}_{funcstart\_724,1}.p3 \% 178))
[Assume known post-assertion, class invariant or type constraint for term
47.17
[54.0] \ \mathbf{minof(int)} \leq \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3},
178).rem
\rightarrow [simplify]
\label{eq:continuous} \textit{[54.3] -32769} < \text{div}(\textbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p3},
178).rem
[Take goal term]
[1.0] minof(int) \leq asType<short int>(div3.rem)
\rightarrow [simplify]
[1.1] -32768 \leq asType<short int>(div3.rem)
\rightarrow [from term 43.6, div3 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p3, 178
[1.2] -32768 \leq asType<short int>(div(heapIs $heap_{tuncstart\_724,1},)
heap_{funcstart_{-724,1}.p3, 178}.rem
\rightarrow [simplify]
[1.5] -32769 < div(heapIs $heap_{funcstart_724,1}, $heap_{funcstart_724,1}.p3,
178).rem
\rightarrow [from term 54.3, literala < div(heapIs $heap<sub>funcstart_724,1</sub>,
heap_{funcstart\_724,1}.p3, 178.rem is true whenever (-1 + literala) < -32769
    Proof of rule precondition:
    [1.5.0](-32769 + -1) < -32769
    \rightarrow [simplify]
    [1.5.2] true
[1.6] true
```

Proof of verification condition: Type constraint satisfied in implicit

```
Condition generated at: C:\Escher\Customers\prang\prang.c (65,15)
Condition defined at:
To prove: asType<short int>(div3.rem) \leq maxof(int)
Given:
heap_{init}.LIMIT == (int)80
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
\theta
\theta
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\theta_{init}.r2 == asType<short int>((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart_{-724.1}})
div1 == div(\mathbf{heapIs} \$ heap_{funcstart_{-724.1}},
asType < int > (\$heap_{funcstart\_724,1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ / \ 
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}))) = =
asType<integer>(div1.quot)
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \%
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}))) = =
asType<integer>(div1.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p1) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1})) =>
(asType < integer > (\$heap_{funcstart\_724,1}.p1) = =
asType<integer>(div1.rem))
```

conversion from 'short int' to 'int'

```
(asType < integer > (\$heap_{funcstart_{-724,1}}.a1) \le
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2})) \ / \ 
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724.1}.p2)) \%
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p2) = =
asType<integer>(div2.rem))
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}),
asType < int > (\$heap_{funcstart\_724,1}.a3))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}))~\%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))) ==
asType<integer>(div3.rem)
(asType<integer>($heap_funcstart_724.1.p3) <
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a3})) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a3) \le
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})) => !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
```

```
asType<integer>(div3.quot))
$heap_{724,1;745,8} == $heap_{funcstart\_724,1}.\_replace(p1 \rightarrow asType < short)
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType<int>($heap_{funcstart\_724,1}.b1)))
-asType < integer\ const > (\$heap_{724,1;745,8}.M1) < 
asType<integer>($heap<sub>724,1:745,8</sub>.p1)
!(0 == asType < integer > (\$heap_{724,1;745,8}.p1))
asType<integer>($heap<sub>724.1:745.8</sub>.p1) <
asType<integer>($heap<sub>724.1:745.8</sub>.M1)
\$heap_{724,1;747,8} == \$heap_{724,1;745,8}.\mathbf{replace}(p2 \rightarrow \mathbf{asType} {<} \mathbf{short}
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724,1:745,8}.r2)) - (asType < int > (asType < short)
\mathbf{int}{>}(\text{div2.quot})) \ * \ \mathbf{asType}{<} \mathbf{int}{>} (\$\text{heap}_{724,1;745,8}.\text{b2}))))
-asType<integer const>($heap<sub>724.1:747.8</sub>.M2) <
asType<integer>($heap<sub>724.1:747.8</sub>.p2)
!(0 == asType < integer > (\$heap_{724,1:747.8}.p2))
asType<integer>($heap<sub>724.1:747.8</sub>.p2) <
asType<integer>($heap<sub>724.1:747.8</sub>.M2)
Proof:
[Take given term]
[5.0] invariant1(heapIs heap_{funcstart\_724,1})
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
 \texttt{[5.1]} \left( \left( \left( \left( \left( 0 < \mathbf{asType} < \mathbf{integer} > \left( \$ \mathsf{heap}_{funcstart\_724,1}.\mathsf{p1} \right) \right) \right. \&\& \right. \right. 
(asType < integer > (\$heap_{funcstart\_724,1}.p1) <
asType<integer>(sheap_{funcstart_{-724,1}}.M1))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.3] (((((0 < $heap_{funcstart\_724,1}.p1) && ($heap_{funcstart\_724,1}.p1 < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M1})))~\&\&~(0<
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p2) < 
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
```

```
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.4] \ (((((0 < \text{\$heap}_{funcstart\_724,1}.\text{p1}) \&\& \ (\text{\$heap}_{funcstart\_724,1}.\text{p1} <
asType<integer>(heap_{init}.M1))) && (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2})))\ \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) <
\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < $heap_{funcstart_724,1}.p1) && ($heap_{funcstart_724,1}.p1 < function for the content of the 
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
(asType < integer > (\$heap_{funcstart_{-724,1}}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.16] ((((-30269 < -$heap_{funcstart\_724,1}.p1) \lambda (0 < $heap_{funcstart\_724,1}.p1) \lambda
(0 < \$ heap_{funcstart\_724,1}.p2)) && (\$ heap_{funcstart\_724,1}.p2 <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.17] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \; \land \; (0 < \$heap_{funcstart\_724,1}.p1) \; \land 
(0 < \text{$heap}_{funcstart\_724,1}.p2)) \&\& (\text{$heap}_{funcstart\_724,1}.p2 <
asType < integer > (\$heap_{init}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M3}))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > (\$heap_{funcstart\_724.1}.p3) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
```

```
\rightarrow [simplify]
[5.30] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \wedge (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1.p2} \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\$heap_{funcstart\_724,1}.p3 < \mathbf{asType} < \mathbf{integer} > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -\$heap_{funcstart\_724,1}.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.p2) \land (0 < \text{Sheap}_{funcstart\_724,1}.p3)) \&\&
(\text{\$heap}_{funcstart\_724,1}.p3 < asType < integer > (\text{\$heap}_{init}.M3))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1.p2} \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\$heap_{funcstart\_724,1}.p3 < \textbf{asType} < \textbf{integer} > (\textbf{asType} < \textbf{short}
int > ((int)30323)))
\rightarrow [simplify]
[5.40] (-30323 < -$heap<sub>funcstart_724,1.</sub>p3) \land (-30307 <
-\$heap_{funcstart\_724,1}.p2) \wedge (-30269 < -\$heap_{funcstart\_724,1}.p1) \wedge (0 <
\text{Sheap}_{funcstart\_724,1}.\text{p1}) \land (0 < \text{Sheap}_{funcstart\_724,1}.\text{p2}) \land (0 <
heap_{funcstart\_724,1}.p3
[Work on sub-term 6 of conjunction in term 5.40]
\textit{[10.0]}~0 < \$ heap_{funcstart\_724,1}.p3
[Take given term]
[43.0] div3 == div(heapIs $heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
asType < int > (\$heap_{funcstart\_724,1}.a3))
\rightarrow [simplify]
[43.1] \ \mathrm{div3} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3},
asType < int > (\$heap_{funcstart\_724,1}.a3))
\rightarrow [const static or extern object]
[43.2] \ \mathrm{div3} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3},
asType < int > (\$heap_{init}.a3))
\rightarrow [expand definition of constant 'a3' at prang.c (26,20)]
[43.3] \ \mathrm{div3} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3},
asType<int>(asType<short int>((int)178)))
\rightarrow [simplify]
[43.6] \text{ div3} == \text{div}(\text{heapIs } \text{$heap}_{funcstart\_724,1}, \text{$heap}_{funcstart\_724,1}.\text{p3}, 178)
```

```
[Assume known post-assertion, class invariant or type constraint for term 43.6]
[47.0] (asType<integer>(sheap_{funcstart\_724,1}.p3) %
asType<integer>(178)) == asType<integer>(div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{rem}
\rightarrow [simplify]
[47.2] ($heap<sub>funcstart_724,1.</sub>p3 % 178) == asType<integer>(div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{rem}
→ [expand definition of operator '.%' in class 'int' at built in declaration]
[47.3] \; ([\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) < 0] :
-(-asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178), []:
asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178) ==
asType<integer>(div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3,
178).rem)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[47.4] ([asType<integer>(sheap_{funcstart_{-724,1}.p3}) < 0]:
-(-\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}) \% \ 178),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178) ==
\mathbf{asType} {<} \mathbf{integer} {>} ( \mathbf{div} (\mathbf{heapIs} \ \$ \mathbf{heap}_{funcstart\_724,1}, \ \$ \mathbf{heap}_{funcstart\_724,1}. \mathbf{p3}, \\
178).rem)
\rightarrow [simplify]
[47.7] ([0 < -$heap<sub>funcstart_724,1</sub>.p3]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 0)]:
asType < integer > (\$heap_{funcstart-724,1}.p3) \% 178) ==
asType<integer>(div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p3,
178).rem)
\rightarrow [from term 10.0, literala < -$heap<sub>funcstart-724.1</sub>.p3 is false whenever -2 <
(0 + literala)
    Proof of rule precondition:
    [47.7.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [47.7.2] true
[47.8] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}) \; \% \; 178),
[!(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178) = =
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3,
178).rem)
\rightarrow [simplify]
```

```
[47.11] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) \; \% \; 178), \; [!(0.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \;
<-$heap<sub>funcstart_724,1.</sub>p3)]: asType<integer>($heap<sub>funcstart_724,1.</sub>p3) %
178) == asType<integer>(div(heapIs heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p3, 178}.rem
\rightarrow [from term 10.0, literala < -$heap<sub>funcstart_724.1</sub>.p3 is false whenever -2 <
(0 + literala)
        Proof of rule precondition:
        [47.11.0] - 2 < (0 + 0)
        \rightarrow [simplify]
        [47.11.2] true
[47.12] ([\mathbf{false}]: -(-\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) \% 178),
[!false]: asType<integer>(p_{funcstart\_724,1}.p3) % 178) ==
asType<integer>(div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p3,
178).rem)
\rightarrow [simplify]
[47.17] 0 == (-\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3},
178).rem + (\text{$heap}_{funcstart\_724,1}.p3 \% 178))
[Assume known post-assertion, class invariant or type constraint for term
47.17
[55.0] div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem \leq
maxof(int)
\rightarrow [simplify]
[55.9] -32768 < -\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.p3,
178).rem
[Take goal term]
[1.0] asType<short int>(div3.rem) \le maxof(int)
\rightarrow [from term 43.6, div3 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p3, 178
[1.1] asType<short int>(div(heapIs $heap_{funcstart_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{rem} \leq \text{maxof(int)}
\rightarrow [simplify]
[1.11] -32768 < -\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.p3,
178).rem
\rightarrow [from term 55.9, literala < -\text{div}(\text{heapIs }\$\text{heap}_{funcstart\_724,1},
heap_{funcstart\_724,1}.p3, 178.rem is true whenever (-1 + literala) < -32768
        Proof of rule precondition:
        [1.11.0](-32768 + -1) < -32768
```

```
[1.11.2] true
[1.12] true
Proof of verification condition: Type constraint satisfied in implicit
conversion from 'short int const' to 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (65,10)
Condition defined at:
To prove: minof(int) \leq \$heap_{724,1;747,8}.r3
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
heap_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta = asType < short int > ((int)2)
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
\theta sheap<sub>init</sub>.a2 == asType<short int>((int)176)
\theta
heap_{init}.M3 == asType < short int > ((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart_{-724,1}})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(\mathbf{asType} {<} \mathbf{int} {>} (\mathbf{asType} {<} \mathbf{int} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ \%
```

 \rightarrow [simplify]

```
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p1) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(asType < integer > (\$heap_{funcstart\_724.1}.p1) = =
asType<integer>(div1.rem))
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
(asType<integer>(asType<int>($heap_{tuncstart\_724.1}.p2)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724.1}.a2))) = =
asType<integer>(div2.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}) ==
asType<integer>(div2.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a2}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
\mathrm{div3} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1},
asType < int > ($heap_{funcstart\_724,1}.p3),
asType < int > (\$heap_{funcstart\_724,1}.a3))
(asType<int>(sheap<sub>funcstart_724.1</sub>.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a3})) = {>}
```

```
(asType < integer > (\$heap_{funcstart_{-724,1}}.p3) = =
asType<integer>(div3.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a3}) \leq
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})) => !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
\$ heap_{724,1;745,8} == \$ heap_{funcstart\_724,1}.\_\textbf{replace}(p1 \rightarrow \textbf{asType} < \textbf{short}
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
-asType < integer const > (\$heap_{724,1:745.8}.M1) < 
asType<integer>($heap<sub>724.1:745.8</sub>.p1)
!(0 == asType < integer > (\$heap_{724,1:745.8}, p1))
\mathbf{asType}{<}\mathbf{integer}{>}(\${heap}_{724,1;745,8}.p1) <
asType < integer > (\$heap_{724,1;745,8}.M1)
heap_{724,1:747,8} == heap_{724,1:745,8}.replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724,1:745,8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724,1:745,8</sub>.b2))))
-asType<integer const>($heap<sub>724.1:747.8</sub>.M2) <
\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{724,1;747,8}.\mathrm{p2})
!(0 == asType < integer > (\$heap_{724,1;747,8}.p2))
asType<integer>($heap<sub>724.1:747.8</sub>.p2) <
asType<integer>($heap<sub>724,1:747,8</sub>.M2)
Proof:
[Take given term]
[11.0] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
\rightarrow [simplify]
[11.1] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType < int > (\$heap_{funcstart\_724,1}.a1))
\rightarrow [const static or extern object]
[11.2] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType < int > (\$heap_{init}.a1))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
[11.3] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
```

```
asType<int>(asType<short int>((int)177)))
\rightarrow [simplify]
[11.6] div1 == div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177)
[Take given term]
[27.0] div2 == div(heapIs heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
\rightarrow [simplify]
[27.1] div2 == div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2,
asType < int > (\$heap_{funcstart\_724.1}.a2))
\rightarrow [const static or extern object]
[27.2] div2 == div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p2,
asType < int > (\$heap_{init}.a2))
\rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
\label{eq:continuous} \mbox{[27.3]} \mbox{ div2} == \mbox{div}(\mbox{\bf heapIs} \mbox{ \$heap}_{funcstart\_724,1}, \mbox{ \$heap}_{funcstart\_724,1}.\mbox{p2},
asType<int>(asType<short int>((int)176)))
\rightarrow [simplify]
[27.6] div2 == div(heapIs $heap<sub>funcstart_724,1</sub>, $heap<sub>funcstart_724,1</sub>.p2, 176)
[Take given term]
[59.0] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1.quot})) * \mathbf{asType}{<} \mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1},p1,177}
[59.1] \theta == 
int>((asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},))
\rho_{tuncstart\_724,1.p1, 177}.rem) * asType < int > (\rho_{tuncstart\_724,1.r1}) - (\rho_{tuncstart\_724,1.r1}
(asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724,1}.b1)))
\rightarrow [simplify]
[59.3] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
\mathbf{asType} \small{<} \mathbf{int} \small{>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{r1})) \\ - (\mathbf{asType} \small{<} \mathbf{int} \small{>} (\mathbf{asType} \small{<} \mathbf{short}
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
\rightarrow [const static or extern object]
[59.4] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
```

```
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
\mathbf{asType} {<} \mathbf{int} {>} (\$ \mathbf{heap}_{init}.\mathbf{r1})) - (\mathbf{asType} {<} \mathbf{int} {>} (\mathbf{asType} {<} \mathbf{short}
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
\rightarrow [expand definition of constant 'r1' at prang.c (15,20)]
[59.5] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType<int>(asType<short int>((int)171))) -
(asType<int>(asType<short int>(div1.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [simplify]
[59.8] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem * 171)
- (asType<int>(asType<short int>(div1.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart_{724.1}},
heap_{funcstart_{-724,1}}.p1, 177
[59.9] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).rem)
- (asType < int > (asType < short int > (div(heapIs $heap_{funcstart\_724,1}, 
heap_{funcstart_{-724,1}}.p1, 177).quot) *
asType < int > (\$heap_{funcstart\_724,1}.b1)))
\rightarrow [simplify]
[59.11] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType < int > (\$heap_{funcstart\_724,1}.b1)))
\rightarrow [const static or extern object]
\textit{[59.12]} \$ heap_{724,1;745,8} == \$ heap_{funcstart\_724,1}.\_\textbf{replace}(p1 \rightarrow \textbf{asType} < \textbf{short}
int>((171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType < int > (\$heap_{init}.b1))))
\rightarrow [expand definition of constant 'b1' at prang.c (17,20)]
[59.13] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\textbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType<int>(asType<short int>((int)2))))
\rightarrow [simplify]
[59.19] $\text{heap}_{724,1;745,8} == \text{$heap}_{funcstart\_724,1}._\text{$replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, \ 177).\operatorname{rem})))
```

```
[Take given term]
[63.0] $\text{heap}_{724,1:747,8} == $\text{heap}_{724,1:745,8}._\text{replace}(p2 \to \text{asType} < \text{short}
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724.1:745.8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [from term 59.19, $heap<sub>724.1:745.8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724,1}),
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs p_{funcstart\_724,1})
$heap_{funcstart\_724,1}.p1, 177).rem))]
[63.1] $\text{heap}_{724,1;747,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem))).\_replace(p2 \rightarrow asType < short
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724.1:745.8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType< int>($heap_{724,1:745,8}.b2))))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{funcstart_724,1},
\$heap_{funcstart\_724,1}.p2,\ 176)]
[63.2] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
(177).rem))._replace(p2 \rightarrow asType < short)
int>((asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},
\text{sheap}_{funcstart=724,1}.\text{p2}, 176).\text{rem}) * asType<int>(\text{sheap}_{724,1:745,8}.\text{r2})) -
(asType<int>(asType<short int>(div2.quot)) *
asType<int>($heap<sub>724,1;745,8</sub>.b2))))
\rightarrow [simplify]
[63.4] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724.1}, \ \$heap_{funcstart\_724.1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
(177).rem))._replace(p2 \rightarrow asType<short int>((div(heapIs)))._replace(p2)
\rho_{funcstart_{724,1}}, \rho_{funcstart_{724,1},p2, 176}.rem *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{724,1:745,8}.\mathrm{r2})) - (\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{short}
int>(div2.quot)) * asType< int>($heap_{724,1;745,8}.b2))))
\rightarrow [from term 59.19, $heap<sub>724,1;745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1},p1,177,rem}
[63.5] $heap<sub>724,1:747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\label{eq:div_heap} \text{div}(\textbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
(177).rem))._replace(p2 \rightarrow asType<short int>((div(heapIs
```

```
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem *
\mathbf{asType} \small{<} \mathbf{int} \small{>} (\$ \mathbf{heap}_{funcstart\_724,1}. \_\mathbf{replace} (\mathtt{p1} \rightarrow ((-2 * \operatorname{div}(\mathbf{heapIs}
\$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).quot) + (171 * div(\textbf{heapIs}) + (171 * div(\textbf{heapIs})) + (171
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).rem))).r2)) -
(asType<int>(asType<short int>(div2.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{b2}))))
→ [const member of object with modified fields]
[63.6] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((\operatorname{div}(\mathbf{heapIs}))))
\rho_{funcstart\_724,1}, \rho_{funcstart\_724,1.p2, 176}.rem *
asType < int > (\$heap_{funcstart\_724,1}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType< int>($heap_{724,1;745,8}.b2))))
\rightarrow [const static or extern object]
[63.7] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((\operatorname{div}(\mathbf{heapIs}))))
\rho_{funcstart_{-724,1}}, \rho_{funcstart_{-724,1}}, \rho_{funcstart_{-724,1}}, \rho_{funcstart_{-724,1}}, \rho_{funcstart_{-724,1}}
asType < int > (\$heap_{init}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [expand definition of constant 'r2' at prang.c (20,20)]
[63.8] $heap<sub>724,1:747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((\operatorname{div}(\mathbf{heapIs}))))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem *
asType<int>(asType<short int>((int)172))) -
(asType<int>(asType<short int>(div2.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{b2}))))
\rightarrow [simplify]
[63.11] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((\operatorname{div}(\mathbf{heapIs}))))
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}.p2, 176).rem * 172) -
(asType<int>(asType<short int>(div2.quot)) *
asType < int > (\$heap_{724.1:745.8}.b2))))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1},p2,176}
```

```
[63.12] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\label{eq:div_heap} \text{div}(\textbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem) -
(asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},
\text{sheap}_{funcstart\_724,1.p2}, 176).\text{quot}) * asType<int>(\text{sheap}_{724,1;745,8}.\text{b2}))))
\rightarrow [simplify]
[63.14] $\text{heap}_{724,1:747,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\label{eq:div_heap} \text{div}(\textbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}.p2, 176).quot *
asType < int > (\$heap_{724,1;745,8}.b2))))
\rightarrow [from term 59.19, $heap<sub>724,1;745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart_{-724,1},p1, 177}.\text{quot}) + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart_{-724,1}})
heap_{funcstart_{724,1}}.p1, 177).rem)
[63.15] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem}) - (\text{div}(\text{heapIs}))
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1},p2,176}.quot *
\mathbf{asType}{<}\mathbf{int}{>}(\$\text{heap}_{funcstart\_724,1}.\mathbf{\_replace}(\text{p1} \rightarrow ((\text{-}2 * \text{div}(\mathbf{heapIs}
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs})
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).rem))).b2))))
\rightarrow [const member of object with modified fields]
[63.16] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((172 * div(\mathbf{heapIs}))))
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}.p2, 176).quot *
asType < int > (\$heap_{funcstart\_724,1}.b2))))
\rightarrow [const static or extern object]
[63.17] $\text{heap}_{724,1;747,8} == $\text{heap}_{funcstart_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((172 * div(\mathbf{heapIs}))))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem}) - (\text{div}(\text{heapIs})
```

```
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}.p2, 176).quot *
asType < int > (\$heap_{init}.b2))))
\rightarrow [expand definition of constant 'b2' at prang.c (22,20)]
[63.18] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 2, 176).quot *
asType<int>(asType<short int>((int)35)))))
\rightarrow [simplify]
[63.24] $\text{heap}_{724,1;747,8} == \text{$heap}_{funcstart\_724,1}._\text{$replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p2, 176).rem)
[Take goal term]
\textit{[1.0]}\;\mathbf{minof(int)} \leq \$\mathrm{heap}_{724,1;747,8}.\mathrm{r3}
\rightarrow [simplify]
[1.1] -32768 \leq $heap<sub>724.1:747.8</sub>.r3
\rightarrow [from term 63.24, $heap<sub>724,1;747,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1}, 177).quot) + (171 * div(heapIs $heap_{funcstart\_724,1}, 177).quot)
heap_{funcstart\_724,1}.p1, 177).rem))._replace(p2 \rightarrow (-35 * div(\mathbf{heapIs})))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart_{724.1}}, heap_{funcstart_{724.1}}, 2, 176).rem
[1.2] -32768 \le \text{$heap}_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs})
\rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}
* div(\mathbf{heapIs} \ \$ heap_{funcstart\_724,1}, \ \$ heap_{funcstart\_724,1}.p2, \ 176).quot) + (172 \ *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p2, \ 176).rem))).r3
\rightarrow [const member of object with modified fields]
[1.4] -32768 \leq $heap<sub>funcstart_724,1</sub>.r3
\rightarrow [const static or extern object]
[1.5] -32768 < \text{$heap}_{init}.r3
\rightarrow [expand definition of constant 'r3' at prang.c (25,20)]
[1.6] - 32768 \le asType \le short int > ((int)170)
```

```
\rightarrow [simplify]
[1.9] true
Proof of verification condition: Type constraint satisfied in implicit
conversion from 'short int const' to 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (65,10)
Condition defined at:
To prove: heap_{724,1:747,8}.r3 \le maxof(int)
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta
heap_{init}.M2 == asType < short int > ((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta == asType<short int>((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
heap_{init}.b3 == asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart_{-724,1}})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724.1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}))~\%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
```

```
(asType < integer > (\$heap_{funcstart\_724,1}.p1) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) = =
asType<integer>(div1.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a1) \le
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType < integer > (div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p2})) \ / \\
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.quot)
(asType<int>(asType<int>($heap_{funcstart\_724,1}.p2)) %
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(asType < integer > (\$heap_{funcstart\ 724.1}.p2) = =
asType<integer>(div2.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a2) \le
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})) => !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart_{-724.1}},
asType < int > (\$heap_{funcstart\_724,1}.p3),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p3})) \ / \\
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}))~\%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a3}))) = =
asType<integer>(div3.rem)
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}) ==
asType<integer>(div3.rem))
```

```
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.a3) \leq
\mathbf{asType} \small{<} \mathbf{integer} \small{>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3})) => !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType < integer > (div3.quot))
$heap_{724,1;745,8} == $heap_{funcstart\_724,1}.\_replace(p1 \rightarrow asType < short)
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
-asType<integer const>($heap<sub>724,1;745,8</sub>.M1) <
asType<integer>($heap<sub>724,1:745,8</sub>.p1)
!(0 == asType < integer > (\$heap_{724,1:745.8}.p1))
asType<integer>($heap<sub>724,1:745,8</sub>.p1) <
asType<integer>($heap<sub>724,1:745,8</sub>.M1)
heap_{724,1;747,8} == heap_{724,1;745,8}.replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724.1:745.8}.r2)) - (asType < int > (asType < short)
\mathbf{int}{>}(\text{div2.quot})) * \mathbf{asType}{<} \mathbf{int}{>} (\$\text{heap}_{724,1;745,8}.\text{b2}))))
-\mathbf{asType}{<}\mathbf{integer}\ \mathbf{const}{>}(\$\mathrm{heap}_{724,1;747,8}.\mathrm{M2}) <
asType<integer>($heap<sub>724,1:747,8</sub>.p2)
!(0 == asType < integer > (\$heap_{724,1;747,8}.p2))
asType<integer>($heap<sub>724,1:747,8</sub>.p2) <
asType<integer>($heap<sub>724,1;747,8</sub>.M2)
Proof:
[Take given term]
[11.0] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
\rightarrow [simplify]
[11.1] \text{ div1} == \text{div}(\mathbf{heapIs} \$ heap_{funcstart\_724,1}, \$ heap_{funcstart\_724,1}.p1,
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
\rightarrow [const static or extern object]
[11.2] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType < int > (\$heap_{init}.a1))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
[11.3] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType<int>(asType<short int>((int)177)))
\rightarrow [simplify]
```

```
[11.6] div1 == div(heapIs \theta_{funcstart_{-724,1}}, \theta_{funcstart_{-724,1}}, p1, 177)
[Take given term]
[27.0] \operatorname{div2} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
\rightarrow [simplify]
[27.1] div2 == div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2,
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
\rightarrow [const static or extern object]
[27.2] \text{ div2} == \text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p2},
asType < int > (\$heap_{init}.a2))
\rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
[27.3] div2 == div(heapIs $heap_{funcstart\_724.1}, $heap_{funcstart\_724.1}.p2,
asType<int>(asType<short int>((int)176)))
\rightarrow [simplify]
[27.6] \text{ div2} == \text{div}(\mathbf{heapIs} \$ heap_{funcstart\_724,1}, \$ heap_{funcstart\_724,1}.p2, 176)
[Take given term]
[59.0] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177
[59.1] \rho_{13} = \rho_{13} - \rho_{13} = \rho_{13} = \rho_{13} - \rho_{13} = \rho_{
int>((asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},
\rho_{tuncstart\_724,1.p1, 177}.rem) * asType < int > (\rho_{tuncstart\_724,1.r1}) - (\rho_{tuncstart\_724,1.r1}
(asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724,1}.b1)))
\rightarrow [simplify]
[59.3] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
\rightarrow [const static or extern object]
[59.4] \rho_{1745,8} == \rho_{1745,8} == \rho_{1745,8} == \rho_{1745,8}._replace(p1 \rightarrow \rho_{1745,8} == \rho_{1745,8}
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType < int > (\$heap_{init}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
```

```
\rightarrow [expand definition of constant 'r1' at prang.c (15,20)]
[59.5] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType<int>(asType<short int>((int)171))) -
(asType < int > (asType < short int > (div1.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [simplify]
[59.8] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem * 171)
- (asType<int>(asType<short int>(div1.quot))
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{tuncstart_724.1},
heap_{funcstart_{-724,1}}.p1, 177
[59.9] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((171 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)
- (asType<int>(asType<short int>(div(heapIs $heap_{funcstart_724.1},
heap_{funcstart_{724,1}}.p1, 177).quot) *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [simplify]
[59.11] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType < int > (\$heap_{funcstart\_724.1}.b1)))
\rightarrow [const static or extern object]
[59.12] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\textbf{heapIs} \$ \text{heap}_{funcstart\_724.1}, \$ \text{heap}_{funcstart\_724.1}. \text{p1}, 177).\text{quot} *
asType < int > (\$heap_{init}.b1)))
\rightarrow [expand definition of constant 'b1' at prang.c (17,20)]
[59.13] \theta_{13} = \theta_
int>((171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType<int>(asType<short int>((int)2))))
\rightarrow [simplify]
[59.19] \text{Sheap}_{724,1;745,8} == \text{Sheap}_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, \ 177).\operatorname{rem})))
[Take given term]
[63.0] $\text{heap}_{724,1:747,8} == $\text{heap}_{724,1:745,8}._\text{replace}(p2 \rightarrow \text{asType} < \text{short}
```

```
int>((asType<int>(asType<short int>(div2.rem)) *
\mathbf{asType} \small{<} \mathbf{int} \small{>} (\$ \mathrm{heap}_{724,1;745,8}.\mathrm{r2})) - (\mathbf{asType} \small{<} \mathbf{int} \small{>} (\mathbf{asType} \small{<} \mathbf{short}
int>(div2.quot)) * asType<int>($heap<sub>724,1:745,8</sub>.b2))))
\rightarrow [from term 59.19, $heap<sub>724.1:745.8</sub> is equal to
heap_{funcstart\_724.1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724.1}),
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1}, 177).quot) + (171 * div(heapIs $heap_{funcstart\_724,1}, 17
heap_{funcstart\_724,1}.p1, 177).rem))
[63.1] heap_{724,1;747,8} == heap_{funcstart\_724,1}.\_replace(p1 \to ((-2 * 
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
\mathbf{asType} \small{<} \mathbf{int} \small{>} (\$ \mathrm{heap}_{724,1;745,8}.\mathrm{r2})) - (\mathbf{asType} \small{<} \mathbf{int} \small{>} (\mathbf{asType} \small{<} \mathbf{short}
int>(div2.quot)) * asType<int>($heap<sub>724,1:745,8</sub>.b2))))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p2, 176)
[63.2] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart} \ 724.1, \ \$ \operatorname{heap}_{funcstart} \ 724.1, \ p1,
177).rem)))._replace(p2 \rightarrow asType<short
int>((asType < int > (asType < short int > (div(heapIs $heap_{funcstart\_724,1}, 
\text{sheap}_{funcstart\_724,1.p2, 176}.\text{rem}) * asType < int > (\text{sheap}_{724,1.745,8.r2})) -
(asType<int>(asType<short int>(div2.quot)) *
asType < int > (\$heap_{724,1:745.8}.b2))))
\rightarrow [simplify]
[63.4] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{$heap}_{funcstart\_724,1}, \ \text{$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem *
asType < int > (\$heap_{724.1:745.8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [from term 59.19, $heap<sub>724,1:745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p1, 177).rem}
[63.5] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1},p2, 176}.rem *
asType<int>($heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 * div(heapIs
```

```
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
\text{Sheap}_{funcstart_{724,1}}, \text{Sheap}_{funcstart_{724,1},p1, 177).rem})).r2)) -
(asType<int>(asType<short int>(div2.quot)) *
asType < int > (\$heap_{724,1;745,8}.b2))))
→ [const member of object with modified fields]
[63.6] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
\text{Sheap}_{funcstart_{-724,1}}, \text{Sheap}_{funcstart_{-724,1}}.p2, 176).rem *
asType < int > (\$heap_{funcstart\_724,1}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724,1:745,8</sub>.b2))))
\rightarrow [const static or extern object]
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2, 176).rem *
asType < int > (\$heap_{init}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType< int>($heap_{724.1:745.8}.b2))))
\rightarrow [expand definition of constant 'r2' at prang.c (20,20)]
[63.8] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
(177).rem)._replace(p2 \rightarrow asType<short int>((div(heapIs)))._replace(p2 \rightarrow asType<short int>((div(heapIs)))._replace(p3 \rightarrow asType<
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, 176).rem *
asType<int>(asType<short int>((int)172))) -
(asType < int > (asType < short int > (div2.quot)) *
asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [simplify]
[63.11] $\text{heap}_{724,1:747,8} == $\text{heap}_{funcstart_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}.p2, 176).rem * 172) -
(asType<int>(asType<short int>(div2.quot)) *
asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{funcstart\_724,1},
$heap_{tuncstart_{724,1}}.p2, 176)]
[63.12] $\text{heap}_{724,1;747,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
```

```
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem) -
(asType<int>(asType<short int>(div(heapIs $heap_{funcstart_724,1},))
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot}) * asType<int>(\text{Sheap}_{724,1:745.8}.\text{b2}))))
\rightarrow [simplify]
[63.14] $\text{heap}_{724,1:747,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem}) - (\text{div}(\text{heapIs})
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot *
asType<int>($heap<sub>724,1;745,8</sub>.b2))))
\rightarrow [from term 59.19, $heap<sub>724.1:745.8</sub> is equal to
heap_{funcstart\_724.1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724.1}),
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs p_{funcstart\_724,1}),
heap_{funcstart_{724,1}}.p1, 177).rem)
[63.15] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}. p1, \ 177). \operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
\text{Sheap}_{funcstart_{-724,1}}, \text{Sheap}_{funcstart_{-724,1}}.p2, 176).quot *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathbf{\_replace}(\mathrm{p1} \rightarrow ((\text{-}2 * \mathrm{div}(\mathbf{heapIs}
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs}))
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, 177).rem)).b2))))
\rightarrow [const member of object with modified fields]
[63.16] $\text{heap}_{724,1;747,8} == \text{$heap}_{funcstart\_724,1}._\text{$replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}.p2, 176).quot
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b2}))))
\rightarrow [const static or extern object]
[63.17] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}.p2, 176).quot *
asType < int > (\$heap_{init}.b2))))
```

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\rightarrow [expand definition of constant 'b2' at prang.c (22,20)]
[63.18] $\text{heap}_{724,1:747,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}.p2, 176).quot
asType<int>(asType<short int>((int)35)))))
\rightarrow [simplify]
[63.24] $\text{heap}_{724,1;747,8} == \text{$heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{tuncstart_724.1},
\text{Sheap}_{funcstart\_724.1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724.1},
heap_{funcstart_{-724,1}}.p2, 176).rem)
[Take goal term]
[1.0] $heap<sub>724,1;747,8</sub>.r3 \leq maxof(int)
\rightarrow [from term 63.24, $heap<sub>724,1:747,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.p1, 177).quot) + (171 * div(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart\ 724.1}.p1,\ 177).rem)._replace(p2 \rightarrow (-35 * div(heapIs)))._replace
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p2, 176).rem)
[1.1] \text{heap}_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs \text{heap}_{funcstart\_724,1},
\theta_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1}, 177).quot) + (171 * div(heapIs $heap_{funcstart\_724,1}, 177).
\rho_{funcstart\_724,1.p1, 177).rem}))._replace(p2 \rightarrow ((-35 * div(heapIs
\theta_{funcstart_{-724,1}}, \theta_{funcstart_{-724,1}}, \theta_{funcstart_{-724,1}}, \theta_{funcstart_{-724,1}}, \theta_{funcstart_{-724,1}}
\$ heap_{funcstart\_724,1}, \$ heap_{funcstart\_724,1}.p2, \ 176).rem))).r3 \leq \textbf{maxof(int)}
\rightarrow [const member of object with modified fields]
[1.3] heap_{funcstart\_724,1}.r3 \leq maxof(int)
\rightarrow [const static or extern object]
[1.4] $heap<sub>init</sub>.r3 \leq maxof(int)
\rightarrow [expand definition of constant 'r3' at prang.c (25,20)]
[1.5] asType<short int>((int)170) \le maxof(int)
\rightarrow [simplify]
[1.9] true
```

Proof of verification condition: Arithmetic result of operator '*' is within limit of type 'int'

```
Condition generated at: C:\Escher\Customers\prang\prang.c (65,13)
Condition defined at:
To prove: minof(int) \le (asType<int>(asType<short int>(div3.rem)) *
asType < int > (\$heap_{724,1;747,8}.r3))
Given:
heap_{init}.LIMIT == (int)80
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
\theta
heap_{init}.a1 == asType < short int > ((int)177)
\theta = asType < short int > ((int)2)
heap_{init}.M2 == asType < short int > ((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
\theta = asType < short int > ((int)30323)
\theta
\theta
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart\_724,1})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ / \\
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}))~\%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}))) = =
asType<integer>(div1.rem)
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) <
\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{a1})) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) ==
asType<integer>(div1.rem))
```

```
(asType < integer > (\$heap_{funcstart_{-724,1}}.a1) \le
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2})) \ / \ 
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724.1}.p2)) \%
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p2) = =
asType<integer>(div2.rem))
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}),
asType < int > (\$heap_{funcstart\_724,1}.a3))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}))~\%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))) ==
asType<integer>(div3.rem)
(asType<integer>($heap_funcstart_724.1.p3) <
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a3})) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a3) \le
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})) => !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
```

```
asType<integer>(div3.quot))
$heap_{724,1;745,8} == $heap_{funcstart\_724,1}.\_replace(p1 \rightarrow asType < short)
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType<int>($heap_{funcstart\_724,1}.b1)))
-asType < integer\ const > (\$heap_{724,1;745,8}.M1) < 1
asType<integer>($heap<sub>724,1:745,8</sub>.p1)
!(0 == asType < integer > (\$heap_{724,1;745,8}.p1))
asType<integer>($heap<sub>724.1:745.8</sub>.p1) <
asType<integer>($heap<sub>724.1:745.8</sub>.M1)
\$heap_{724,1;747,8} == \$heap_{724,1;745,8}.\mathbf{replace}(p2 \rightarrow \mathbf{asType} {<} \mathbf{short}
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724,1:745,8}.r2)) - (asType < int > (asType < short)
\mathbf{int}{>}(\text{div2.quot})) \ * \ \mathbf{asType}{<} \mathbf{int}{>} (\$\text{heap}_{724,1;745,8}.\text{b2}))))
-asType<integer const>($heap<sub>724.1:747.8</sub>.M2) <
asType<integer>($heap<sub>724.1:747.8</sub>.p2)
!(0 == asType < integer > (\$heap_{724,1:747.8}.p2))
asType<integer>($heap<sub>724.1:747.8</sub>.p2) <
asType<integer>($heap<sub>724.1:747.8</sub>.M2)
Proof:
[Take given term]
[5.0] invariant1(heapIs heap_{funcstart\_724,1})
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
 \texttt{[5.1]} \left( \left( \left( \left( \left( 0 < \mathbf{asType} < \mathbf{integer} > \left( \$ \mathsf{heap}_{funcstart\_724,1}.\mathsf{p1} \right) \right) \right. \&\& \right. \right. 
(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 
asType<integer>(sheap_{funcstart_{-724,1}}.M1))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 < function for the start of the start 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.3] (((((0 < $heap_{funcstart\_724,1}.p1) && ($heap_{funcstart\_724,1}.p1 < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M1})))~\&\&~(0<
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p2) < 
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 < function for the start of the start 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
```

```
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.4] \ (((((0 < \text{\$heap}_{funcstart\_724,1}.\text{p1}) \&\& \ (\text{\$heap}_{funcstart\_724,1}.\text{p1} <
asType<integer>(heap_{init}.M1))) && (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2})))\ \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) <
\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < $heap_{funcstart_{724,1}}.p1) && ($heap_{funcstart_{724,1}}.p1 < 
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
(asType < integer > (\$heap_{funcstart_{-724,1}}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.16] ((((-30269 < -$heap_{funcstart\_724,1}.p1) \lambda (0 < $heap_{funcstart\_724,1}.p1) \lambda
(0 < \$ heap_{funcstart\_724,1}.p2))&& (\$ heap_{funcstart\_724,1}.p2 <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.17] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \; \land \; (0 < \$heap_{funcstart\_724,1}.p1) \; \land 
(0 < \text{$heap}_{funcstart\_724,1}.p2)) \&\& (\text{$heap}_{funcstart\_724,1}.p2 <
asType < integer > (\$heap_{init}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M3}))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > (\$heap_{funcstart\_724.1}.p3) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
```

```
\rightarrow [simplify]
[5.30] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \wedge (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1.p2} \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\$heap_{funcstart\_724,1}.p3 < \mathbf{asType} < \mathbf{integer} > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -$heap_{funcstart\_724,1}.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.p2) \land (0 < \text{Sheap}_{funcstart\_724,1}.p3)) \&\&
(\text{\$heap}_{funcstart\_724,1}.p3 < asType < integer > (\text{\$heap}_{init}.M3))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1.p2} \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\$heap_{funcstart\_724,1}.p3 < \textbf{asType} < \textbf{integer} > (\textbf{asType} < \textbf{short}
int > ((int)30323)))
\rightarrow [simplify]
[5.40] (-30323 < -$heap<sub>funcstart_724,1.</sub>p3) \land (-30307 <
-\$heap_{funcstart\_724,1}.p2) \land (-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < -\$heap_{funcstart\_724,1}.p2)
\text{Sheap}_{funcstart\_724,1}.\text{p1}) \land (0 < \text{Sheap}_{funcstart\_724,1}.\text{p2}) \land (0 <
heap_{funcstart_{-724,1}.p3}
[Work on sub-term 6 of conjunction in term 5.40]
\textit{[10.0]}~0 < \$ heap_{funcstart\_724,1}.p3
[Take given term]
[11.0] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \ \hat{\mathbf{s}}_{heap}) + \operatorname{div1}_{funcstart} = \mathbf{f}_{funcstart}
asType < int > (\$heap_{funcstart\_724,1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
\rightarrow [simplify]
[11.1] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType < int > (\$heap_{funcstart\_724,1}.a1))
\rightarrow [const static or extern object]
[11.2] div1 == div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}.p1,
asType < int > (\$heap_{init}.a1))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
[11.3] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType<int>(asType<short int>((int)177)))
\rightarrow [simplify]
[11.6] \text{ div1} == \text{div}(\text{heapIs } \text{$heap}_{funcstart\_724,1}, \text{$heap}_{funcstart\_724,1}.\text{p1}, 177)
```

```
[Take given term]
[27.0] div2 == div(heapIs $heap<sub>funcstart_724,1</sub>,
asType < int > (\$heap_{funcstart\_724,1}.p2),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a2}))
\rightarrow [simplify]
[27.1] div2 == div(heapIs $heap_{funcstart\_724.1}, $heap_{funcstart\_724.1}.p2,
asType < int > (\$heap_{funcstart\_724,1}.a2))
\rightarrow [const static or extern object]
\label{eq:continuous} \mbox{[27.2]} \mbox{ div2} == \mbox{div}(\mbox{\bf heapIs} \mbox{ \$heap}_{funcstart\_724,1}, \mbox{ \$heap}_{funcstart\_724,1}.\mbox{p2},
\mathbf{asType}{<}\mathbf{int}{>}(\$\text{heap}_{init}.\text{a2}))
\rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
[27.3] div2 == div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2,
asType<int>(asType<short int>((int)176)))
\rightarrow [simplify]
[27.6] div2 == div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p2, 176)
[Take given term]
[43.0] div3 == div(heapIs $heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
asType < int > (\$heap_{funcstart\_724,1}.a3))
\rightarrow [simplify]
[43.1] \ \mathrm{div3} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3},
asType < int > (\$heap_{funcstart\_724,1}.a3))
\rightarrow [const static or extern object]
[43.2] \operatorname{div3} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p3,
asType < int > (\$heap_{init}.a3))
\rightarrow [expand definition of constant 'a3' at prang.c (26,20)]
[43.3] \ \mathrm{div3} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3},
asType<int>(asType<short int>((int)178)))
\rightarrow [simplify]
[43.6] \ \mathrm{div3} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}, \ 178)
[Assume known post-assertion, class invariant or type constraint for term 43.6]
[47.0] (as
Type<integer>($heap_{funcstart\_724,1}.p3) \%
asType < integer > (178)) == asType < integer > (div(heapIs))
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, 178).rem
\rightarrow [simplify]
[47.2] ($heap<sub>funcstart_724,1</sub>.p3 % 178) == asType<integer>(div(heapIs)
```

```
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{rem}
→ [expand definition of operator '.%' in class 'int' at built in declaration]
[47.3] \; ([\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) < 0] :
-(-asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178), []:
asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178) ==
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3,
178).rem)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[47.4] ([asType<integer>(heap_{funcstart\_724,1}.p3) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178),
[!(asType < integer > (\$heap_{funcstart\_724.1}.p3) < 0)]:
asType < integer > (\$heap_{funcstart_{-724,1}}.p3) \% 178) = =
asType<integer>(div(heapIs p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}),
178).rem)
\rightarrow [simplify]
[47.7] ([0 < -$heap<sub>funcstart_724,1.</sub>p3]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178),
[!(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178) ==
asType<integer>(div(heapIs $heap_{tuncstart\_724.1}, $heap_{tuncstart\_724.1}.p3,
178).rem)
\rightarrow [from term 10.0, literala < -$heap_{funcstart\_724,1}.p3 is false whenever -2 <
(0 + literala)
        Proof of rule precondition:
        [47.7.0] - 2 < (0 + 0)
        \rightarrow [simplify]
        [47.7.2] true
[47.8] ([\mathbf{false}]: -(-\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}) \% 178),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 0)]:
asType < integer > (\$heap_{funcstart\_724.1}.p3) \% 178) = =
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3,
178).rem)
\rightarrow [simplify]
[47.11] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) \; \% \; 178), \; [!(0.11)] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) \; \% \; 178), \; [!(0.11)] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) \; \% \; 178), \; [!(0.11)] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) \; \% \; 178), \; [!(0.11)] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) \; \% \; 178), \; [!(0.11)] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) \; \% \; 178), \; [!(0.11)] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) \; \% \; 178), \; [!(0.11)] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) \; \% \; 178), \; [!(0.11)] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) \; \% \; 178), \; [!(0.11)] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) \; \% \; 178), \; [!(0.11)] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) \; \% \; 178), \; [!(0.11)] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) \; \% \; 178), \; [!(0.11)] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) \; \% \; 178), \; [!(0.11)] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) \; \% \; 178), \; [!(0.11)] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) \; \% \; 178), \; [!(0.11)] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) \; \% \; 178), \; [!(0.11)] \; ([\mathbf{false}]: \; -(-\mathbf{false} > (\$ heap_{funcstart\_724,1}.p3)) \; \% \; 178), \; [!(0.11)] \; ([\mathbf{false}]: \; -(-\mathbf{false} > (\$ heap_{funcstart\_724,1}.p3)) \; \% \; 178), \; [!(0.11)] \; ([\mathbf{false}]: \; -(-\mathbf{false} > (\$ heap_{funcstart\_724,1}.p3)) \; \% \; 178), \; [!(0.11)] \; ([\mathbf{false}]: \; -(-\mathbf{false} > (\$ heap_{funcstart\_724,1}.p3)) \; \% \; 178), \; [!(0.11)] \; ([\mathbf{false}]: \; -(-\mathbf{false} > (\$ heap_{funcstart\_724,1}.p3)) \; \% \; 178), \; [!(0.11)] \; ([\mathbf{false} > (\$ heap
< -$heap<sub>funcstart_724.1</sub>.p3)]: asType<integer>($heap<sub>funcstart_724.1</sub>.p3) %
178) == asType < integer > (div(heapIs \$heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p3, 178}.rem
\rightarrow [from term 10.0, literala < -$heap<sub>funcstart_724,1</sub>.p3 is false whenever -2 <
(0 + literala)
```

```
Proof of rule precondition:
        [47.11.0] - 2 < (0 + 0)
        \rightarrow [simplify]
        [47.11.2] true
[47.12] \; ([\mathbf{false}]: \; -(\mathbf{-asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}) \; \% \; 178),
[!false]: asType<integer>(sheap_{funcstart\_724,1.p3}) % 178) ==
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3,
178).rem)
\rightarrow [simplify]
[47.17] 0 == (-\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p3,
178).rem + (heap_{funcstart\_724,1}.p3 \% 178)
[Take given term]
[59.0] \rho_{1745,8} == \rho_{1745
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{tuncstart\_724.1}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1.quot})) \ * \ \mathbf{asType}{<} \mathbf{int}{>} (\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177
[59.1] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},))
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}) * asType<int>(\text{Sheap}_{funcstart\_724,1}.\text{r1})) -
(asType<int>(asType<short int>(div1.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [simplify]
[59.3] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType < int > (\$heap_{tuncstart\_724.1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType<int>($heap_{funcstart\_724,1}.b1)))
\rightarrow [const static or extern object]
\text{[59.4] \$heap}_{724,1;745,8} == \$heap_{funcstart\_724,1}.\_\textbf{replace}(p1 \rightarrow \textbf{asType} < \textbf{short}
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
\mathbf{asType} {<} \mathbf{int} {>} (\$ \mathbf{heap}_{init}.\mathbf{r1})) - (\mathbf{asType} {<} \mathbf{int} {>} (\mathbf{asType} {<} \mathbf{short}
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
\rightarrow [expand definition of constant 'r1' at prang.c (15,20)]
[59.5] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
\mathbf{int}{>}((\mathrm{div}(\mathbf{heapIs}\ \$\mathrm{heap}_{funcstart\_724,1},\ \$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},\ 177).\mathrm{rem}\ *
```

asType<int>(asType<short int>((int)171))) - (asType<int>(asType<short int>(div1.quot)) *

 $asType < int > (\$heap_{funcstart_724,1}.b1))))$

```
\rightarrow [simplify]
[59.8] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem * 171)
- (asType<int>(asType<short int>(div1.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1}}.p1, 177
\text{[59.9] \$heap}_{724,1;745,8} == \$heap_{funcstart\_724,1}.\_\textbf{replace}(p1 \rightarrow \textbf{asType} < \textbf{short}
\mathbf{int} > ((171 * \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, 177).\operatorname{rem})
- (asType < int > (asType < short int > (div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1},p1, 177}, quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [simplify]
[59.11] \text{sheap}_{724,1;745,8} == \text{sheap}_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int > ((171 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724.1}, \$ \text{heap}_{funcstart\_724.1}.\text{p1}, 177).\text{quot} *
asType < int > (\$heap_{funcstart\_724.1}.b1)))
\rightarrow [const static or extern object]
[59.12] \theta_{12} = \theta_{124,1;745,8} = \theta_{124,1;74
\mathbf{int} > ((171 * \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, 177).\operatorname{rem})
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType < int > (\$heap_{init}.b1)))
\rightarrow [expand definition of constant 'b1' at prang.c (17,20)]
[59.13] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).rem)
- (div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, 177).quot *
asType<int>(asType<short int>((int)2))))
\rightarrow [simplify]
[59.19] $heap<sub>724,1;745,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).rem)))
[Take given term]
[63.0] $\text{heap}_{724,1;747,8} == $\text{heap}_{724,1;745,8}._\text{replace}(p2 \rightarrow \text{asType} < \text{short}
\mathbf{int}{>}((\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{short}\ \mathbf{int}{>}(\mathbf{div}2.\mathbf{rem}))\ ^*
asType < int > (\$heap_{724.1:745.8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724,1:745,8</sub>.b2))))
\rightarrow [from term 59.19, $heap<sub>724.1:745.8</sub> is equal to
heap_{funcstart\_724.1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724.1}),
heap_{funcstart_{-724,1},p1, 177}, quot) + (171 * div(heapIs heap_{funcstart_{-724,1},p1, 177})
heap_{funcstart_{-724,1}.p1, 177}.rem)
```

```
[63.1] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\label{eq:div_heap} \text{div}(\textbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).rem)))._replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724,1:745,8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{tuncstart_{724.1}},
heap_{funcstart_{-724,1}}.p2, 176
[63.2] $heap<sub>724,1:747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\label{eq:div_heap} \text{div}(\textbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).rem))).\_replace(p2 \rightarrow asType < short
\mathbf{int}{>}((\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{short}\ \mathbf{int}{>}(\mathbf{div}(\mathbf{heapIs}\ \$\mathbf{heap}_{funcstart\_724,1},
\label{eq:funcstart_724,1.p2} $$ \text{heap}_{funcstart_724,1.p2},\ 176).rem)) * asType < int > ($$ \text{heap}_{724,1;745,8.r2})) - $$
(asType<int>(asType<short int>(div2.quot)) *
asType < int > (\$heap_{724,1;745,8}.b2))))
\rightarrow [simplify]
[63.4] $heap<sub>724,1:747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem *
asType < int > (\$heap_{724.1:745.8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [from term 59.19, $heap<sub>724,1:745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724,1}),
\text{Sheap}_{funcstart\ 724,1}, p1,\ 177).quot) + (171 * div(\textbf{heapIs}\ \text{Sheap}_{funcstart\ 724,1},
heap_{funcstart_{-724,1}}.p1, 177).rem)
[63.5] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((\operatorname{div}(\mathbf{heapIs}))))
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}.p2, 176).rem *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathbf{\_replace}(\mathrm{p1} \rightarrow ((-2 * \mathrm{div}(\mathbf{heapIs}
\text{Sheap}_{funcstart_{-724,1}}, \text{Sheap}_{funcstart_{-724,1}}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs}))
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 177).rem)).r2)) -
(asType<int>(asType<short int>(div2.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\${\rm heap}_{724,1;745,8}.{\rm b2}))))
→ [const member of object with modified fields]
[63.6] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
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\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
(177).rem))._replace(p2 \rightarrow asType<short int>((div(heapIs)))._replace(p2)
\rho_{funcstart_{724,1}}, \rho_{funcstart_{724,1},p2, 176}.rem *
asType < int > (\$heap_{funcstart\_724,1}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType< int>($heap_{724,1:745,8}.b2))))
\rightarrow [const static or extern object]
[63.7] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem *
asType < int > (\$heap_{init}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724,1:745.8</sub>.b2))))
\rightarrow [expand definition of constant 'r2' at prang.c (20,20)]
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem))). replace(p2 \rightarrow asType < short int > ((div(heapIs))) = (div(heapIs))
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2, 176).rem *
asType<int>(asType<short int>((int)172))) -
(asType<int>(asType<short int>(div2.quot)) *
asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [simplify]
[63.11] $\text{heap}_{724,1:747,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}. p1, \ 177). \operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((\operatorname{div}(\mathbf{heapIs}))))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem} * 172) -
(asType<int>(asType<short int>(div2.quot)) *
asType < int > (\$heap_{724,1;745,8}.b2))))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{funcstart_{724,1}},
heap_{funcstart_{-724,1}}.p2, 176
[63.12] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem) -
(asType<int>(asType<short int>(div(heapIs $heap_{funcstart_724.1},
\text{sheap}_{funcstart\_724,1.p2, 176}.\text{quot}) * asType < int > (\text{sheap}_{724,1:745,8}.\text{b2}))))
\rightarrow [simplify]
[63.14] $\text{heap}_{724,1;747,8} == \text{$heap}_{funcstart\_724,1}._\text{$replace}(p1 \to ((-2 *
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\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 176).quot *
asType<int>($heap<sub>724,1;745,8</sub>.b2))))
\rightarrow [from term 59.19, $heap<sub>724,1;745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724,1}),
\text{Sheap}_{funcstart\_724.1}.p1, 177).quot) + (171 * div(\text{heapIs } \text{Sheap}_{funcstart\_724.1},
heap_{funcstart_{-724,1}}.p1, 177).rem)
[63.15] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem}) - (\text{div}(\textbf{heapIs})
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, 2, 176).quot *
\mathbf{asType}{<}\mathbf{int}{>}(\$\text{heap}_{funcstart\_724,1}.\_\mathbf{replace}(\text{p1} \rightarrow ((\text{-2} * \text{div}(\mathbf{heapIs}
\text{Sheap}_{funcstart_{-724,1}}, \text{Sheap}_{funcstart_{-724,1}}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs})
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).rem))).b2))))
\rightarrow [const member of object with modified fields]
[63.16] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}.p2, 176).quot *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b2}))))
\rightarrow [const static or extern object]
[63.17] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((172 * div(\mathbf{heapIs}))))
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}.p2, 176).quot
asType < int > (\$heap_{init}.b2))))
\rightarrow [expand definition of constant 'b2' at prang.c (22,20)]
[63.18] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 2, 176).quot *
```

```
asType<int>(asType<short int>((int)35))))
\rightarrow [simplify]
[63.24] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p2, 176).rem)
[Take goal term]
[1.0] minof(int) \le (asType<int>(asType<short int>(div3.rem)) *
asType<int>($heap<sub>724.1:747.8</sub>.r3))
\rightarrow [simplify]
[1.1] -32768 \leq (asType<int>(asType<short int>(div3.rem)) *
asType<int>($heap<sub>724.1:747.8</sub>.r3))
\rightarrow [from term 43.6, div3 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p3, 178
[1.2] -32768 \leq (asType\leqint>(asType\leqshort int>(div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p3, 178).rem)) *
asType<int>($heap<sub>724,1;747,8</sub>.r3))
\rightarrow [simplify]
[1.4] -32768 \leq (div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p3,
178).rem * asType<int>($heap<sub>724,1;747,8</sub>.r3))
\rightarrow [from term 63.24, $heap<sub>724,1:747,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.p1, 177).quot) + (171 * div(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{uncstart\_724,1}.p1, 177).rem))._replace\rho_{uncstart\_724,1}.p1, 177).rem))._replace
heap_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem))]
[1.5] -32768 \le (\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p3},
178).rem * asType<int>($heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{tuncstart_724.1},
\text{Sheap}_{funcstart_{724,1},p2, 176}.quot) + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart_{724,1},p2})
heap_{funcstart_{724,1}.p2, 176).rem})).r3)
\rightarrow [const member of object with modified fields]
[1.7] - 32768 \le (\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p3},
178).rem * asType < int > (\$heap_{funcstart\_724,1}.r3))
\rightarrow [const static or extern object]
```

```
[1.8] -32768 \leq (div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p3,
178).rem * asType < int > (\$heap_{init}.r3))
\rightarrow [expand definition of constant 'r3' at prang.c (25.20)]
 \label{eq:constant_724,1} \text{[1.9] -32768} \leq (\text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p3},
178).rem * asType < int > (asType < short int > ((int)170)))
\rightarrow [simplify]
[1.14] - 32769 < (170 * div(\mathbf{heapIs} \$ heap_{funcstart\_724,1}, \$ heap_{funcstart\_724,1}.p3,
178).rem)
\rightarrow [literal comparison of product]
[1.15] ([170 < 0]: (-32769 / -170) < -\text{div}(\mathbf{heapIs} \$ \mathbf{heap}_{funcstart\_724,1},
\theta_{funcstart\_724,1}.p3, 178).rem, [0 < 170]: (-32769 / 170) < div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{rem}, [0 == 170]: -32769 < 0)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[1.16] ([170 < 0]: (-32769 / -170) < -\text{div}(\text{heapIs } \text{$heap}_{tuncstart\_724.1},
\text{Sheap}_{funcstart\_724.1.p3}, 178).\text{rem}, [(0 < 170) \land !(170 < 0)]: (-32769 / 170) < 0
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).rem, \ [(0 == 170)]
\wedge !(0 < 170) \wedge !(170 < 0)]: -32769 < 0
\rightarrow [simplify]
[1.24] \ -193 < {\rm div}(\mathbf{heapIs} \ \$ heap_{funcstart\_724,1}, \ \$ heap_{funcstart\_724,1}.p3, \ 178).rem
→ [negate goal and search for contradiction]
 [1.25] ! (-193 < \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p3}, 
178).rem)
\rightarrow [simplify]
 [1.27] \ 192 < -{\rm div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}, 
178).rem
[Create new term from terms 1.27, 47.17 using rule: transitivity 15]
[87.0] (0 + 192) < -($heap_funcstart_724,1.p3 % 178)
\rightarrow [simplify]
[87.2] false
Proof of verification condition: Arithmetic result of operator '*' is within
limit of type 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (65,13)
Condition defined at:
```

To prove: (asType<int>(asType<short int>(div3.rem)) *

 $asType < int > ($heap_{724,1;747,8}.r3)) \le maxof(int)$

Given:

```
heap_{init}.LIMIT == (int)80
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta = asType < short int > ((int)2)
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\rho_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
\theta sheap<sub>init</sub>.M3 == asType<short int>((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
heap_{init}.a3 == asType<short int>((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
invariant
1(heap<br/>Is heap_{funcstart\_724,1})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \ \operatorname{\$heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) /
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}))) = =
asType<integer>(div1.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))) = =
asType<integer>(div1.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1})) =>
(asType < integer > (\$heap_{funcstart\_724,1}.p1) = =
asType<integer>(div1.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathtt{a1}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
```

```
div2 == div(\mathbf{heapIs} \ \text{$heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724.1}.a2)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p2) = =
asType<integer>(div2.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a2}) \leq
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})) => !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
asType < int > (\$heap_{funcstart\ 724.1}.a3))
(asType<int>(asType<int>($heap_{tuncstart\_724.1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathtt{a3}))) ==
asType<integer>(div3.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) ==
asType<integer>(div3.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a3) \le
asType < integer > (\$heap_{funcstart\_724,1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
\text{Sheap}_{724,1;745,8} == \text{Sheap}_{funcstart\_724,1}.\_\mathbf{replace}(\text{p1} \to \mathbf{asType} < \mathbf{short})
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
```

```
-asType<integer const>($heap<sub>724.1:745.8</sub>.M1) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{p1})
!(0 == \mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathrm{heap}_{724,1;745,8}.\mathrm{p1}))
asType<integer>($heap<sub>724,1;745,8</sub>.p1) <
\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{724,1;745,8}.\mathrm{M1})
heap_{724,1:747,8} == heap_{724,1:745,8}.replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\text{heap}_{724,1;745,8}.\text{r2})) - (\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{short}
int>(div2.quot)) * asType<int>($heap<sub>724,1:745,8</sub>.b2))))
-asType<integer const>($heap<sub>724.1:747.8</sub>.M2) <
\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{724,1;747,8}.\mathrm{p2})
!(0 == asType < integer > (\$heap_{724,1:747.8}.p2))
asType < integer > ($heap_{724,1;747,8}.p2) < 
asType<integer>($heap<sub>724,1.747,8</sub>.M2)
Proof:
[Take given term]
[5.0] invariant1(heapIs heap_{funcstart\_724,1})
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
 \texttt{[5.1]} \left( \left( \left( \left( \left( 0 < \mathbf{asType} < \mathbf{integer} > \left( \$ \mathsf{heap}_{funcstart\_724,1}.\mathsf{p1} \right) \right) \right. \&\& \right. \right. 
(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 
asType < integer > (\$heap_{funcstart_{-724,1}}.M1))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M2})))~\&\&~(0<
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType<integer>($heap_funcstart_724,1.M3))
\rightarrow [simplify]
[5.3] (((((0 < $heap_{funcstart\_724,1}.p1) && ($heap_{funcstart\_724,1}.p1 < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M1})))~\&\&~(0<
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M2})))~\&\&~(0<
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.4] (((((0 < $heap_{funcstart\_724,1}.p1) && ($heap_{funcstart\_724,1}.p1 <
asType < integer > (\$heap_{init}.M1))) \&\& (0 <
```

```
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
 (asType < integer > (\$heap_{funcstart\_724,1}.p2) < 
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M2}))) \ \&\& \ (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
 (asType<integer>($heap_{tuncstart\_724,1}.p3) <
asType<integer>($heap_funcstart_724,1.M3))
 \rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
 [5.5] (((((0 < $heap_{funcstart_724,1}.p1) && ($heap_{funcstart_724,1}.p1 < footnote{in the content of the c
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
 (\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M2})))~\&\&~(0<
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
 (\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
 \rightarrow [simplify]
 [5.16] \; ((((-30269 < -\$ heap_{funcstart\_724,1}.p1) \; \land \; (0 < \$ heap_{funcstart\_724
 (0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > ($heap_{funcstart\_724,1}.p3))) &&
 (\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{M3}))
 \rightarrow [const static or extern object]
 |5.17| \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \; \land \; (0 < \$heap_{funcstart\_724,1}.p1) \; \land 
 (0 < \text{$heap}_{funcstart\_724,1}.p2)) \&\& (\text{$heap}_{funcstart\_724,1}.p2 <
asType < integer > (\$heap_{init}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
 (asType < integer > ($heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
 \rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
 [5.18] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < \text{$heap}_{funcstart\_724,1}.p2)) \&\& (\text{$heap}_{funcstart\_724,1}.p2 <
asType < integer > (asType < short int > ((int)30307)))) && (0 < integer) && (0 < integer
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
 (\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M3}))
 \rightarrow [simplify]
 [5.30] ((-30307 < -$heap_{funcstart\_724,1}.p2) \land (-30269 <
 -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{724,1},p2} \land (0 < \text{Sheap}_{funcstart_{724,1},p3})) \&\&
 (\text{\$heap}_{funcstart\_724,1}.p3 < asType < integer > (\text{\$heap}_{funcstart\_724,1}.M3))
```

```
\rightarrow [const static or extern object]
[5.31] ((-30307 < -$heap_funcstart_724,1.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1.p2} \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\$heap_{funcstart\_724,1}.p3 < \textbf{asType} < \textbf{integer} > (\$heap_{init}.M3))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap_funcstart_724,1.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.p2) \land (0 < \text{Sheap}_{funcstart\_724,1}.p3)) \&\&
(\text{sheap}_{funcstart\_724,1}.\text{p3} < \text{asType} < \text{integer} > (\text{asType} < \text{short})
int > ((int)30323)))
\rightarrow [simplify]
[5.40] (-30323 < -\$heap_{funcstart\_724,1}.p3) \land (-30307 < -30307)
-\$heap_{funcstart\_724,1}.p2) \land (-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < -\$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.\text{p1}) \land (0 < \text{Sheap}_{funcstart\_724,1}.\text{p2}) \land (0 <
heap_{funcstart_{724.1}.p3}
[Work on sub-term 6 of conjunction in term 5.40]
[10.0] 0 < \text{$heap}_{funcstart\_724,1}.p3
[Take given term]
[11.0] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
\rightarrow [simplify]
[11.1] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType < int > (\$heap_{funcstart\_724,1}.a1))
\rightarrow [const static or extern object]
[11.2] div1 == div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
asType < int > (\$heap_{init}.a1))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
\textit{[11.3]} \ \text{div1} == \text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
asType < int > (asType < short int > ((int)177)))
\rightarrow [simplify]
[11.6] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}, \ 177)
[Take given term]
[27.0] \operatorname{div2} == \operatorname{div}(\mathbf{heapIs} \ \operatorname{\$heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724.1}.p2),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
```

```
\rightarrow [simplify]
[27.1] \ \mathrm{div2} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2},
asType < int > (\$heap_{funcstart\_724,1}.a2))
\rightarrow [const static or extern object]
\label{eq:continuous} \mbox{\sc [27.2] div2} == \mbox{\sc div}(\mathbf{heapIs} \ \$\mbox{\sc heap}_{funcstart\_724,1}, \ \$\mbox{\sc heap}_{funcstart\_724,1}.\mbox{\sc p2},
asType < int > (\$heap_{init}.a2))
\rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
[27.3] div2 == div(heapIs $heap_{funcstart\_724.1}, $heap_{funcstart\_724.1}.p2,
asType<int>(asType<short int>((int)176)))
\rightarrow [simplify]
[27.6] \text{ div2} == \text{div}(\mathbf{heapIs} \$ heap_{funcstart\_724,1}, \$ heap_{funcstart\_724,1}.p2, 176)
[Take given term]
[43.0] \operatorname{div3} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
asType < int > (\$heap_{funcstart\_724,1}.a3))
\rightarrow [simplify]
[43.1] \text{ div3} == \text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
\rightarrow [const static or extern object]
[43.2] \operatorname{div3} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p3,
asType < int > (\$heap_{init}.a3))
\rightarrow [expand definition of constant 'a3' at prang.c (26,20)]
[43.3] \ \mathrm{div3} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3},
asType<int>(asType<short int>((int)178)))
\rightarrow [simplify]
[43.6] \ \mathrm{div3} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}, \ 178)
[Take given term]
[59.0] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1.quot})) * \mathbf{asType}{<} \mathbf{int}{>} (\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177
[59.1] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724.1},
\rho_{tuncstart\_724,1.p1, 177}.rem) * asType < int > (\rho_{tuncstart\_724,1.r1}) - (\rho_{tuncstart\_724,1.r1}
(asType<int>(asType<short int>(div1.quot)) *
```

```
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [simplify]
[59.3] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType<int>($heap_{funcstart\_724,1}.b1)))
\rightarrow [const static or extern object]
[59.4] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType < int > (\$heap_{init}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType<int>($heap_{funcstart\_724,1}.b1)))
\rightarrow [expand definition of constant 'r1' at prang.c (15,20)]
[59.5] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
\mathbf{int} > ((\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, \ 177).\operatorname{rem} \ *
asType<int>(asType<short int>((int)171))) -
(asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [simplify]
[59.8] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem * 171)
- (asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724.1}.b1)))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart_724,1},
heap_{funcstart_{-724,1}}.p1, 177
[59.9] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((171 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)
- (asType<int>(asType<short int>(div(heapIs $heap_{funcstart_724.1},
heap_{funcstart_{-724,1}}.p1, 177).quot) *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [simplify]
[59.11] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int > ((171 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724.1}, \$ \text{heap}_{funcstart\_724.1}. \text{p1}, 177).\text{quot} *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [const static or extern object]
[59.12] heap_{724,1;745,8} == heap_{funcstart\_724,1}. replace(p1 \rightarrow asType<short
int>((171 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType < int > (\$heap_{init}.b1)))
```

```
\rightarrow [expand definition of constant 'b1' at prang.c (17,20)]
[59.13] \text{sheap}_{724,1;745,8} == \text{sheap}_{funcstart\_724,1}.replace(p1 \rightarrow asType<short
int>((171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).rem)
- (div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1, 177).quot *
asType<int>(asType<short int>((int)2))))
\rightarrow [simplify]
[59.19] \text{$heap}_{724,1;745,8} == \text{$heap}_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, \ 177).\operatorname{rem})))
[Take given term]
[63.0] $\text{heap}_{724,1:747,8} == $\text{heap}_{724,1:745,8}._\text{replace}(p2 \to \text{asType} < \text{short}
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724,1:745,8}.r2)) - (asType < int > (asType < short)
\mathbf{int}{>}(\text{div2.quot})) \ * \ \mathbf{asType}{<} \mathbf{int}{>} (\$\text{heap}_{724,1;745,8}.\text{b2}))))
\rightarrow [from term 59.19, $heap<sub>724,1;745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{724,1},p1,177,rem})
[63.1] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}. p1, \ 177). \operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
(177).rem))._replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724,1;745,8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType< int>($heap_{724,1:745,8}.b2))))
\rightarrow [from term 27.6, div2 is equal to div(heap
Is $heap_funcstart_724,1,
heap_{funcstart_{-724,1}}.p2, 176
[63.2] $\text{heap}_{724.1:747.8} == $\text{heap}_{funcstart_724.1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
(177).rem))._replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div(heapIs $heap_{tuncstart_724.1},
\text{sheap}_{funcstart\_724,1.p2}, 176).rem) * asType < int > (\text{sheap}_{724,1;745,8.r2})) -
(asType<int>(asType<short int>(div2.quot)) *
asType < int > (\$heap_{724,1;745,8}.b2))))
\rightarrow [simplify]
[63.4] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((\operatorname{div}(\mathbf{heapIs}))))
\text{Sheap}_{funcstart\ 724.1}, \text{Sheap}_{funcstart\ 724.1}.p2, 176).rem *
```

```
asType < int > (\$heap_{724.1:745.8}.r2)) - (asType < int > (asType < short)
\mathbf{int}{>}(\text{div2.quot})) \ * \ \mathbf{asType}{<} \mathbf{int}{>} (\$\text{heap}_{724,1;745,8}.\text{b2}))))
\rightarrow [from term 59.19, $heap<sub>724,1:745,8</sub> is equal to
heap_{funcstart\_724.1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724.1}),
heap_{funcstart_{724,1},p1, 177}, quot) + (171 * div(heapIs p_{funcstart_{724,1},p1, 177}), quot)
\$heap_{funcstart\_724,1}.p1,\ 177).rem))]
[63.5] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
div(\mathbf{heapIs} \ \text{$heap}_{funcstart\_724,1}, \ \text{$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((\operatorname{div}(\mathbf{heapIs}))))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem *
asType < int > (\$heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * div(heapIs)))))))
\rho_{tuncstart_{-724,1}}, \rho_{tuncstart_{-724,1}}, 177).quot + (171 * div(heapIs)
\text{Sheap}_{funcstart_{-724,1}}, \text{Sheap}_{funcstart_{-724,1}}.p1, 177).rem))).r2)) -
(asType<int>(asType<short int>(div2.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\${\rm heap}_{724,1;745,8}.{\rm b2}))))
→ [const member of object with modified fields]
[63.6] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}. p1, \ 177). \operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((\operatorname{div}(\mathbf{heapIs}))))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem *
asType < int > (\$heap_{funcstart\_724,1}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType< int>($heap_{724.1:745.8}.b2))))
\rightarrow [const static or extern object]
[63.7] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem *
asType < int > (\$heap_{init}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType< int>($heap_{724,1:745,8}.b2))))
\rightarrow [expand definition of constant 'r2' at prang.c (20,20)]
[63.8] $heap<sub>724.1:747.8</sub> == $heap<sub>funcstart_724.1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((\operatorname{div}(\mathbf{heapIs}))))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem *
asType<int>(asType<short int>((int)172))) -
(asType<int>(asType<short int>(div2.quot)) *
asType < int > (\$heap_{724,1;745,8}.b2))))
\rightarrow [simplify]
```

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[63.11] $\text{heap}_{724,1;747,8} == \text{$heap}_{funcstart_724,1}._\text{$\mathbf{replace}$}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\label{eq:div_heap} \text{div}(\textbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
(177).rem))._replace(p2 \rightarrow asType<short int>((div(heapIs)))._replace(p2)
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p2, 176).rem * 172) -
(asType<int>(asType<short int>(div2.quot)) *
asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{tuncstart_{724.1}},
heap_{funcstart_{-724,1}}.p2, 176
[63.12] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem}) -
(asType < int > (asType < short int > (div(heapIs $heap_{funcstart\_724,1}, 
\text{sheap}_{funcstart\_724,1.p2}, 176).\text{quot}) * asType<int>(\text{sheap}_{724,1:745,8}.\text{b2}))))
\rightarrow [simplify]
[63.14] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}. \operatorname{pl},
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1},p2,176}.quot *
asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [from term 59.19, $heap<sub>724,1;745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1},p1, 177}, quot) + (171 * div(heapIs heap_{funcstart_{724,1},p1, 177})
heap_{funcstart} 724.1.p1, 177).rem))]
[63.15] $\text{heap}_{724,1;747,8} == \text{$heap}_{funcstart\_724,1}._\text{$replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((172 * div(\mathbf{heapIs}
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}.p2, 176).quot
\mathbf{asType}{<}\mathbf{int}{>}(\$\text{heap}_{funcstart\_724,1}.\mathbf{\_replace}(\text{p1} \rightarrow ((\text{-}2 * \text{div}(\mathbf{heapIs}
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1},p1, 177}.quot + (171 * div(heapIs))
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 177).rem)).b2))))
\rightarrow [const member of object with modified fields]
[63.16] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
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\theta_{funcstart_{-724,1}}, \theta_{funcstart_{-724,1},p2, 176}.rem) - (div(heapIs)
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}.p2, 176).quot *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b2}))))
\rightarrow [const static or extern object]
[63.17] $\text{heap}_{724,1;747,8} == \text{$heap}_{funcstart\_724,1}._\text{$replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 2, 176.quot *
asType < int > (\$heap_{init}.b2))))
\rightarrow [expand definition of constant 'b2' at prang.c (22,20)]
[63.18] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 2, 176).quot *
asType<int>(asType<short int>((int)35)))))
\rightarrow [simplify]
[63.24] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p2, 176).rem)
[Take goal term]
[1.0] (asType<int>(asType<short int>(div3.rem)) *
asType < int > (\$heap_{724,1:747,8}.r3)) \le maxof(int)
\rightarrow [from term 43.6, div3 is equal to div(heapIs $heap_{funcstart\_724.1},
heap_{funcstart_{-724,1}}.p3, 178
[1.1] (asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},))
\text{sheap}_{funcstart, 724,1.p3, 178}.\text{rem}) * asType < int > (\text{sheap}_{724,1:747,8.r3})) \le
maxof(int)
\rightarrow [simplify]
[1.3] (div(heapIs heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}.p3, 178).rem *
asType < int > (\$heap_{724,1:747,8}.r3)) \le maxof(int)
\rightarrow [from term 63.24, $heap_{724,1;747,8}$ is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1},p1, 177}, quot) + (171 * div(heapIs p_{funcstart_{724,1},p1, 177}), quot)
```

```
heap_{funcstart\_724.1}.p1, 177).rem))._replace(p2 \rightarrow (-35 * div(heapIs)))._
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p2, 176).rem)
[1.4] (div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem *
asType < int > (\$heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * div(heapIs)))))))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs}))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).rem))._replace(p2 \rightarrow ((-35)
* div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, p2, 176).quot) + (172 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p2}, \ 176).\operatorname{rem}))).\operatorname{r3})) \le
maxof(int)
\rightarrow [const member of object with modified fields]
[1.6] (div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{r3})) \leq \mathbf{maxof}(\mathbf{int})
\rightarrow [const static or extern object]
[1.7] (div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem *
asType < int > (\$heap_{init}.r3)) \le maxof(int)
\rightarrow [expand definition of constant 'r3' at prang.c (25,20)]
[1.8] (div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1},p3, 178}).rem *
asType < int > (asType < short int > ((int)170))) \le maxof(int)
\rightarrow [simplify]
[1.21] -32768 < (-170 * div(heapIs $heap_{tuncstart\_724,1}),
heap_{funcstart_{-724,1}.p3, 178}.rem
\rightarrow [literal comparison of product]
[1.22] ([-170 < 0]: (-32768 / 170) < -\text{div}(\text{heapIs } \text{$heap}_{funcstart\_724,1},
\rho_{tuncstart_{-724,1}.p3, 178}.rem, [0 < -170]: (-32768 / -170) < \text{div}(\mathbf{heapIs})
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{rem}, [-170 == 0]: -32768 <
0)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[1.23] ([-170 < 0]: (-32768 / 170) < -\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1},
\rho_{tuncstart_{724,1},p3,178}.rem, [(0 < -170) \land !(-170 < 0)]: (-32768 / -170) < 0
div(\mathbf{heapIs} \$ heap_{funcstart\_724,1}, \$ heap_{funcstart\_724,1}.p3, 178).rem, [(-170 ==
0) \wedge !(-170 < 0) \wedge !(0 < -170)]: -32768 < 0)
\rightarrow [simplify]
[1.27] -193 < -\text{div}(\text{heapIs }\text{\$heap}_{funcstart\_724,1}, \text{\$heap}_{funcstart\_724,1}.p3,
178).rem
→ [negate goal and search for contradiction]
[1.28]!(-193 < -\text{div}(\text{heapIs }\text{\$heap}_{funcstart\_724,1}, \text{\$heap}_{funcstart\_724,1}.p3,
```

178).rem)

```
\rightarrow [simplify]
[1.31] 192 < div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem
[Assume known post-assertion, class invariant or type constraint for term 43.6]
[47.0] (asType<integer>(peq_{funcstart\_724,1}.p3) %
\mathbf{asType}{<}\mathbf{integer}{>}(178)) == \mathbf{asType}{<}\mathbf{integer}{>}(\mathrm{div}(\mathbf{heapIs}
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, 178).rem
\rightarrow [simplify]
[47.2] ($heap<sub>funcstart_724,1.</sub>p3 % 178) == asType<integer>(div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{rem}
→ [expand definition of operator '.%' in class 'int' at built in declaration]
[47.3] ([asType<integer>($heap_{funcstart\_724,1}.p3) < 0]:
-(-\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}) \%178), []:
asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178) ==
asType<integer>(div(heapIs p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}),
178).rem)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[47.4] ([asType<integer>(sheap_{funcstart\_724,1}.p3) < 0]:
-(-\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}) \% \ 178),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 0)]:
asType < integer > (\$heap_{funcstart\ 724,1}.p3) \% 178) ==
asType<integer>(div(heapIs $heap_{tuncstart\_724.1}, $heap_{tuncstart\_724.1}.p3,
178).rem)
\rightarrow [simplify]
[47.7] ([0 < -$heap<sub>funcstart_724,1</sub>.p3]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178) ==
asType<integer>(div(heapIs $heap_{tuncstart\_724.1}, $heap_{tuncstart\_724.1}.p3,
178).rem)
\rightarrow [from term 10.0, literala < -$heap<sub>funcstart_724.1</sub>.p3 is false whenever -2 <
(0 + literala)
   Proof of rule precondition:
   [47.7.0] - 2 < (0 + 0)
   \rightarrow [simplify]
   [47.7.2] true
[47.8] ([\mathbf{false}]: -(-\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) \% 178),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178) = =
```

```
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3,
178).rem)
\rightarrow [simplify]
[47.11] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) \; \% \; 178), \; [!(0.12)] \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.12)) \; ((0.
<-$heap<sub>funcstart_724,1.</sub>p3)]: asType<integer>($heap<sub>funcstart_724,1.</sub>p3) %
178) == asType<integer>(div(heapIs heap_{funcstart\_724,1},
heap_{funcstart_{724,1}.p3, 178}.rem
\rightarrow [from term 10.0, literala < -$heap<sub>funcstart_724,1</sub>.p3 is false whenever -2 <
(0 + literala)
         Proof of rule precondition:
         [47.11.0] - 2 < (0 + 0)
         \rightarrow [simplify]
         [47.11.2] true
[47.12] ([\mathbf{false}]: -(-\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) \% 178),
[!false]: asType<integer>($heap<sub>funcstart_724.1.</sub>p3) % 178) ==
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3,
178).rem)
\rightarrow [simplify]
[47.17] \ 0 == (-\text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p3},
178).rem + (\text{$heap}_{funcstart\_724,1}.p3 \% 178))
\rightarrow [remainder is less than divisor]
         Proof of rule precondition:
         [47.17.0] (178 + -\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3},
         178).rem) \leq 0
         \rightarrow [simplify]
         [47.17.11]\ 177 < \mathrm{div}(\mathbf{heapIs}\ \$ \mathrm{heap}_{funcstart\_724,1},\ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3},
         178).rem
         \rightarrow [from term 1.31, literala < div(heapIs $heap_{funcstart\_724,1},
         heap_{funcstart_{-724,1}}.p3, 178.rem is true whenever (-1 + literala) < 192
                  Proof of rule precondition:
                  [47.17.11.0](-1 + 177) < 192
                  \rightarrow [simplify]
                  [47.17.11.2] true
         [47.17.12] true
[47.18] false
```

```
conversion from 'int' to 'short int'
Condition generated at: C:\Escher\Customers\prang\prang.c (65,40)
Condition defined at:
To prove: minof(short int) \le div3.quot
Given:
heap_{init}.LIMIT == (int)80
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
\theta sheap<sub>init</sub>.a1 == asType<short int>((int)177)
\theta
heap_{init}.M2 == asType < short int > ((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
\theta
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta
\rho = asType < short int > ((int)2)
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart_{-724,1}})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ / \\
asType < integer > (asType < int > (\$heap_{funcstart\_724.1}.a1))) = =
asType<integer>(div1.quot)
(\mathbf{asType} {<} \mathbf{int} {>} (\mathbf{asType} {<} \mathbf{int} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}))) = =
asType<integer>(div1.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(asType < integer > (\$heap_{funcstart\_724.1}.p1) = =
```

Proof of verification condition: Type constraint satisfied in explicit

```
asType<integer>(div1.rem))
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
\label{eq:div2} \text{div2} == \text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
(asType<int>(asType<int>($heap_{tuncstart\_724.1}.p2)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.quot)
(asType<int>(asType<int>($heap_{funcstart\_724,1}.p2)) %
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p2) <
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{a2})) = >
(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p2) ==
asType<integer>(div2.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a2}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
\label{eq:div3} \text{div3} == \text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1},
\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}),
asType < int > (\$heap_{funcstart\_724.1}.a3))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))) ==
asType<integer>(div3.rem)
(asType<integer>($heap_{tuncstart\_724,1.p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) ==
asType<integer>(div3.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a3) \le
asType < integer > (\$heap_{funcstart\_724,1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
```

```
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
\$heap_{724,1;745,8} == \$heap_{funcstart\_724,1}.\_\mathbf{replace}(p1 \to \mathbf{asType} < \mathbf{short}
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724.1}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1.quot})) \ * \ \mathbf{asType}{<} \mathbf{int}{>} (\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
-asType < integer const > (\$heap_{724,1:745.8}.M1) < 
asType<integer>($heap<sub>724.1:745.8</sub>.p1)
!(0 == asType < integer > (\$heap_{724,1;745,8}.p1))
asType<integer>($heap<sub>724.1:745.8</sub>.p1) <
\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{724,1;745,8}.\mathrm{M1})
\text{Sheap}_{724,1;747,8} == \text{Sheap}_{724,1;745,8}. \text{replace}(p2 \to asType < short)
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724,1:745,8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
-{\bf asType}{<}{\bf integer~const}{>}(\${\rm heap}_{724,1;747,8}.{\rm M2})<
asType<integer>($heap<sub>724.1:747.8</sub>.p2)
!(0 == asType < integer > (\$heap_{724,1:747.8} \cdot p2))
asType<integer>($heap<sub>724.1:747.8</sub>.p2) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;747,8}.\mathrm{M2})
Proof:
[Take given term]
[5.0] invariant1(heapIs heap_{funcstart\_724,1})
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
[5.1] ((((((0 < asType < integer > ($heap_{funcstart\_724,1}.p1)) &&
(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(asType<integer>($heap_funcstart_724,1.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType<integer>($heap_funcstart_724,1.M3))
\rightarrow [simplify]
[5.3] (((((0 < \text{heap}_{funcstart\_724,1}.p1) && (\text{heap}_{funcstart\_724,1}.p1 <
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
```

```
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M3}))
\rightarrow [const static or extern object]
[5.4] \ (((((0 < \text{\$heap}_{funcstart\_724,1}.\text{p1}) \&\& \ (\text{\$heap}_{funcstart\_724,1}.\text{p1} <
asType < integer > (\$heap_{init}.M1))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) <
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M3}))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < $heap_{funcstart\_724,1}.p1) && ($heap_{funcstart\_724,1}.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))~\&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.16] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \; \land \; (0 < \$heap_{funcstart\_724,1}.p1) \; \land 
(0 < \text{$heap}_{funcstart\_724,1}.p2)) \&\& (\text{$heap}_{funcstart\_724,1}.p2 <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1.p3}) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [const static or extern object]
[5.17] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \; \land \; (0 < \$heap_{funcstart\_724,1}.p1) \; \land 
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType < integer > (\$heap_{init}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > (\$heap_{funcstart_{-724.1}}.p3) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < \$ heap_{funcstart\_724,1}.p2)) && (\$ heap_{funcstart\_724,1}.p2 <
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
```

```
asType < integer > (\$heap_{funcstart_{-724,1}}.M3))
\rightarrow [simplify]
[5.30] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{-724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{-724,1}.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.p3 < asType < integer > (\text{\$heap}_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -$heap_funcstart_724.1.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1.p2}) \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\text{\$heap}_{funcstart\_724.1}.\text{p3} < \text{asType} < \text{integer} > (\text{\$heap}_{init}.\text{M3}))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap_{tuncstart\_724.1}.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{-724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{-724,1}.p3})) \&\&
(\$heap_{funcstart\_724,1}.p3 < \mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{short})
int > ((int)30323)))
\rightarrow [simplify]
[5.40] (-30323 < -$heap<sub>funcstart_724,1.</sub>p3) \wedge (-30307 <
-\$heap_{funcstart\_724,1}.p2) \land (-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < -\$heap_{funcstart\_724,1}.p1)
\theta_{funcstart\_724,1}.p1) \land (0 < \theta_{funcstart\_724,1}.p2) \land (0 < \theta_{funcstart\_724,1}.p2) \land (0 < \theta_{funcstart\_724,1}.p2)
heap_{funcstart_{-724,1}.p3}
[Work on sub-term 6 of conjunction in term 5.40]
[10.0] 0 < $\text{heap}_{funcstart_724,1}.p3
[Take given term]
[43.0] div3 == div(heapIs $heap_{tuncstart\_724.1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
asType < int > (\$heap_{funcstart\_724,1}.a3))
\rightarrow [simplify]
[43.1] \text{ div3} == \text{div}(\mathbf{heapIs} \$ heap_{funcstart\_724,1}, \$ heap_{funcstart\_724,1}.p3,
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
\rightarrow [const static or extern object]
[43.2] \ \mathrm{div3} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3},
asType < int > (\$heap_{init}.a3))
\rightarrow [expand definition of constant 'a3' at prang.c (26,20)]
[43.3] \ \mathrm{div3} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3},
asType<int>(asType<short int>((int)178)))
\rightarrow [simplify]
```

```
[43.6] div3 == div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p3, 178)
[Assume known post-assertion, class invariant or type constraint for term 43.6]
[46.0] (asType<integer>(sheap_{funcstart\_724,1}.p3) /
asType<integer>(178)) == asType<integer>(div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p3, 178).quot)
\rightarrow [simplify]
[46.2] ($heap<sub>funcstart_724,1.</sub>p3 / 178) == asType<integer>(div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p3, 178).quot)
→ [expand definition of operator './' in class 'int' at built in declaration]
[46.3] ([asType<integer>(heap_{funcstart\_724,1}.p3) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178), []:
asType < integer > ($heap_{funcstart\_724,1}.p3) / 178) ==
asType<integer>(div(heapIs $heap_{tuncstart\_724.1}, $heap_{tuncstart\_724.1}.p3,
178).quot)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[46.4] ([asType<integer>(heap_{funcstart\_724,1}.p3) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178) = =
\mathbf{asType} {<} \mathbf{integer} {>} ( \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}, \\
178).quot)
\rightarrow [simplify]
[46.7] ([0 < -$heap<sub>funcstart_724,1.</sub>p3]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178) = =
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3,
178).quot)
\rightarrow [from term 10.0, literala < -$heap<sub>funcstart_724,1</sub>.p3 is false whenever -2 <
(0 + literala)
   Proof of rule precondition:
   [46.7.0] - 2 < (0 + 0)
   \rightarrow [simplify]
   [46.7.2] true
[46.8] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178),
[!(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) < 0)]:
asType < integer > (\$heap_{funcstart\_724.1}.p3) / 178) = =
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3,
178).quot)
```

```
\rightarrow [simplify]
[46.11] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178), [!(0 < integer) < integer)
-$heap_{funcstart\_724,1}.p3)]: asType<integer>($heap_{funcstart\_724,1}.p3) / 178)
== asType < integer > (div(heapIs $heap_{funcstart\_724,1},
\$ heap_{funcstart\_724,1}.p3,\ 178).quot)
\rightarrow [from term 10.0, literala < -$heap<sub>funcstart_724,1</sub>.p3 is false whenever -2 <
(0 + literala)
    Proof of rule precondition:
    [46.11.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [46.11.2] true
[46.12] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178),
[!false]: asType<integer>(\ensuremath{\text{sheap}}_{funcstart\_724,1}.p3) / 178) ==
\mathbf{asType} \small{<} \mathbf{integer} \small{>} ( \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}, \\
178).quot)
\rightarrow [simplify]
[46.17] 0 == (-\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3},
178).quot + (\text{$heap}_{funcstart\_724,1}.p3 / 178))
[Assume known post-assertion, class invariant or type constraint for term
46.17
[52.0] \operatorname{minof(int)} \leq \operatorname{div}(\operatorname{heapIs} \operatorname{\$heap}_{funcstart\_724,1}, \operatorname{\$heap}_{funcstart\_724,1}.p3,
178).quot
\rightarrow [simplify]
\label{eq:constant_724,1} \text{-}32769 < \text{div}(\textbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p3},
178).quot
[Take goal term]
[1.0] minof(short int) \leq div3.quot
\rightarrow [simplify]
[1.1] - 32768 \le \text{div} 3.\text{quot}
\rightarrow [from term 43.6, div3 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p3, 178
[1.2] -32768 \le \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p3},
178).quot
\rightarrow [simplify]
[1.4] - 32769 < \operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p3},
178).quot
```

```
\rightarrow [from term 52.3, literala < div(heapIs $heap_{funcstart_724,1},
heap_{funcstart\_724,1}.p3, 178).quot is true whenever (-1 + literala) < -32769
   Proof of rule precondition:
   [1.4.0](-32769 + -1) < -32769
   \rightarrow [simplify]
   [1.4.2] true
[1.5] true
Proof of verification condition: Type constraint satisfied in explicit
conversion from 'int' to 'short int'
Condition generated at: C:\Escher\Customers\prang\prang.c (65,40)
Condition defined at:
To prove: div3.quot \leq maxof(short int)
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
\theta
heap_{init}.a1 == asType < short int > ((int)177)
\theta
heap_{init}.M2 == asType < short int > ((int)30307)
heap_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
\theta = asType < short int > ((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart_{724,1}})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \ \operatorname{\$heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724.1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
```

```
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1})) \ / \\
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}))) = =
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{div1}.\mathbf{quot})
(asType<int>(asType<int>($heap_{funcstart\_724,1}.p1)) %
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) ==
asType<integer>(div1.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a1) \le
asType < integer > (\$heap_{funcstart\_724,1}.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart_{-724.1}},
\mathbf{asType} < \mathbf{int} > (\$ heap_{funcstart\_724,1}.p2),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2})) \ / \\
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))) ==
asType<integer>(div2.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724.1}.p2)) \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.rem)
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2})) =>
(asType < integer > (\$heap_{funcstart\_724,1}.p2) = =
asType<integer>(div2.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a2}) \leq
\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
asType < int > (\$heap_{funcstart\_724,1}.a3))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p3})) \ / \\
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3})) \%
```

```
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.rem)
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(asType < integer > (\$heap_{funcstart_{-724,1}}.p3) = =
asType<integer>(div3.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a3) \le
asType < integer > (\$heap_{funcstart\_724,1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
\$ heap_{724,1;745,8} == \$ heap_{funcstart\_724,1}.\_\textbf{replace}(p1 \rightarrow \textbf{asType} < \textbf{short}
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
-asType < integer const > (\$heap_{724,1;745,8}.M1) < 100
asType < integer > ($heap_{724,1;745,8}.p1)
!(0 == asType < integer > (\$heap_{724,1;745,8}.p1))
asType<integer>($heap<sub>724,1:745,8</sub>.p1) <
asType<integer>($heap<sub>724,1:745,8</sub>.M1)
heap_{724,1:747,8} == heap_{724,1:745,8}.replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724,1:745,8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
-asType<integer const>($heap<sub>724,1:747,8</sub>.M2) <
\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{724,1;747,8}.\mathrm{p2})
!(0 == asType < integer > (\$heap_{724,1:747.8}.p2))
asType<integer>($heap<sub>724.1:747.8</sub>.p2) <
asType<integer>($heap<sub>724.1:747.8</sub>.M2)
Proof:
[Take given term]
[5.0] invariant1(heapIs heap_{funcstart\_724,1})
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
[5.1] ((((((0 < asType < integer > ($heap_{funcstart\_724,1}.p1)) &&
(asType < integer > (\$heap_{funcstart\_724,1}.p1) <
as
Type<integer>(\rho_{funcstart\_724,1}.M1))) & (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
```

```
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M3}))
\rightarrow [simplify]
[5.3] \ (((((0 < \text{\$heap}_{funcstart\_724,1}.\text{p1}) \&\& \ (\text{\$heap}_{funcstart\_724,1}.\text{p1} <
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.4] (((((0 < \text{heap}_{funcstart\_724,1}.p1) && (\text{heap}_{funcstart\_724,1}.p1 <
asType < integer > (\$heap_{init}.M1))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart_{-724,1}}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < $heap_{funcstart_724,1}.p1) && ($heap_{funcstart_724,1}.p1 < 
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
\mathbf{asType} \small{<} \mathbf{integer} \small{>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M2}))) \ \&\& \ (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
(asType<integer>($heap_funcstart_724,1.p3) <
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M3}))
\rightarrow [simplify]
[5.16] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \; \land \; (0 < \$heap_{funcstart\_724,1}.p1) \; \land 
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})))\ \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M3}))
\rightarrow [const static or extern object]
[5.17] \left( \left( \left( \left( -30269 < -\$ \text{heap}_{funcstart\_724,1}.\text{p1} \right) \right. \wedge \left. \left( 0 < \$ \text{heap}_{funcstart\_724,1}.\text{p1} \right) \right. \wedge \right. \right)
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType < integer > (\$heap_{init}.M2))) \&\& (0 <
```

```
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})))\ \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < \text{$heap}_{funcstart\_724.1}.p2)) \&\& (\text{$heap}_{funcstart\_724.1}.p2 <
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.30] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.p2) \land (0 < \text{Sheap}_{funcstart\_724,1}.p3)) \&\&
(\text{\$heap}_{funcstart\_724,1}.\text{p3} < \text{asType} < \text{integer} > (\text{\$heap}_{funcstart\_724,1}.\text{M3}))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -$heap_{funcstart\_724,1}.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.p2) \land (0 < \text{Sheap}_{funcstart\_724,1}.p3)) \&\&
(\text{\$heap}_{funcstart\_724,1}.p3 < asType < integer > (\text{\$heap}_{init}.M3))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap_{tuncstart_724.1}.p2) \land (-30269 <
-\$ heap_{funcstart\_724,1}.p1) \land (0 < \$ heap_{funcstart\_724,1}.p1) \land (0 < \$ heap_{funcstart\_724,1}.p1) \land (0 < \$ heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{724,1}.p3})) \&\&
(\text{sheap}_{funcstart\_724,1}.\text{p3} < \text{asType} < \text{integer} > (\text{asType} < \text{short})
int > ((int)30323)))
\rightarrow [simplify]
[5.40] (-30323 < -$heap<sub>funcstart_724,1</sub>.p3) \land (-30307 <
-\$heap_{funcstart\_724,1}.p2) \land (-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < -\$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.\text{p1}) \land (0 < \text{Sheap}_{funcstart\_724,1}.\text{p2}) \land (0 <
heap_{funcstart_{-724,1}.p3}
[Work on sub-term 6 of conjunction in term 5.40]
[10.0] 0 < heap_{funcstart_{-724,1}}.p3
[Take given term]
[43.0] div3 == div(heapIs $heap_{tuncstart\_724.1},
asType < int > (\$heap_{funcstart\_724.1}.p3),
asType < int > (\$heap_{funcstart\_724,1}.a3))
\rightarrow [simplify]
[43.1] \ \mathrm{div3} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3},
```

```
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
\rightarrow [const static or extern object]
[43.2] \operatorname{div3} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p3,
asType < int > (\$heap_{init}.a3))
\rightarrow [expand definition of constant 'a3' at prang.c (26,20)]
[43.3] \ \mathrm{div3} == \ \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3},
asType<int>(asType<short int>((int)178)))
\rightarrow [simplify]
[43.6] \text{ div3} == \text{div}(\text{heapIs } \text{$heap}_{funcstart\_724,1}, \text{$heap}_{funcstart\_724,1}.\text{p3}, 178)
[Assume known post-assertion, class invariant or type constraint for term 43.6]
[46.0] (asType<integer>($heap_{tuncstart_724.1}.p3) /
asType<integer>(178)) == asType<integer>(div(heapIs
\$ \mathrm{heap}_{funcstart\_724,1},\,\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3},\,178).\mathrm{quot})
\rightarrow [simplify]
[46.2] ($heap<sub>funcstart_724,1.</sub>p3 / 178) == asType<integer>(div(heapIs)
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, 178).quot
→ [expand definition of operator './' in class 'int' at built in declaration]
[46.3] ([asType<integer>(heap_{funcstart\_724,1}.p3) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178), []:
asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178) = =
asType<integer>(div(heapIs p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}),
178).quot)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[46.4] ([asType<integer>(heap_{funcstart\_724,1}.p3) < 0]:
-(-\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) \ / \ 178),
[!(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178) = =
asType<integer>(div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p3,
178).quot)
\rightarrow [simplify]
[46.7] ([0 < -\$heap_{funcstart\_724,1}.p3]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178) ==
asType<integer>(div(heapIs $heap_{tuncstart\_724.1}, $heap_{tuncstart\_724.1}.p3,
178).quot)
\rightarrow [from term 10.0, literala < -$heap<sub>funcstart_724,1</sub>.p3 is false whenever -2 <
(0 + literala)
```

```
Proof of rule precondition:
    [46.7.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [46.7.2] true
[46.8] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}) \; / \; 178),
[!(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178) = =
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3,
178).quot)
\rightarrow [simplify]
[46.11] \; ([{\bf false}]: \; -({\bf -asType}{<} {\bf integer}{>} (\$ {\rm heap}_{funcstart\_724,1}.{\rm p3}) \; / \; 178), \; [!(0 < 
-\$heap_{funcstart\_724,1}.p3)]: asType<integer>(\$heap_{funcstart\_724,1}.p3) / 178)
== asType < integer > (div(heapIs \$heap_{funcstart\_724.1},
\theta_{funcstart\_724,1}.p3, 178.quot
\rightarrow [from term 10.0, literala < -$heap<sub>funcstart_724,1</sub>.p3 is false whenever -2 <
(0 + literala)
    Proof of rule precondition:
    [46.11.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [46.11.2] true
[46.12] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}) \; / \; 178),
[!false]: asType<integer>($heap<sub>funcstart_724,1.</sub>p3) / 178) ==
asType<integer>(div(heapIs $heap_{tuncstart\_724.1}, $heap_{tuncstart\_724.1}.p3,
178).quot)
\rightarrow [simplify]
[46.17] \ 0 == (-\text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p3},
178).quot + (\text{$heap}_{funcstart\_724,1}.p3 / 178))
[Assume known post-assertion, class invariant or type constraint for term
46.17
[53.0] div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).quot \leq
maxof(int)
\rightarrow [simplify]
\label{eq:continuous} \mbox{[53.9] -32768} < -\mbox{div}(\mbox{\bf heapIs} \ \mbox{\$heap}_{funcstart\_724,1}, \ \mbox{\$heap}_{funcstart\_724,1}.\mbox{p3},
178).quot
[Take goal term]
```

 \rightarrow [from term 43.6, div3 is equal to div(heapIs \$heap_{funcstart_724,1},

[1.0] div3.quot \leq maxof(short int)

```
heap_{funcstart_{-724,1}}.p3, 178
[1.1] div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).quot \leq
maxof(short int)
\rightarrow [simplify]
[1.10] -32768 < -\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.p3,
178).quot
\rightarrow [from term 53.9, literala < -\text{div}(\text{heapIs } \text{\$heap}_{funcstart\_724,1},
heap_{funcstart\_724,1}.p3, 178, quot is true whenever (-1 + literala) < -32768
   Proof of rule precondition:
   [1.10.0](-32768 + -1) < -32768
   \rightarrow [simplify]
   [1.10.2] true
[1.11] true
Proof of verification condition: Type constraint satisfied in implicit
conversion from 'short int' to 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (65,40)
Condition defined at:
To prove: minof(int) \le asType < short int > (div3.quot)
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\theta_{init}.r2 == asType<short int>((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
heap_{init}.b2 == asType < short int > ((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
```

```
\rho_{init}.p2 == asType < short int > ((int)2)
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart\_724,1})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}))\ \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(asType<integer>($heap_funcstart_724.1.p1) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p1) = =
asType<integer>(div1.rem))
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.quot)
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2})) \ \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2})) =>
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}) ==
asType<integer>(div2.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a2) \le
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})) => !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
```

```
div3 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
(asType<int>(asType<int>($heap_{tuncstart\_724.1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(\mathbf{asType} {<} \mathbf{integer} {>} (\mathbf{asType} {<} \mathbf{int} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3})) \ \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathtt{a3}))) ==
asType<integer>(div3.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724.1}.a3)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}) ==
asType<integer>(div3.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a3}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType < integer > (div3.quot))
$heap_{724,1;745,8} == $heap_{funcstart\_724,1}.\_replace(p1 \rightarrow asType < short)
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_tuncstart_724.1.r1)) - (asType<int>(asType<short
\mathbf{int}{>}(\mathbf{div1.quot})) * \mathbf{asType}{<} \mathbf{int}{>} (\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
-asType < integer const > (\$heap_{724,1;745,8}.M1) < 100
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{p1})
!(0 == \mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathrm{heap}_{724,1;745,8}.\mathrm{p1}))
asType < integer > (\$heap_{724,1;745,8}.p1) <
asType<integer>($heap<sub>724.1:745.8</sub>.M1)
\text{heap}_{724.1:747.8} == \text{heap}_{724.1:745.8}._replace(p2 \rightarrow asType<short)
int>((asType<int>(asType<short int>(div2.rem))
asType < int > (\$heap_{724,1;745,8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724,1:745,8</sub>.b2))))
-asType<integer const>($heap<sub>724.1:747.8</sub>.M2) <
asType<integer>($heap<sub>724.1:747.8</sub>.p2)
!(0 == asType < integer > (\$heap_{724,1:747.8}, p2))
asType<integer>($heap<sub>724.1:747.8</sub>.p2) <
asType<integer>($heap<sub>724,1;747,8</sub>.M2)
Proof:
[Take given term]
[5.0] invariant1(heapIs heapIs
```

```
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
[5.1] ((((((0 < asType < integer > ($heap_{funcstart\_724,1}.p1)) &&
(asType < integer > (\$heap_{funcstart\_724,1}.p1) <
as
Type<integer>(\rho_{funcstart\_724,1}.M1))) & (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
(asType < integer > (\$heap_{funcstart\_724.1}.p3) < 
asType<integer>($heap_funcstart_724,1.M3))
\rightarrow [simplify]
[5.3] \ (((((0 < \$heap_{funcstart\_724,1}.p1) \&\& \ (\$heap_{funcstart\_724,1}.p1 < (
as
Type<integer>(\rho_{funcstart\_724,1}.M1))) & (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 < funcstart\_724,1.M2))
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
(asType<integer>($heap_funcstart_724.1.p3) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.4] (((((0 < $heap_{funcstart_{724,1}}.p1) && ($heap_{funcstart_{724,1}}.p1 < 
asType < integer > (\$heap_{init}.M1))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < \text{\$heap}_{funcstart\_724,1}.p1) \&\& (\text{\$heap}_{funcstart\_724,1}.p1 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2})))\ \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p2) < 
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{tuncstart_{-724,1}}.M3))
\rightarrow [simplify]
|5.16| \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \; \land \; (0 < \$heap_{funcstart\_724,1}.p1) \; \land 
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M2})))~\&\&~(0<
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
```

```
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.17] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \; \land \; (0 < \$heap_{funcstart\_724,1}.p1) \; \land 
(0 < \text{\$heap}_{funcstart\_724,1}.\text{p2})) && (\text{\$heap}_{funcstart\_724,1}.\text{p2} <
asType < integer > ($heap_{init}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})))\ \&\&
(asType<integer>($heap_{tuncstart\_724,1}.p3) <
asType<integer>($heap_funcstart_724,1.M3))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -\$heap_{tuncstart\_724.1}.p1) \land (0 < \$heap_{tuncstart\_724.1}.p1) 
(0 < \mathrm{\$heap}_{funcstart\_724,1}.\mathrm{p2})) && (\mathrm{\$heap}_{funcstart\_724,1}.\mathrm{p2} <
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p3) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [simplify]
[5.30] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{724,1}.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.p3 < asType < integer > (\text{\$heap}_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\theta_{funcstart\_724,1}.p2) \land (0 < \theta_{funcstart\_724,1}.p3)) \&\&
(\text{\$heap}_{funcstart\_724,1}.\text{p3} < \text{asType} < \text{integer} > (\text{\$heap}_{init}.\text{M3}))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \wedge (-30269 <
 -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1.p2}) \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\$heap_{funcstart\_724,1}.p3 < \mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{short}
int > ((int)30323))
\rightarrow [simplify]
[5.40] (-30323 < -\$heap_{funcstart\_724,1.p3}) \land (-30307 <
-\$heap_{funcstart\_724,1}.p2) \wedge (-30269 < -\$heap_{funcstart\_724,1}.p1) \wedge (0 <
\text{Sheap}_{funcstart\_724,1}.\text{p1}) \land (0 < \text{Sheap}_{funcstart\_724,1}.\text{p2}) \land (0 <
heap_{funcstart_{724,1}.p3}
[Work on sub-term 6 of conjunction in term 5.40]
[10.0] 0 < \text{$heap}_{funcstart\_724,1}.p3
```

```
[Take given term]
[43.0] div3 == div(heapIs $heap<sub>funcstart_724,1</sub>,
asType < int > (\$heap_{funcstart\_724,1}.p3),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
\rightarrow [simplify]
[43.1] div3 == div(heapIs $heap_{funcstart\_724.1}, $heap_{funcstart\_724.1}.p3,
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
\rightarrow [const static or extern object]
[43.2] div3 == div(heapIs $heap_{funcstart\_724.1}, $heap_{funcstart\_724.1}.p3,
asType < int > (\$heap_{init}.a3))
\rightarrow [expand definition of constant 'a3' at prang.c (26,20)]
[43.3] \ \mathrm{div3} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3},
asType<int>(asType<short int>((int)178)))
\rightarrow [simplify]
[43.6] \text{ div3} == \text{div}(\text{heapIs } \text{$heap}_{funcstart\_724,1}, \text{$heap}_{funcstart\_724,1}.p3, 178)
[Assume known post-assertion, class invariant or type constraint for term 43.6]
[46.0] (asType<integer>($heap_{tuncstart\_724.1}.p3) /
asType<integer>(178)) == asType<integer>(div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p3, 178).quot
\rightarrow [simplify]
[46.2] (\theta = asType<integer>(div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p3, 178).quot
→ [expand definition of operator './' in class 'int' at built in declaration]
[46.3] ([asType<integer>(heap_{funcstart\_724,1}.p3) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724.1}.p3) / 178), []:
asType < integer > ($heap_{funcstart\_724,1}.p3) / 178) ==
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3,
178).quot)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[46.4] ([asType<integer>(sheap_{funcstart\_724,1.p3}) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178),
[!(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178) = =
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3,
178).quot)
\rightarrow [simplify]
[46.7] ([0 < -\$heap_{funcstart\_724,1.p3}]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178),
```

```
[!(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178) = =
\mathbf{asType} {<} \mathbf{integer} {>} ( \mathbf{div} (\mathbf{heapIs} \ \$ \mathbf{heap}_{funcstart\_724,1}, \ \$ \mathbf{heap}_{funcstart\_724,1}. \mathbf{p3}, \\
178).quot)
\rightarrow [from term 10.0, literala < -$heap<sub>funcstart_724.1</sub>.p3 is false whenever -2 <
(0 + literala)
        Proof of rule precondition:
        [46.7.0] - 2 < (0 + 0)
        \rightarrow [simplify]
        [46.7.2] true
[46.8] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178),
[!(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) < 0)]:
asType < integer > (\$heap_{funcstart\_724.1}.p3) / 178) = =
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3,
178).quot)
\rightarrow [simplify]
[46.11] \; ([{\bf false}]: \; -({\bf -asType}{<} {\bf integer}{>} (\$ {\rm heap}_{funcstart\_724,1}.{\rm p3}) \; / \; 178), \; [!(0 < 10.11)] \; ([{\bf false}]: \; -({\bf -asType}{<} {\bf integer}{>} (\$ {\bf integer}{
-\$heap_{funcstart\_724,1}.p3): asType<integer>(\$heap_{funcstart\_724,1}.p3) / 178)
== asType < integer > (div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p3, 178.quot
\rightarrow [from term 10.0, literala < -$heap<sub>funcstart_724,1</sub>.p3 is false whenever -2 <
(0 + literala)
        Proof of rule precondition:
        [46.11.0] - 2 < (0 + 0)
        \rightarrow [simplify]
        [46.11.2] true
[46.12] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178),
[!false]: asType<integer>($heap<sub>funcstart_724,1.</sub>p3) / 178) ==
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3,
178).quot)
\rightarrow [simplify]
[46.17] \ 0 == (-\text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p3},
178).quot + (\text{$heap}_{funcstart\_724,1}.p3 / 178))
[Assume known post-assertion, class invariant or type constraint for term
[52.0] \operatorname{minof(int)} \leq \operatorname{div}(\operatorname{heapIs} \operatorname{\$heap}_{funcstart\_724,1}, \operatorname{\$heap}_{funcstart\_724,1}.p3,
178).quot
\rightarrow [simplify]
```

```
178).quot
[Take goal term]
[1.0] minof(int) \leq asType<short int>(div3.quot)
\rightarrow [simplify]
[1.1] -32768 \leq asType<short int>(div3.quot)
\rightarrow [from term 43.6, div3 is equal to div(heapIs $heap_{funcstart_{724,1}},
heap_{funcstart_{724,1}}.p3, 178
[1.2] -32768 \leq asType<short int>(div(heapIs $heap_{funcstart\_724,1},)
heap_{funcstart_{-724,1}}.p3, 178.quot
\rightarrow [simplify]
[1.5] -32769 < div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p3,
178).quot
\rightarrow [from term 52.3, literala < div(heapIs $heap<sub>funcstart_724,1</sub>,
heap_{funcstart\_724,1}.p3, 178, quot is true whenever (-1 + literala) < -32769
   Proof of rule precondition:
   [1.5.0] (-32769 + -1) < -32769
   \rightarrow [simplify]
   [1.5.2] true
[1.6] true
Proof of verification condition: Type constraint satisfied in implicit
conversion from 'short int' to 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (65,40)
Condition defined at:
To prove: asType<short int>(div3.quot) \le maxof(int)
Given:
heap_{init}.LIMIT == (int)80
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
\theta
\theta
\theta
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
```

[52.3] -32769 < div(heapIs \$heap_{funcstart_724,1}, \$heap_{funcstart_724,1}.p3,

```
\theta_{init}.a2 == asType<short int>((int)176)
\theta sheap<sub>init</sub>.b2 == asType<short int>((int)35)
\theta sheap<sub>init</sub>.M3 == asType<short int>((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
heap_{init}.b3 == asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
invariant
1<br/>( \mathbf{heapIs}\ \$ \mathbf{heap}_{funcstart\_724,1})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \ \operatorname{\$heap}_{funcstart\_724,1},
\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(asType<int>(asType<int>($heap_{tuncstart\_724.1}.p1)) /
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}))) = =
asType<integer>(div1.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) ==
asType<integer>(div1.rem))
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) /
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))) ==
asType<integer>(div2.rem)
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) <
```

```
asType < integer > (\$heap_{funcstart_{-724,1}}.a2)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p2) = =
asType<integer>(div2.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a2}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
asType < int > (\$heap_{funcstart_{-724,1}}.a3))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(asType<int>(sheap<sub>funcstart_724,1.</sub>p3)) %
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a3}))) = =
asType<integer>(div3.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) ==
asType<integer>(div3.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a3) \le
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})) => !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
\mathbf{asType} \hspace{-0.1em}<\hspace{-0.1em} \mathbf{int} \hspace{-0.1em}> \hspace{-0.1em} (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{r1})) - (\mathbf{asType} \hspace{-0.1em}<\hspace{-0.1em} \mathbf{int} \hspace{-0.1em}> \hspace{-0.1em} (\mathbf{asType} \hspace{-0.1em}<\hspace{-0.1em} \mathbf{short})
int>(div1.quot)) * asType<int>($heap_{funcstart\_724,1}.b1)))
-asType<integer const>($heap<sub>724,1:745,8</sub>.M1) <
asType<integer>($heap<sub>724,1:745,8</sub>.p1)
!(0 == asType < integer > (\$heap_{724,1:745.8}.p1))
asType<integer>($heap<sub>724.1:745.8</sub>.p1) <
asType<integer>($heap<sub>724,1:745,8</sub>.M1)
\$heap_{724,1;747,8} == \$heap_{724,1;745,8}. \textbf{\_replace}(p2 \rightarrow \textbf{asType} < \textbf{short}
int>((asType<int>(asType<short int>(div2.rem)) *
\mathbf{asType} < \mathbf{int} > (\$ heap_{724,1;745,8}.r2)) - (\mathbf{asType} < \mathbf{int} > (\mathbf{asType} < \mathbf{short})
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
-asType<integer const>($heap<sub>724.1:747.8</sub>.M2) <
```

```
asType<integer>($heap<sub>724.1:747.8</sub>.p2)
!(0 == asType < integer > (\$heap_{724,1:747.8} \cdot p2))
asType<integer>($heap<sub>724.1:747.8</sub>.p2) <
asType<integer>($heap<sub>724,1;747,8</sub>.M2)
Proof:
[Take given term]
[5.0] invariant1(heapIs heap_{funcstart\_724,1})
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
 \texttt{[5.1]} \left( \left( \left( \left( (0 < \mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p1) \right) \right. \&\& \right. \right. 
(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 < funcstart\_724,1)
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [simplify]
[5.3] (((((0 < $heap_{funcstart_724,1}.p1) && ($heap_{funcstart_724,1}.p1 < function for the content of the 
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 < function for the start of the start 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M3}))
\rightarrow [const static or extern object]
asType < integer > (\$heap_{init}.M1))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < $heap_{funcstart_{724,1}}.p1) && ($heap_{funcstart_{724,1}}.p1 < 
\mathbf{asType} \small{<} \mathbf{integer} \small{>} (\mathbf{asType} \small{<} \mathbf{short} \ \mathbf{int} \small{>} ((\mathbf{int})30269)))) \ \&\& \ (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(asType<integer>($heap_{tuncstart\_724.1}.p2) <
```

```
asType<integer>(heap_{funcstart\_724,1}.M2))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.16] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p3) < 
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M3}))
\rightarrow [const static or extern object]
[5.17] ((((-30269 < -$heap_{funcstart\_724,1}.p1) \lambda (0 < $heap_{funcstart\_724,1}.p1) \lambda
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType < integer > (\$heap_{init}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M3}))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p3) < 
asType<integer>($heap_funcstart_724,1.M3))
\rightarrow [simplify]
[5.30] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\$heap_{funcstart\_724,1}.p2) \land (0 < \$heap_{funcstart\_724,1}.p3)) \&\&
(\text{\$heap}_{funcstart\_724,1}.p3 < asType < integer > (\text{\$heap}_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -$heap_funcstart_724,1.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1.p2} \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.\text{p3} < \text{asType} < \text{integer} > (\text{\$heap}_{init}.\text{M3}))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \wedge (-30269 <
 -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.p2) \land (0 < \text{Sheap}_{funcstart\_724,1}.p3)) \&\&
(\text{\$heap}_{funcstart\_724,1}.p3 < asType < integer > (asType < short)
int > ((int)30323)))
```

```
\rightarrow [simplify]
[5.40] (-30323 < -$heap<sub>funcstart_724,1.</sub>p3) \land (-30307 <
-\$heap_{funcstart\_724,1}.p2) \wedge (-30269 < -\$heap_{funcstart\_724,1}.p1) \wedge (0 <
\text{Sheap}_{funcstart\_724,1}.\text{p1}) \land (0 < \text{Sheap}_{funcstart\_724,1}.\text{p2}) \land (0 <
heap_{funcstart_{-724,1}.p3}
[Work on sub-term 6 of conjunction in term 5.40]
[10.0] \ 0 < \$ heap_{funcstart\_724,1}.p3
[Take given term]
[43.0] div3 == div(heapIs $heap_{funcstart\_724,1},
\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
\rightarrow [simplify]
[43.1] \ \mathrm{div3} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3},
asType < int > (\$heap_{funcstart\_724,1}.a3))
\rightarrow [const static or extern object]
[43.2] \operatorname{div3} == \operatorname{div}(\mathbf{heapIs} \ \operatorname{\$heap}_{funcstart\_724,1}, \ \operatorname{\$heap}_{funcstart\_724,1}.p3,
asType < int > (\$heap_{init}.a3))
\rightarrow [expand definition of constant 'a3' at prang.c (26,20)]
[43.3] \ \mathrm{div3} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3},
asType<int>(asType<short int>((int)178)))
\rightarrow [simplify]
[43.6] div3 == div(heapIs $heap_{funcstart\_724,1}$, $heap_{funcstart\_724,1}.p3, 178)
[Assume known post-assertion, class invariant or type constraint for term 43.6]
[46.0] (asType<integer>($heap_{funcstart\_724,1}.p3) /
asType<integer>(178)) == asType<integer>(div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p3, 178).quot)
\rightarrow [simplify]
[46.2] ($heap<sub>funcstart_724,1.</sub>p3 / 178) == asType<integer>(div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot}
→ [expand definition of operator './' in class 'int' at built in declaration]
[46.3] ([asType<integer>(heap_{funcstart\_724.1}.p3) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178), []:
asType < integer > ($heap_{funcstart\_724,1}.p3) / 178) ==
asType<integer>(div(heapIs p_{funcstart-724,1}, p_{funcstart-724,1}, p_{funcstart-724,1}),
178).quot)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[46.4] ([asType<integer>($heap_{funcstart\_724.1}.p3) < 0]:
```

```
-(-asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 0)]:
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})~/~178) ==
asType<integer>(div(heapIs p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}),
178).quot)
\rightarrow [simplify]
[46.7] ([0 < -$heap<sub>funcstart_724,1</sub>.p3]:
-(-\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) \ / \ 178),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178) = =
\mathbf{asType} < \mathbf{integer} > (\mathbf{div}(\mathbf{heapIs} \$ \mathbf{heap}_{funcstart\_724,1}, \$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3},
178).quot)
\rightarrow [from term 10.0, literala < -$heap<sub>funcstart_724.1</sub>.p3 is false whenever -2 <
(0 + literala)
        Proof of rule precondition:
        [46.7.0] - 2 < (0 + 0)
        \rightarrow [simplify]
        [46.7.2] true
[46.8] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 0)]:
\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) \ / \ 178) = =
asType<integer>(div(heapIs $heap_{tuncstart_724.1}, $heap_{tuncstart_724.1.p3},
178).quot)
\rightarrow [simplify]
[46.11] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178), [!(0 < integer) < (integer) < (
-\$heap_{funcstart\_724,1}.p3): asType<integer>(\$heap_{funcstart\_724,1}.p3) / 178)
== asType < integer > (div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p3}, 178).quot
\rightarrow [from term 10.0, literala < -$heap<sub>funcstart_724,1</sub>.p3 is false whenever -2 <
(0 + literala)
        Proof of rule precondition:
        [46.11.0] - 2 < (0 + 0)
        \rightarrow [simplify]
        [46.11.2] true
[46.12] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178),
[!false]: asType<integer>(\theta_{funcstart\_724,1.p3}) / 178) ==
\mathbf{asType} < \mathbf{integer} > (\mathbf{div}(\mathbf{heapIs} \ \$ \mathbf{heap}_{funcstart\_724,1}, \ \$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}, \\
178).quot)
```

```
\rightarrow [simplify]
[46.17] 0 == (-\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.p3,
178).quot + (\text{$heap}_{funcstart\_724,1}.p3 / 178))
[Assume known post-assertion, class invariant or type constraint for term
46.17
[53.0] div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).quot \leq
maxof(int)
\rightarrow [simplify]
\label{eq:continuous} \mbox{[53.9] -32768} < -\mbox{div}(\mbox{\bf heapIs} \ \mbox{\$heap}_{funcstart\_724,1}, \ \mbox{\$heap}_{funcstart\_724,1}.\mbox{p3},
178).quot
[Take goal term]
[1.0] asType<short int>(div3.quot) \leq maxof(int)
\rightarrow [from term 43.6, div3 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1}}.p3, 178
[1.1] asType<short int>(div(heapIs heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} \leq \text{maxof}(\text{int})
\rightarrow [simplify]
[1.11] -32768 < -\text{div}(\mathbf{heapIs} \ \text{$heap}_{funcstart\_724.1}, \ \text{$heap}_{funcstart\_724.1.p3},
178).quot
\rightarrow [from term 53.9, literala < -div(heapIs $heap_{funcstart\_724,1},
\rho_{funcstart\_724,1}.p3,\ 178).quot is true whenever (-1 + literala) < -32768
    Proof of rule precondition:
    [1.11.0](-32768 + -1) < -32768
    \rightarrow [simplify]
    [1.11.2] true
[1.12] true
Proof of verification condition: Type constraint satisfied in implicit
conversion from 'short int const' to 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (65,35)
Condition defined at:
To prove: minof(int) \le \text{$heap}_{724,1;747,8}.b3
Given:
heap_{init}.LIMIT == (int)80
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
```

```
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta = asType < short int > ((int)2)
heap_{init}.M2 == asType < short int > ((int)30307)
\theta_{init}.r2 == asType<short int>((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs $heap_{tuncstart_724.1})
div1 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}))\ /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(\mathbf{asType} {<} \mathbf{integer} {>} (\mathbf{asType} {<} \mathbf{int} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1})) =>
(asType < integer > (\$heap_{funcstart\_724.1}.p1) = =
asType<integer>(div1.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathtt{a1}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p1)) => !(0 ==
asType < integer > (div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
```

```
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}))\ /
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.quot)
(asType<int>(asType<int>($heap_{funcstart\_724,1}.p2)) %
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p2) = =
asType<integer>(div2.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a2) \le
asType < integer > (\$heap_{funcstart\_724,1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart_{-724.1}},
\mathbf{asType} < \mathbf{int} > (\$ heap_{funcstart\_724,1}.p3),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3})) \ / \\
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a3}))) = =
asType<integer>(div3.quot)
(asType<integer>(asType<int>($heap_{tuncstart\_724.1}.p3)) %
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a3}))) = =
asType<integer>(div3.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a3})) = >
(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a3}) \leq
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3})) => !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
-asType < integer const > (\$heap_{724,1:745.8}.M1) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{p1})
!(0 == asType < integer > (\$heap_{724,1;745,8}.p1))
```

```
{\bf asType}{<} {\bf integer}{>} (\${\rm heap}_{724,1;745,8}.{\rm p1}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{M1})
heap_{724,1:747,8} == heap_{724,1:745,8}.replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724.1:745.8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType< int>($heap_{724,1;745,8}.b2))))
-asType < integer const > (\$heap_{724,1:747,8}.M2) < 
asType<integer>($heap<sub>724,1:747,8</sub>.p2)
!(0 == \mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathrm{heap}_{724,1;747,8}.\mathrm{p2}))
asType<integer>($heap<sub>724.1:747.8</sub>.p2) <
asType<integer>($heap<sub>724,1:747,8</sub>.M2)
Proof:
[Take given term]
[11.0] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
\rightarrow [simplify]
[11.1]~{\rm div1} == {\rm div}(\mathbf{heapIs}~\$ \mathrm{heap}_{funcstart\_724,1},~\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
\rightarrow [const static or extern object]
\textit{[11.2]} \ \text{div1} == \text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
asType < int > (\$heap_{init}.a1))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
[11.3] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType<int>(asType<short int>((int)177)))
\rightarrow [simplify]
[11.6] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, 177)
[Take given term]
[27.0] \operatorname{div2} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
\rightarrow [simplify]
[27.1] \operatorname{div2} == \operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p2,
asType < int > (\$heap_{funcstart\_724,1}.a2))
\rightarrow [const static or extern object]
[27.2] \operatorname{div2} == \operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p2,
asType < int > (\$heap_{init}.a2))
```

```
\rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
[27.3] \ \mathrm{div2} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2},
asType<int>(asType<short int>((int)176)))
\rightarrow [simplify]
[27.6] \text{ div2} == \text{div}(\mathbf{heapIs} \$ heap_{funcstart\_724,1}, \$ heap_{funcstart\_724,1}.p2, 176)
[Take given term]
[59.0] \rho_{1745,8} == \rho_{1745
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1.quot})) \ * \ \mathbf{asType}{<} \mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{tuncstart_724.1},
heap_{funcstart_{-724,1}}.p1, 177
[59.1] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},
\theta_{funcstart\_724,1.p1, 177}.rem) * asType < int > (\theta_{funcstart\_724,1.r1}) - (\theta_{funcstart\_724,1.r1}
(asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [simplify]
[59.3] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
\mathbf{asType} \small{<} \mathbf{int} \small{>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{r1})) \\ - (\mathbf{asType} \small{<} \mathbf{int} \small{>} (\mathbf{asType} \small{<} \mathbf{short}
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
\rightarrow [const static or extern object]
[59.4] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType < int > (\$heap_{init}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
\rightarrow [expand definition of constant 'r1' at prang.c (15,20)]
[59.5] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType<int>(asType<short int>((int)171))) -
(asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [simplify]
[59.8] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem * 171)
 - (asType < int > (asType < short int > (div1.quot))*
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
```

```
heap_{funcstart_{-724,1}}.p1, 177
[59.9] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int > ((171 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)
 - (asType<int>(asType<short int>(div(heapIs $heap_{tuncstart\_724.1},
heap_{funcstart_{724,1}}.p1, 177).quot) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [simplify]
[59.11] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType < int > (\$heap_{funcstart\_724,1}.b1)))
\rightarrow [const static or extern object]
[59.12] \theta_{12} = \theta_{124,1;745,8} = \theta_{124,1;74
int>((171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType < int > (\$heap_{init}.b1))))
\rightarrow [expand definition of constant 'b1' at prang.c (17,20)]
[59.13] \text{sheap}_{724,1;745,8} == \text{sheap}_{funcstart\_724,1}.replace(p1 \rightarrow asType<short
\mathbf{int} > ((171 * \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, 177).\operatorname{rem})
 — (div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).quot *
asType<int>(asType<short int>((int)2))))
\rightarrow [simplify]
[59.19] $\text{heap}_{724,1:745,8} == \text{$heap}_{funcstart\_724,1}._\text{$replace}(p1 \to ((-2 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).rem)))
[Take given term]
[63.0] $\text{heap}_{724,1:747,8} == $\text{heap}_{724,1:745,8}._\text{replace}(p2 \rightarrow \text{asType} < \text{short}
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724,1:745,8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724,1:745,8</sub>.b2))))
\rightarrow [from term 59.19, $heap<sub>724,1;745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1},p1, 177}, quot) + (171 * div(heapIs p_{funcstart_{724,1},p1, 177}), quot)
$heap_{uncstart_724.1.p1, 177).rem})]
[63.1] \rho_{13,1,747,8} == \rho_{13,1,747,8} == \rho_{13,1,747,8} = \rho_{13,1,747,
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
(177).rem))).\_replace(p2 \rightarrow asType < short)
int>((asType<int>(asType<short int>(div2.rem)) *
\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{724,1;745,8}.\mathrm{r2})) - (\mathbf{asType} < \mathbf{int} > (\mathbf{asType} < \mathbf{short}))
```

```
int>(div2.quot)) * asType< int>($heap_{724.1:745.8}.b2))))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p2, 176
[63.2] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
(177).rem))).\_replace(p2 \rightarrow asType < short)
\mathbf{int}{>}((\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{short}\ \mathbf{int}{>}(\mathbf{div}(\mathbf{heapIs}\ \$\mathbf{heap}_{funcstart\_724,1},
\text{sheap}_{funcstart\_724,1.p2, 176}.\text{rem}) * asType < int > (\text{sheap}_{724,1;745,8.r2})) -
(asType<int>(asType<short int>(div2.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\${\rm heap}_{724,1;745,8}.{\rm b2}))))
\rightarrow [simplify]
[63.4] heap_{724,1;747,8} == heap_{funcstart\_724,1}.\_replace(p1 \to ((-2 * 
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
(177).rem))._replace(p2 \rightarrow asType<short int>((div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem *
\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{724,1;745,8}.\mathrm{r2})) - (\mathbf{asType} < \mathbf{int} > (\mathbf{asType} < \mathbf{short}))
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [from term 59.19, $heap<sub>724.1:745.8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724,1}),
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p1, 177).rem}
[63.5] $heap<sub>724,1:747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((\operatorname{div}(\mathbf{heapIs}))))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathtt{\_replace}(\mathrm{p1} \rightarrow ((\text{-}2\ *\ \mathrm{div}(\mathbf{heapIs}
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1},p1, 177).rem})).r2)) -
(asType<int>(asType<short int>(div2.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{b2}))))
\rightarrow [const member of object with modified fields]
[63.6] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((\operatorname{div}(\mathbf{heapIs}))))
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}.p2, 176).rem *
asType < int > (\$heap_{funcstart\_724,1}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType< int>($heap_{724,1;745,8}.b2))))
\rightarrow [const static or extern object]
```

```
[63.7] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\label{eq:div_heap} \text{div}(\textbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
(177).rem))._replace(p2 \rightarrow asType<short int>((div(heapIs)))._replace(p2 \rightarrow asType
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}.p2, 176).rem *
asType < int > (\$heap_{init}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [expand definition of constant 'r2' at prang.c (20,20)]
[63.8] $heap<sub>724,1:747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\label{eq:div_heap} \text{div}(\textbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((\operatorname{div}(\mathbf{heapIs}))))
\rho_{funcstart\_724,1}, \rho_{funcstart\_724,1.p2, 176}.rem *
asType<int>(asType<short int>((int)172))) -
(asType<int>(asType<short int>(div2.quot)) *
asType<int>($heap<sub>724,1;745,8</sub>.b2))))
\rightarrow [simplify]
[63.11] $\text{heap}_{724,1;747,8} == \text{$heap}_{funcstart_724,1}. \text{$\bf replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}. p1, \ 177). \operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p2, 176).rem * 172) -
(asType<int>(asType<short int>(div2.quot)) *
asType < int > (\$heap_{724,1:745.8}.b2))))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1},p2,176}
[63.12] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem) -
(asType<int>(asType<short int>(div(heapIs $heap_{funcstart_724.1},
\text{Sheap}_{funcstart\_724,1}.p2, 176).quot) * asType<int>(\text{Sheap}_{724,1:745,8}.b2))))
\rightarrow [simplify]
[63.14] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs)
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}.p2, 176).quot *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{b2}))))
\rightarrow [from term 59.19, $heap<sub>724,1:745,8</sub> is equal to
```

```
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1},p1, 177}, quot) + (171 * div(heapIs heap_{funcstart_{724,1},p1, 177})
heap_{funcstart_{-724,1}}.p1, 177).rem)
[63.15] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
\text{Sheap}_{funcstart_{724,1}}, \text{Sheap}_{funcstart_{724,1}}, p2, 176).quot *
asType < int > (\$heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * div(heapIs)))))))
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p1, 177).quot) + (171 * div(heapIs
\text{Sheap}_{funcstart_{-724,1}}, \text{Sheap}_{funcstart_{-724,1}}.p1, 177).rem))).b2))))
→ [const member of object with modified fields]
[63.16] $\text{heap}_{724.1:747.8} == $\text{heap}_{funcstart_724.1}._\text{replace}(p1 \to ((-2 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724.1}, \ \$heap_{funcstart\_724.1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1},p2,176}.rem) - (div(heapIs)
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 2, 176.quot *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{b2}))))
\rightarrow [const static or extern object]
[63.17] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 2, 176.quot *
asType < int > (\$heap_{init}.b2)))
\rightarrow [expand definition of constant 'b2' at prang.c (22,20)]
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\label{eq:div_heap} \text{div}(\textbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 176).quot *
asType<int>(asType<short int>((int)35)))))
\rightarrow [simplify]
[63.24] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
```

```
heap_{funcstart_{-724,1}.p2, 176).rem))
[Take goal term]
[1.0] minof(int) \leq $heap<sub>724,1:747.8</sub>.b3
\rightarrow [simplify]
[1.1] -32768 \leq $heap<sub>724.1:747.8</sub>.b3
\rightarrow [from term 63.24, $heap<sub>724,1;747,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs p_{funcstart\_724,1})
\rho_{funcstart\_724,1}.p1, 177).rem))._replace\rho_{funcstart\_724,1}.p1, 177).rem))._replace
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).quot) + (172 * div(\textbf{heapIs})
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem)
[1.2] -32768 \leq $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
* div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, p2, 176).quot) + (172 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p2, \ 176).rem))).b3
\rightarrow [const member of object with modified fields]
\textit{[1.4] -32768} \leq \$ heap_{funcstart\_724,1}.b3
\rightarrow [const static or extern object]
[1.5] -32768 \le \text{$heap}_{init}.b3
\rightarrow [expand definition of constant 'b3' at prang.c (27,20)]
[1.6] -32768 \leq asType<short int>((int)63)
\rightarrow [simplify]
[1.9] true
Proof of verification condition: Type constraint satisfied in implicit
conversion from 'short int const' to 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (65,35)
Condition defined at:
To prove: heap_{724,1;747,8}.b3 \le maxof(int)
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta
```

```
heap_{init}.M2 == asType < short int > ((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
\theta
heap_{init}.b2 == asType<short int>((int)35)
\theta sheap<sub>init</sub>.M3 == asType<short int>((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\rho = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart_{-724,1}})
div1 == div(\mathbf{heapIs} \$ heap_{funcstart\_724.1},
asType < int > (\$heap_{funcstart\_724.1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) ==
asType<integer>(div1.quot)
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \%
asType < integer > (asType < int > (\$heap_{funcstart_{-724.1}}.a1))) = =
asType<integer>(div1.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1})) =>
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) ==
asType<integer>(div1.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a1) \le
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart_{-724.1}},
asType < int > (\$heap_{funcstart\_724,1}.p2),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p2})) \ / \\
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) \%
```

```
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(asType < integer > ($heap_{funcstart\_724.1}.p2) = =
asType<integer>(div2.rem))
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
(asType<integer>(asType<int>($heap_{tuncstart\_724.1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724.1}.a3))) = =
asType<integer>(div3.quot)
(asType < integer > (asType < int > (\$heap_{tuncstart\_724,1}.p3)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) ==
asType<integer>(div3.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a3}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
\$heap_{724,1;745,8} == \$heap_{funcstart\_724,1}.\_\mathbf{replace}(p1 \rightarrow \mathbf{asType} < \mathbf{short}
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
-\mathbf{asType} {<} \mathbf{integer\ const} {>} (\$ \mathbf{heap}_{724,1;745,8}.\mathbf{M1}) <
asType<integer>($heap<sub>724,1;745,8</sub>.p1)
!(0 == asType < integer > (\$heap_{724,1;745,8}.p1))
asType<integer>($heap<sub>724,1;745,8</sub>.p1) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{M1})
heap_{724,1:747,8} == heap_{724,1:745,8}._replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div2.rem))
```

```
asType < int > (\$heap_{724.1:745.8}.r2)) - (asType < int > (asType < short)
\mathbf{int}{>}(\text{div2.quot})) \ * \ \mathbf{asType}{<} \mathbf{int}{>} (\$\text{heap}_{724,1;745,8}.\text{b2}))))
-\mathbf{asType}{<}\mathbf{integer\ const}{>}(\$\mathrm{heap}_{724,1;747,8}.\mathrm{M2}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;747,8}.\mathrm{p2})
!(0 == asType < integer > (\$heap_{724,1;747,8}.p2))
asType<integer>($heap<sub>724,1:747,8</sub>.p2) <
asType<integer>($heap<sub>724,1:747,8</sub>.M2)
Proof:
[Take given term]
[11.0] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a1}))
\rightarrow [simplify]
[11.1] div1 == div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
asType < int > (\$heap_{funcstart\_724.1}.a1))
\rightarrow [const static or extern object]
[11.2] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType < int > (\$heap_{init}.a1))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
\label{eq:linear_start_724,1} [11.3] \ \mathrm{div1} == \ \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType<int>(asType<short int>((int)177)))
\rightarrow [simplify]
[11.6] div1 == div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p1, 177)
[Take given term]
[27.0] div2 == div(heapIs $heap_{tuncstart\_724.1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
\rightarrow [simplify]
[27.1]~{\rm div2} == {\rm div}(\mathbf{heapIs}~\$ \mathrm{heap}_{funcstart\_724,1},\,\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2},
asType < int > (\$heap_{funcstart\_724,1}.a2))
\rightarrow [const static or extern object]
[27.2]~{\rm div2} == {\rm div}(\mathbf{heapIs}~\$ \mathrm{heap}_{funcstart\_724,1},\,\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2},
asType < int > (\$heap_{init}.a2))
\rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
[27.3] \operatorname{div2} == \operatorname{div}(\mathbf{heapIs} \operatorname{\$heap}_{funcstart\_724,1}, \operatorname{\$heap}_{funcstart\_724,1}.p2,
asType<int>(asType<short int>((int)176)))
```

```
[27.6] \text{ div2} == \text{div}(\mathbf{heapIs} \$ heap_{funcstart\_724,1}, \$ heap_{funcstart\_724,1}.p2, 176)
[Take given term]
[59.0] \rho_{1745,8} == \rho_{1745,8} == \rho_{1745,8} == \rho_{1745,8}._replace(p1 \rightarrow \rho_{1745,8} == \rho_{1745,8}
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1.quot})) \ * \ \mathbf{asType}{<} \mathbf{int}{>} (\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177
[59.1] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}) * asType < int > (\text{Sheap}_{funcstart\_724,1}.\text{r1})) -
(asType<int>(asType<short int>(div1.quot)) *
\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
\rightarrow [simplify]
[59.3] \rho_{1745,8} == \rho_{1745,8} == \rho_{1745,8} == \rho_{1745,8}._replace(p1 \rightarrow \rho_{1745,8} == \rho_{1745,8}
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType < int > (\$heap_{tuncstart\_724.1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
\rightarrow [const static or extern object]
[59.4] \rho_{1745,8} == \rho_{1745,8} == \rho_{1745,8} == \rho_{1745,8}._replace(p1 \rightarrow \rho_{1745,8} == \rho_{1745,8}
\mathbf{int}{>}((\mathrm{div}(\mathbf{heapIs}\ \$\mathrm{heap}_{funcstart\_724,1},\ \$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},\ 177).\mathrm{rem}\ *
asType < int > (\$heap_{init}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
\rightarrow [expand definition of constant 'r1' at prang.c (15,20)]
[59.5] \rho_{1745,8} == \rho_{1745,8} == \rho_{1745,8} == \rho_{1745,8}._replace(p1 \rightarrow \rho_{1745,8} == \rho_{1745,8}
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType<int>(asType<short int>((int)171))) -
(asType<int>(asType<short int>(div1.quot)) *
\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
\rightarrow [simplify]
[59.8] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
\mathbf{int} > ((\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, \ 177).\operatorname{rem} \ * \ 171)
- (asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177
[59.9] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).rem)
```

 \rightarrow [simplify]

```
- (asType<int>(asType<short int>(div(heapIs $heap_{tuncstart\_724.1},
heap_{funcstart_{724,1}}.p1, 177).quot) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [simplify]
[59.11] \theta == 
int>((171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [const static or extern object]
[59.12] heap_{724,1;745,8} == heap_{funcstart\_724,1}. replace(p1 \rightarrow asType<short
int>((171 * div(heapIs \$heap_{tuncstart\_724.1}, \$heap_{tuncstart\_724.1}, p1, 177).rem)
- (div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1, 177).quot *
asType < int > (\$heap_{init}.b1)))
\rightarrow [expand definition of constant 'b1' at prang.c (17,20)]
[59.13] heap_{724,1;745,8} == heap_{funcstart\_724,1}. replace(p1 \rightarrow asType<short
int>((171 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType<int>(asType<short int>((int)2))))
\rightarrow [simplify]
[59.19] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724.1}, \ \text{\$heap}_{funcstart\_724.1}, 177).rem)))
[Take given term]
[63.0] $heap<sub>724.1:747.8</sub> == $heap<sub>724.1:745.8</sub>._replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724.1:745.8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [from term 59.19, $heap<sub>724,1:745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724,1}),
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1}, 177).quot) + (171 * div(heapIs $heap_{funcstart\_724,1}, 17
heap_{funcstart_{-724,1},p1,177,rem}
[63.1] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724.1}, \ \$heap_{funcstart\_724.1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{r2})) - (\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{short}
int>(div2.quot)) * asType< int>($heap_{724,1:745,8}.b2))))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1},p2,176}
```

```
[63.2] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\label{eq:div_heap} \text{div}(\textbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).rem)))._replace(p2 \rightarrow asType<short
\mathbf{int}{>}((\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{short}\ \mathbf{int}{>}(\mathbf{div}(\mathbf{heapIs}\ \$\mathbf{heap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{rem}) * asType < int > (\text{Sheap}_{724,1:745.8}.\text{r2})) -
(asType<int>(asType<short int>(div2.quot)) *
asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [simplify]
[63.4] $heap<sub>724,1:747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((\operatorname{div}(\mathbf{heapIs}))))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem *
\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{724,1;745,8}.\mathrm{r2})) - (\mathbf{asType} < \mathbf{int} > (\mathbf{asType} < \mathbf{short}))
int>(div2.quot)) * asType<int>($heap<sub>724,1:745,8</sub>.b2))))
\rightarrow [from term 59.19, $heap<sub>724.1:745.8</sub> is equal to
heap_{funcstart\_724.1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724.1}),
\text{Sheap}_{funcstart\_724,1}.p1, 177).quot) + (171 * div(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177).rem)
[63.5] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724.1}, \ \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((\operatorname{div}(\mathbf{heapIs}))))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem *
asType < int > (\$heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * div(heapIs)))))))
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p1, 177).quot) + (171 * div(heapIs
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, 177).rem))).r2)) -
(asType<int>(asType<short int>(div2.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{b2}))))
\rightarrow [const member of object with modified fields]
[63.6] $heap<sub>724.1:747.8</sub> == $heap<sub>funcstart_724.1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((\operatorname{div}(\mathbf{heapIs}))))
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1},p2,176}.rem *
\mathbf{asType} \hspace{-0.1em}<\hspace{-0.1em} \mathbf{int} \hspace{-0.1em}> \hspace{-0.1em} (\$ heap_{funcstart\_724,1}.r2)) - (\mathbf{asType} \hspace{-0.1em}<\hspace{-0.1em} \mathbf{int} \hspace{-0.1em}> \hspace{-0.1em} (\mathbf{asType} \hspace{-0.1em}<\hspace{-0.1em} \mathbf{short})
int > (div2.quot)) * asType < int > (\$heap_{724,1:745,8}.b2))))
\rightarrow [const static or extern object]
[63.7] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
```

```
177).rem)))._{replace(p2 \rightarrow asType < short int > ((div(heapIs))))}
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem *
asType < int > (\$heap_{init}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724,1:745,8</sub>.b2))))
\rightarrow [expand definition of constant 'r2' at prang.c (20,20)]
[63.8] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 176).rem *
asType<int>(asType<short int>((int)172))) -
(asType<int>(asType<short int>(div2.quot)) *
asType < int > (\$heap_{724,1:745,8}.b2))))
\rightarrow [simplify]
[63.11] $\text{heap}_{724,1;747,8} == \text{$heap}_{funcstart\_724,1}.$\text{$_-replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem))).replace(p2 \rightarrow asType < short int > ((div(heapIs)))
\text{Sheap}_{funcstart_{724,1}}, \text{Sheap}_{funcstart_{724,1}}.\text{p2}, 176).\text{rem} * 172) -
(asType<int>(asType<short int>(div2.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\${\rm heap}_{724,1;745,8}.{\rm b2}))))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{funcstart_724,1},
heap_{funcstart_{-724,1}}.p2, 176
[63.12] $\text{heap}_{724,1:747,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}.p2, 176).rem –
(asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},
\text{sheap}_{funcstart\_724,1.p2, 176}.\text{quot}) * asType < int > (\text{sheap}_{724,1;745,8}.\text{b2}))))
\rightarrow [simplify]
[63.14] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}.p2, 176).quot *
asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [from term 59.19, $heap<sub>724.1:745.8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724,1}),
\text{Sheap}_{funcstart\_724,1}.p1, 177).quot) + (171 * div(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177).rem)
```

```
[63.15] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\label{eq:div_heap} \text{div}(\textbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1},p2,176}, quot *
asType<int>($heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs}))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).rem))).b2))))
\rightarrow [const member of object with modified fields]
[63.16] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem))).\_replace(p2 \rightarrow asType<short int>((172 * div(heapIs
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, 2, 176).quot *
asType < int > (\$heap_{funcstart\_724,1}.b2))))
\rightarrow [const static or extern object]
[63.17] $\text{heap}_{724,1:747,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem}) - (\text{div}(\text{heapIs})
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}.p2, 176).quot
asType < int > (\$heap_{init}.b2))))
\rightarrow [expand definition of constant 'b2' at prang.c (22,20)]
[63.18] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((172 * div(\mathbf{heapIs}))))
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p2, 176).quot *
asType<int>(asType<short int>((int)35)))))
\rightarrow [simplify]
[63.24] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
(-35 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p2, 176).rem)
[Take goal term]
```

```
[1.0] $heap<sub>724.1:747.8</sub>.b3 \leq maxof(int)
\rightarrow [from term 63.24, $heap<sub>724.1:747.8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot) + (171 * div(heapIs $heap_{funcstart\_724,1}, 1
\rho_{funcstart\_724,1}.p1, 177).rem))._replace\rho_{funcstart\_724,1}.p1, 177).rem)
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p2, 176).rem)
[1.1] \text{heap}_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs \text{heap}_{funcstart\_724,1}),
\rho_{tuncstart_{-724,1},p1, 177}, quot) + (171 * div(heapIs \rho_{tuncstart_{-724,1},p1, 177}).
\theta_{funcstart\_724,1}.p1, 177).rem))).\_replace(p2 \rightarrow ((-35 * div(heapIs)))._replace(p2 \rightarrow ((-35 * div(heapIs))))._replace(p2 \rightarrow ((-35 * div(heapIs))))._replace(p2 \rightarrow ((-35 * div(heapIs)))))._replace(p2 \rightarrow ((-35 * div(heapIs)))))._replace(p2 \rightarrow ((-35 * div(heapIs)))))._replace(p2 \rightarrow ((-35 * div(heapIs)))))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
\$ heap_{funcstart\_724,1}, \$ heap_{funcstart\_724,1}.p2, 176).rem))).b3 \leq \mathbf{maxof(int)}
→ [const member of object with modified fields]
\textit{[1.3]} \$ heap_{funcstart\_724,1}.b3 \leq \textbf{maxof(int)}
\rightarrow [const static or extern object]
[1.4] $heap<sub>init</sub>.b3 \leq maxof(int)
\rightarrow [expand definition of constant 'b3' at prang.c (27,20)]
[1.5] asType<short int>((int)63) \le maxof(int)
\rightarrow [simplify]
[1.9] true
Proof of verification condition: Arithmetic result of operator '*' is within
limit of type 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (65,38)
Condition defined at:
To prove: minof(int) \le (asType<int>(asType<short int>(div3.quot)) *
asType < int > (\$heap_{724,1;747,8}.b3))
Given:
heap_{init}.LIMIT == (int)80
\theta
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
heap_{init}.M2 == asType < short int > ((int)30307)
\rho_{init}.r2 == asType < short int > ((int)172)
\theta_{init}.a2 == asType<short int>((int)176)
```

```
\theta sheap<sub>init</sub>.b2 == asType<short int>((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
heap_{init}.b3 == asType < short int > ((int)63)
\theta
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart\_724,1})
div1 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(\mathbf{asType} {<} \mathbf{integer} {>} (\mathbf{asType} {<} \mathbf{int} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ / \\
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))) = =
asType<integer>(div1.quot)
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(asType < integer > ($heap_{funcstart\_724,1}.p1) < 
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) ==
asType<integer>(div1.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathtt{a1}) \leq
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1})) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p2})) \ / \\
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))) ==
asType<integer>(div2.quot)
(asType < integer > (asType < int > (\$heap_{tuncstart\_724.1}.p2)) \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.rem)
(asType<integer>($heap_{tuncstart\_724,1}.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
```

```
(asType < integer > ($heap_{funcstart_{-724,1}}.p2) = =
asType<integer>(div2.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
(asType<integer>(asType<int>($heap_{tuncstart\_724.1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}))~\%
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a3}))) = =
asType<integer>(div3.rem)
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3})) =>
(asType < integer > ($heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a3) \le
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})) => !(0 ==
asType<integer>(div3.quot))
!(0 == asTvpe < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
\$heap_{724,1;745,8} == \$heap_{funcstart\_724,1}.\_\textbf{replace}(p1 \rightarrow \textbf{asType} < \textbf{short}
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{tuncstart\_724.1}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1}.\mathbf{quot})) * \mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
-{\bf asType}{<} {\bf integer~const}{>} (\${\rm heap}_{724,1;745,8}.{\rm M1}) <
asType<integer>($heap<sub>724,1:745,8</sub>.p1)
!(0 == asType < integer > (\$heap_{724,1:745.8}.p1))
asType<integer>($heap<sub>724.1:745.8</sub>.p1) <
asType<integer>($heap<sub>724.1:745.8</sub>.M1)
\text{sheap}_{724,1;747,8} == \text{sheap}_{724,1;745,8}.\text{-replace}(p2 \to asType < short)
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724,1;745,8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType< int>($heap_{724,1:745,8}.b2))))
-asType < integer const > (\$heap_{724,1:747.8}.M2) < 
asType<integer>($heap<sub>724.1:747.8</sub>.p2)
```

```
!(0 == asType < integer > (\$heap_{724,1:747.8}.p2))
asType<integer>($heap<sub>724.1:747.8</sub>.p2) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;747,8}.\mathrm{M2})
Proof:
[Take given term]
[5.0] invariant1(heapIs heap_{funcstart\_724,1})
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
[5.1] (((((0 < \mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p1)) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 
asType < integer > (\$heap_{funcstart_{-724,1}}.M1))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart_{-724,1}}.p3))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M3}))
\rightarrow [simplify]
[5.3] \ (((((0 < \$heap_{funcstart\_724,1}.p1) \&\& \ (\$heap_{funcstart\_724,1}.p1 < (
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart_{-724,1}}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
asType < integer > (\$heap_{init}.M1))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 
asType<integer>(sheap_{funcstart\_724,1}.M2)) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < $heap_{funcstart_724,1}.p1) && ($heap_{funcstart_724,1}.p1 < footnote{in the content of the c
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 
\mathbf{asType} \small{<} \mathbf{integer} \small{>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M2}))) \ \&\& \ (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
```

```
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.16] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \; \land \; (0 < \$heap_{funcstart\_724,1}.p1) \; \land 
(0 < \mathrm{\$heap}_{funcstart\_724,1}.\mathrm{p2})) && (\mathrm{\$heap}_{funcstart\_724,1}.\mathrm{p2} <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})))\ \&\&
(asType<integer>($heap_{tuncstart\_724,1}.p3) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [const static or extern object]
[5.17] \left( \left( \left( \left( -30269 < -\$ \text{heap}_{funcstart\_724,1}.\text{p1} \right) \right. \wedge \left. \left( 0 < \$ \text{heap}_{funcstart\_724,1}.\text{p1} \right) \right. \wedge \right. \right)
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType < integer > (\$heap_{init}.M2))) \&\& (0 <
asType < integer > ($heap_{funcstart\_724,1}.p3))) &&
(asType < integer > ($heap_{funcstart\_724,1}.p3) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < \$ heap_{funcstart\_724,1}.p2)) && (\$ heap_{funcstart\_724,1}.p2 <
asType < integer > (asType < short int > ((int)30307)))) && (0 < integer) && (0 < integer
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [simplify]
[5.30] ((-30307 < -\$heap_{funcstart\_724,1}.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.p2) \land (0 < \text{Sheap}_{funcstart\_724,1}.p3)) \&\&
(\text{\$heap}_{funcstart\_724,1}.\text{p3} < \text{asType} < \text{integer} > (\text{\$heap}_{funcstart\_724,1}.\text{M3}))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \land (-30269 <
 -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{724,1}.p3})) \&\&
(\$heap_{funcstart\_724,1}.p3 < \textbf{asType} < \textbf{integer} > (\$heap_{init}.M3))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap_funcstart_724,1.p2) \land (-30269 <
-$heap_{funcstart\_724,1}.p1) \land (0 < $heap_{funcstart\_724,1}.p1) \land (0 <
\text{Sheap}_{funcstart_{724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{724,1}.p3})) \&\&
(\text{sheap}_{funcstart\_724,1}.p3 < asType < integer > (asType < short)
int > ((int)30323)))
\rightarrow [simplify]
```

```
[5.40] (-30323 < -\$heap_{funcstart\_724,1}.p3) \land (-30307 < -30307)
-\$heap_{funcstart\_724,1}.p2) \land (-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < -\$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.\text{p1}) \land (0 < \text{Sheap}_{funcstart\_724,1}.\text{p2}) \land (0 <
heap_{funcstart_{-724,1}.p3}
[Work on sub-term 6 of conjunction in term 5.40]
[10.0] 0 < heap_{funcstart\_724,1}.p3
[Take given term]
[11.0] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
\rightarrow [simplify]
[11.1] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
\rightarrow [const static or extern object]
[11.2] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType < int > (\$heap_{init}.a1))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
\textit{[11.3]} \ \text{div1} == \text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
asType<int>(asType<short int>((int)177)))
\rightarrow [simplify]
[11.6] div1 == div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p1, 177)
[Take given term]
[27.0] div2 == div(heapIs $heap_{funcstart\_724,1},
asType < int > ($heap_{funcstart\_724,1}.p2),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
\rightarrow [simplify]
[27.1]~{\rm div2} == {\rm div}(\mathbf{heapIs}~\$ \mathrm{heap}_{funcstart\_724,1},\,\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
\rightarrow [const static or extern object]
[27.2]~{\rm div2} == {\rm div}(\mathbf{heapIs}~\$ \mathrm{heap}_{funcstart\_724,1},\,\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2},
asType < int > (\$heap_{init}.a2))
\rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
[27.3] \operatorname{div2} == \operatorname{div}(\mathbf{heapIs} \operatorname{\$heap}_{funcstart\_724,1}, \operatorname{\$heap}_{funcstart\_724,1}.p2,
asType<int>(asType<short int>((int)176)))
\rightarrow [simplify]
[27.6]~{\rm div2} == {\rm div}(\mathbf{heapIs}~\$ \mathrm{heap}_{funcstart\_724,1},~\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2},~176)
```

```
[Take given term]
[43.0] div3 == div(heapIs $heap<sub>funcstart_724,1</sub>,
asType < int > (\$heap_{funcstart\_724,1}.p3),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
\rightarrow [simplify]
[43.1] div3 == div(heapIs $heap_{funcstart\_724.1}, $heap_{funcstart\_724.1}.p3,
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
\rightarrow [const static or extern object]
[43.2] div3 == div(heapIs $heap_{funcstart\_724.1}, $heap_{funcstart\_724.1}.p3,
asType < int > (\$heap_{init}.a3))
\rightarrow [expand definition of constant 'a3' at prang.c (26,20)]
[43.3] \ \mathrm{div3} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3},
asType<int>(asType<short int>((int)178)))
\rightarrow [simplify]
[43.6] \text{ div3} == \text{div}(\text{heapIs } \text{$heap}_{funcstart\_724,1}, \text{$heap}_{funcstart\_724,1}.p3, 178)
[Assume known post-assertion, class invariant or type constraint for term 43.6]
[46.0] (asType<integer>($heap_{tuncstart\_724.1}.p3) /
asType<integer>(178)) == asType<integer>(div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p3, 178).quot
\rightarrow [simplify]
[46.2] (\theta = asType<integer>(div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p3, 178).quot
→ [expand definition of operator './' in class 'int' at built in declaration]
[46.3] ([asType<integer>(heap_{funcstart\_724,1}.p3) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724.1}.p3) / 178), []:
asType < integer > ($heap_{funcstart\_724,1}.p3) / 178) ==
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3,
178).quot)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[46.4] ([asType<integer>(sheap_{funcstart\_724,1.p3}) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178),
[!(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178) = =
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3,
178).quot)
\rightarrow [simplify]
[46.7] ([0 < -\$heap_{funcstart\_724,1.p3}]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178),
```

```
[!(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178) = =
\mathbf{asType} {<} \mathbf{integer} {>} ( \mathbf{div} (\mathbf{heapIs} \ \$ \mathbf{heap}_{funcstart\_724,1}, \ \$ \mathbf{heap}_{funcstart\_724,1}. \mathbf{p3}, \\
178).quot)
\rightarrow [from term 10.0, literala < -$heap<sub>funcstart_724.1</sub>.p3 is false whenever -2 <
(0 + literala)
        Proof of rule precondition:
        [46.7.0] - 2 < (0 + 0)
        \rightarrow [simplify]
        [46.7.2] true
[46.8] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178),
[!(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) < 0)]:
asType < integer > (\$heap_{funcstart\_724.1}.p3) / 178) = =
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3,
178).quot)
\rightarrow [simplify]
[46.11] \; ([{\bf false}]: \; -({\bf -asType}{<} {\bf integer}{>} (\$ {\rm heap}_{funcstart\_724,1}.{\rm p3}) \; / \; 178), \; [!(0 < 10.11)] \; ([{\bf false}]: \; -({\bf -asType}{<} {\bf integer}{>} (\$ {\bf integer}{
-\$heap_{funcstart\_724,1}.p3): asType<integer>(\$heap_{funcstart\_724,1}.p3) / 178)
== asType < integer > (div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p3, 178.quot
\rightarrow [from term 10.0, literala < -$heap<sub>funcstart_724,1</sub>.p3 is false whenever -2 <
(0 + literala)
        Proof of rule precondition:
        [46.11.0] - 2 < (0 + 0)
        \rightarrow [simplify]
        [46.11.2] true
[46.12] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178),
[!false]: asType<integer>($heap<sub>funcstart_724,1.</sub>p3) / 178) ==
\mathbf{asType} \small{<} \mathbf{integer} \small{>} ( \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}, \\
178).quot)
\rightarrow [simplify]
[46.17] \ 0 == (-\text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p3},
178).quot + (\text{$heap}_{funcstart\_724,1.p3} / 178))
[Take given term]
[59.0] \rho_{1745,8} == \rho_{1745,8} == \rho_{1745,8} == \rho_{1745,8}
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
```

```
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177)
[59.1] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div(heapIs $heap_{tuncstart\_724.1},
\theta_{tuncstart_{-724,1},p1,177,rem} * asType<int>($\text{heap}_{tuncstart_{-724,1},r1}$) -
(asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [simplify]
[59.3] \text{sheap}_{724,1;745,8} == \text{sheap}_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType < int > (\$heap_{tuncstart\_724.1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType<int>($heap_{funcstart\_724,1}.b1)))
\rightarrow [const static or extern object]
[59.4] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType < int > (\$heap_{init}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1.quot})) * \mathbf{asType}{<} \mathbf{int}{>} (\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
\rightarrow [expand definition of constant 'r1' at prang.c (15,20)]
[59.5] \rho_{1745,8} == \rho_{1745,8} == \rho_{1745,8} == \rho_{1745,8}._replace(p1 \rightarrow \rho_{1745,8} == \rho_{1745,8})
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType<int>(asType<short int>((int)171))) -
(asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724.1}.b1))))
\rightarrow [simplify]
[59.8] \rho_{724,1;745,8} == \rho_{funcstart\_724,1}.\_replace(p1 \rightarrow asType < short)
int > ((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem * 171)
- (asType<int>(asType<short int>(div1.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart_724,1},
heap_{funcstart_{-724,1}}.p1, 177
[59.9] \rho_{1745,8} == \rho_{1745,8} == \rho_{1745,8} == \rho_{1745,8}._replace(p1 \rightarrow \rho_{1745,8} == \rho_{1745,8}
int>((171 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)
- (asType<int>(asType<short int>(div(heapIs $heap_{funcstart_724.1},
heap_{funcstart_{724,1}}.p1, 177).quot) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [simplify]
[59.11] \$ heap_{724,1;745,8} == \$ heap_{funcstart\_724,1}.\_\mathbf{replace} (p1 \to \mathbf{asType} < \mathbf{short})
int>((171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
```

```
\rightarrow [const static or extern object]
[59.12] \rho_{12} = \rho_{124,1;745,8} = \rho_{124,1;74
int>((171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).rem)
- (div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1, 177).quot *
asType < int > (\$heap_{init}.b1)))
\rightarrow [expand definition of constant 'b1' at prang.c (17,20)]
[59.13] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
\mathbf{int} > ((171 * \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, 177).\operatorname{rem})
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType < int > (asType < short int > ((int)2))))
\rightarrow [simplify]
[59.19] \text{Sheap}_{724,1;745,8} == \text{Sheap}_{funcstart\_724,1}.\_\mathbf{replace}(\text{p1} \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).rem)))
[Take given term]
[63.0] $\text{heap}_{724,1:747,8} == $\text{heap}_{724,1:745,8}.$\text{-replace}(p2 \to \text{asType} < \text{short}
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724.1:745.8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724,1:745,8</sub>.b2))))
\rightarrow [from term 59.19, $heap_{724,1;745,8}$ is equal to
heap_{funcstart\_724.1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724.1}),
heap_{funcstart_{724,1},p1, 177}, quot) + (171 * div(heapIs p_{funcstart_{724,1},p1, 177}), quot)
heap_{funcstart_{724,1}.p1, 177).rem}
[63.1] $\text{heap}_{724,1;747,8} == $\text{heap}_{funcstart\_724,1}.$\text{-replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\label{eq:div_heap} \text{div}(\textbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
(177).rem))._replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
\mathbf{asType} \small{<} \mathbf{int} \small{>} (\$ \mathrm{heap}_{724,1;745,8}.\mathrm{r2})) \\ - (\mathbf{asType} \small{<} \mathbf{int} \small{>} (\mathbf{asType} \small{<} \mathbf{short}
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{funcstart_724,1},
heap_{funcstart_{-724,1},p2,176}
[63.2] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
(177).rem))._replace(p2 \rightarrow asType < short)
int>((asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},))
\text{sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem}) * asType < int > (\text{sheap}_{724,1;745,8}.\text{r2})) -
(asType<int>(asType<short int>(div2.quot)) *
asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [simplify]
```

```
[63.4] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\label{eq:div_heap} \text{div}(\textbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
(177).rem))._replace(p2 \rightarrow asType<short int>((div(heapIs)))._replace(p2)
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}.p2, 176).rem *
asType < int > (\$heap_{724,1:745.8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [from term 59.19, $heap<sub>724,1;745,8</sub> is equal to
heap_{funcstart\_724.1}._replace(p1 \rightarrow (-2 * div(heapIs $heap_{funcstart\_724.1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1}, 177).quot) + (171 * div(heapIs $heap_{funcstart\_724,1}, 17
\$heap_{funcstart\_724,1}.p1,\ 177).rem))]
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((\operatorname{div}(\mathbf{heapIs}))))
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}.p2, 176).rem *
asType < int > (\$heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * div(heapIs))))))
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 177).quot) + (171 * div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).rem))).r2)) -
(asType<int>(asType<short int>(div2.quot)) *
asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [const member of object with modified fields]
[63.6] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((\operatorname{div}(\mathbf{heapIs}))))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem *
asType < int > (\$heap_{funcstart\_724,1}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType< int>($heap_{724,1;745,8}.b2))))
\rightarrow [const static or extern object]
[63.7] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724.1}, \ \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((\operatorname{div}(\mathbf{heapIs}))))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem *
asType < int > (\$heap_{init}.r2)) - (asType < int > (asType < short)
int > (div2.quot)) * asType < int > (\$heap_{724,1:745,8}.b2))))
\rightarrow [expand definition of constant 'r2' at prang.c (20.20)]
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
```

```
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem *
asType<int>(asType<short int>((int)172))) -
(asType<int>(asType<short int>(div2.quot)) *
asType < int > (\$heap_{724,1;745,8}.b2))))
\rightarrow [simplify]
[63.11] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem * 172) -
(asType<int>(asType<short int>(div2.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{b2}))))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{tuncstart_{724.1}},
heap_{funcstart_{-724,1}}.p2, 176
[63.12] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 2, 176).rem –
(asType < int > (asType < short int > (div(heapIs $heap_{funcstart\_724,1}, 
\text{sheap}_{funcstart\_724,1.p2}, 176).\text{quot}) * asType<int>(\text{sheap}_{724,1;745,8}.\text{b2}))))
\rightarrow [simplify]
[63.14] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1},p2,176}.quot *
asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [from term 59.19, $heap<sub>724,1;745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724,1}),
heap_{funcstart_{724,1},p1, 177}, quot) + (171 * div(heapIs heap_{funcstart_{724,1},p1, 177})
heap_{funcstart_{724,1},p1,177,rem})
[63.15] $\text{heap}_{724.1:747.8} == $\text{heap}_{funcstart_724.1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem}) - (\text{div}(\text{heapIs}))
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 2, 176).quot *
asType < int > (\$heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * div(heapIs))))))
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).rem))).b2))))
```

```
\rightarrow [const member of object with modified fields]
[63.16] $\text{heap}_{724,1:747,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}.p2, 176).quot
\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{b2}))))
\rightarrow [const static or extern object]
[63.17] $\text{heap}_{724,1;747,8} == \text{$heap}_{funcstart\_724,1}._\text{$replace}(p1 \to ((-2 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724.1}, \theta_{funcstart\_724.1}, \theta_{funcstart\_724.1}, \theta_{funcstart\_724.1}, \theta_{funcstart\_724.1}
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1},p2,176}.quot *
asType < int > (\$heap_{init}.b2))))
\rightarrow [expand definition of constant 'b2' at prang.c (22,20)]
[63.18] $\text{heap}_{724,1;747,8} == \text{$heap}_{funcstart\_724,1}._\text{$replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}.p2, 176).quot *
asType<int>(asType<short int>((int)35)))))
\rightarrow [simplify]
[63.24] $\text{heap}_{724,1;747,8} == \text{$heap}_{funcstart\_724,1}._\text{$replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724.1},
\text{Sheap}_{funcstart_{724,1},p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart_{724,1}},
heap_{funcstart_{-724,1}.p2, 176).rem)
[Take goal term]
[1.0]  minof(int) \leq (asType<int>(asType<short int>(div3.quot)) *
asType < int > (\$heap_{724,1;747,8}.b3))
\rightarrow [simplify]
[1.1] -32768 \leq (asType<int>(asType<short int>(div3.quot)) *
asType < int > ($heap_{724.1:747.8}.b3))
\rightarrow [from term 43.6, div3 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p3, 178
[1.2] -32768 < (asType<int>(asType<short int>(div(heapIs
```

```
\theta_{funcstart_{-724,1}}, \theta_{funcstart_{-724,1}}, 178).quot)) *
asType < int > (\$heap_{724,1;747,8}.b3))
\rightarrow [simplify]
[1.4] -32768 \le (\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p3},
178).quot * asType<int>($heap<sub>724.1:747.8</sub>.b3))
\rightarrow [from term 63.24, $heap<sub>724,1;747,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1},
\theta_{funcstart\_724,1}.p1, 177).rem))._replace(p2 \rightarrow (-35 * div(\mathbf{heapIs})))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 2, 176).rem
 \label{eq:continuous} \textit{[1.5] -32768} \leq (\text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p3},
178).quot * asType<int>($heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p2, 176).rem})).b3)
\rightarrow [const member of object with modified fields]
[1.7] -32768 \leq (div(heapIs $heap_{funcstart\_724.1}, $heap_{funcstart\_724.1}.p3,
178).quot * asType<int>($heap<sub>funcstart 724.1</sub>.b3))
\rightarrow [const static or extern object]
[1.8] -32768 \leq (div(heapIs $heap_{funcstart_{724,1}}, $heap_{funcstart_{724,1}}.p3,
178).quot * asType<int>($heap<sub>init</sub>.b3))
\rightarrow [expand definition of constant 'b3' at prang.c (27,20)]
[1.9] -32768 \leq (div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p3,
178).quot * asType<int>(asType<short int>((int)63)))
\rightarrow [simplify]
[1.14] -32769 < (63 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3,
178).quot)
\rightarrow [literal comparison of product]
[1.15] ([63 < 0]: (-32769 / -63) < -\text{div}(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
\rho_{funcstart_{724,1}.p3, 178}, quot, [0 < 63]: (-32769 / 63) < \text{div}(heapIs)
\$ heap_{funcstart\_724,1}, \$ heap_{funcstart\_724,1}.p3, \ 178).quot, \ [0 == 63]: \ -32769 < 0)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[1.16] ([63 < 0]: (-32769 / -63) < -\text{div}(\text{heapIs } \text{$heap}_{tuncstart\_724.1},
\text{Sheap}_{funcstart\_724.1}.p3, 178).quot, [(0 < 63) \land !(63 < 0)]: (-32769 / 63) < (-32769 / 63)
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).quot, \ [(0 == 63)]
\land !(0 < 63) \land !(63 < 0)]: -32769 < 0)
```

```
[1.24] -521 < div(heapIs $heap_{funcstart_724,1}, $heap_{funcstart_724,1}.p3,
178).quot
\rightarrow [negate goal and search for contradiction]
 \label{eq:loss_loss} $[1.25] ! (-521 < \operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p3, 
178).quot)
\rightarrow [simplify]
[1.27] \ 520 < -\text{div}(\textbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p3},
178).quot
[Create new term from terms 1.27, 46.17 using rule: transitivity 15]
[85.0] \; (0 + 520) < -(\$ heap_{funcstart\_724,1}.p3 \; / \; 178)
\rightarrow [simplify]
[85.7] \ 92560 < -\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}
\rightarrow [from term 10.0, literala < -$heap<sub>funcstart_724,1</sub>.p3 is false whenever -2 <
(0 + literala)
   Proof of rule precondition:
   [85.7.0] - 2 < (0 + 92560)
   \rightarrow [simplify]
   [85.7.2] true
[85.8] false
Proof of verification condition: Arithmetic result of operator '*' is within
limit of type 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (65,38)
Condition defined at:
To prove: (asType<int>(asType<short int>(div3.quot)) *
asType < int > (\$heap_{724,1;747,8}.b3)) \le maxof(int)
Given:
heap_{init}.LIMIT == (int)80
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
\theta
\theta = asType < short int > ((int)2)
heap_{init}.M2 == asType < short int > ((int)30307)
```

 \rightarrow [simplify]

```
\rho_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta
heap_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart\_724,1})
div1 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(asType<int>(asType<int>($heap_{funcstart\_724,1}.p1)) %
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) ==
asType<integer>(div1.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a1) \le
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1})) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}))\ /
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))) ==
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heap_{tuncstart\_724.1}.p2)) %
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.rem)
```

```
(asType < integer > (\$heap_{funcstart\_724,1}.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) ==
asType<integer>(div2.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a2) \le
asType < integer > (\$heap_{funcstart\_724,1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
asType < int > (\$heap_{funcstart\_724.1}.a3))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p3})) \ / \\
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(asType<int>(asType<int>($heap_{funcstart\_724,1}.p3)) %
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(asType < integer > (\$heap_{funcstart\ 724.1}.p3) = =
asType<integer>(div3.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a3) \le
asType < integer > (\$heap_{funcstart\_724,1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
\mathbf{asType} \small{<} \mathbf{int} \small{>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{r1})) \\ - (\mathbf{asType} \small{<} \mathbf{int} \small{>} (\mathbf{asType} \small{<} \mathbf{short}
int>(div1.quot)) * asType< int>($heap_{tuncstart\_724.1}.b1))))
-asType<integer const>($heap<sub>724,1:745,8</sub>.M1) <
asType<integer>($heap<sub>724.1:745.8</sub>.p1)
!(0 == asType < integer > (\$heap_{724.1:745.8}.p1))
asType<integer>($heap<sub>724.1:745.8</sub>.p1) <
asType<integer>($heap<sub>724,1:745,8</sub>.M1)
heap_{724,1;747,8} == heap_{724,1;745,8}._replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724.1:745.8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
```

```
-asType < integer const > (\$heap_{724,1:747.8}.M2) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;747,8}.\mathrm{p2})
!(0 == asType < integer > (\$heap_{724,1:747.8}.p2))
asType<integer>($heap<sub>724,1;747,8</sub>.p2) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;747,8}.\mathrm{M2})
Proof:
[Take given term]
[5.0] invariant1(heapIs heap_{funcstart\_724,1})
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
[5.1] ((((((0 < asType<integer>(sheap_{funcstart\_724.1}.p1)) &&
(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 < function for the start of the start 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2})))\ \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.3] \ (((((0 < \$heap_{funcstart\_724,1}.p1) \&\& \ (\$heap_{funcstart\_724,1}.p1 < 
\mathbf{asType} \small{<} \mathbf{integer} \small{>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M1}))) \ \&\& \ (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2})))\ \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p2) < 
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [const static or extern object]
[5.4] (((((0 < \text{\$heap}_{funcstart\_724,1}.p1) \&\& (\text{\$heap}_{funcstart\_724,1}.p1 <
asType<integer>(heap_{init}.M1))) && (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})))\ \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] \ (((((0 < \text{\$heap}_{funcstart\_724,1}.\text{p1}) \&\& \ (\text{\$heap}_{funcstart\_724,1}.\text{p1} <
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
```

```
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p3) < 
asType<integer>($heap_funcstart_724,1.M3))
\rightarrow [simplify]
[5.16] ((((-30269 < -$heap_{funcstart\_724,1}.p1) \lambda (0 < $heap_{funcstart\_724,1}.p1) \lambda
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType<integer>(heap_{funcstart\_724,1}.M2))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.17] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \; \land \; (0 < \$heap_{funcstart\_724,1}.p1) \; \land 
(0 < \text{Sheap}_{funcstart_{724,1}.p2})) \&\& (\text{Sheap}_{funcstart_{724,1}.p2} <
asType < integer > (\$heap_{init}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{tuncstart_{-724,1}}.M3))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < \text{$heap}_{funcstart\_724,1}.p2)) \&\& (\text{$heap}_{funcstart\_724,1}.p2 <
asType < integer > (asType < short int > ((int)30307)))) && (0 < integer) && (0 < integer
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [simplify]
[5.30] ((-30307 < -$heap<sub>funcstart_724,1</sub>.p2) \wedge (-30269 <
  -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{724,1}.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.\text{p3} < \text{asType} < \text{integer} > (\text{\$heap}_{funcstart\_724,1}.\text{M3}))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -$heap_funcstart_724,1.p2) \land (-30269 <
-$heap_{funcstart\_724,1}.p1) \land (0 < $heap_{funcstart\_724,1}.p1) \land (0 <
\text{Sheap}_{funcstart\_724,1.p2} \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\$heap_{funcstart\_724,1}.p3 < \textbf{asType} < \textbf{integer} > (\$heap_{init}.M3))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap_{tuncstart\_724,1}.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1.p2}) \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\text{sheap}_{funcstart\_724,1}.p3 < asType < integer > (asType < short)
```

```
int > ((int)30323)))
\rightarrow [simplify]
[5.40] (-30323 < -\$heap_{funcstart\_724,1}.p3) \land (-30307 < -30307)
-\$heap_{funcstart\_724,1}.p2) \land (-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < -\$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.\text{p1}) \land (0 < \text{Sheap}_{funcstart\_724,1}.\text{p2}) \land (0 <
heap_{funcstart_{-724,1}.p3}
\rightarrow [separate conjunction and work on first sub-term]
\label{eq:fine_start_724,1.p3} [5.41] \mbox{ -30323} < -\$ heap_{funcstart\_724,1}.p3
[Work on sub-term 6 of conjunction in term 5.40]
[10.0] 0 < heap_{funcstart\_724,1}.p3
[Take given term]
[11.0] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
\rightarrow [simplify]
[11.1] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
\rightarrow [const static or extern object]
[11.2] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType < int > (\$heap_{init}.a1))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
\textit{[11.3]} \ \text{div1} == \text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
asType<int>(asType<short int>((int)177)))
\rightarrow [simplify]
[11.6] div1 == div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p1, 177)
[Take given term]
[27.0] div2 == div(heapIs $heap<sub>funcstart_724,1</sub>,
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
\rightarrow [simplify]
[27.1]~{\rm div2} == {\rm div}(\mathbf{heapIs}~\$ \mathrm{heap}_{funcstart\_724,1},\,\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2},
asType < int > (\$heap_{funcstart\_724,1}.a2))
\rightarrow [const static or extern object]
[27.2] \operatorname{div2} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p2,
asType < int > (\$heap_{init}.a2))
\rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
```

```
[27.3] div2 == div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}.p2,
asType < int > (asType < short int > ((int)176)))
\rightarrow [simplify]
[27.6]~{\rm div2} == {\rm div}(\mathbf{heapIs}~\$ \mathrm{heap}_{funcstart\_724,1},~\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2},~176)
[Take given term]
[43.0] div3 == div(heapIs $heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
asType < int > (\$heap_{funcstart\_724.1}.a3))
\rightarrow [simplify]
[43.1] \operatorname{div3} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p3,
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
\rightarrow [const static or extern object]
[43.2] \ \mathrm{div3} == \ \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3},
asType < int > (\$heap_{init}.a3))
\rightarrow [expand definition of constant 'a3' at prang.c (26,20)]
[43.3] div3 == div(heapIs $heap_{funcstart\_724.1}, $heap_{funcstart\_724.1}.p3,
asType<int>(asType<short int>((int)178)))
\rightarrow [simplify]
[43.6] \text{ div3} == \text{div}(\mathbf{heapIs} \$ heap_{funcstart\_724,1}, \$ heap_{funcstart\_724,1}.p3, 178)
[Assume known post-assertion, class invariant or type constraint for term 43.6]
[46.0] \; (\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) \; / \\
asType<integer>(178)) == asType<integer>(div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p3, 178).quot)
\rightarrow [simplify]
[46.2] ($heap<sub>funcstart_724.1.</sub>p3 / 178) == asType<integer>(div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p3, 178).quot)
→ [expand definition of operator './' in class 'int' at built in declaration]
[46.3] ([asType<integer>(heap_{funcstart\_724,1}.p3) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178), []:
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})~/~178) ==
\mathbf{asType} < \mathbf{integer} > (\mathbf{div}(\mathbf{heapIs} \ \$ \mathbf{heap}_{funcstart\_724,1}, \ \$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}, \\
178).quot)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[46.4] \; ([\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178),
[!(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p3})<0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178) = =
```

```
\mathbf{asType} {<} \mathbf{integer} {>} ( \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}, \\
178).quot)
\rightarrow [simplify]
[46.7] ([0 < -\$heap_{funcstart\_724,1}.p3]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178) ==
asType<integer>(div(heapIs $heap_{funcstart\_724.1}, $heap_{funcstart\_724.1}.p3,
178).quot)
\rightarrow [from term 10.0, literala < -$heap<sub>funcstart_724,1</sub>.p3 is false whenever -2 <
(0 + literala)
    Proof of rule precondition:
    [46.7.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [46.7.2] true
[46.8] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) \; / \; 178),
[!(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) < 0)]:
asType<integer>($heap<sub>funcstart_724,1.</sub>p3) / 178) ==
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3,
178).quot)
\rightarrow [simplify]
[46.11] \; ([{\bf false}]: \; -({\bf -asType}{<} {\bf integer}{>} (\$ {\rm heap}_{funcstart\_724,1}.{\rm p3}) \; / \; 178), \; [!(0 < 
-\$heap_{funcstart\_724,1}.p3)]: asType<integer>(\$heap_{funcstart\_724,1}.p3) / 178)
== asType < integer > (div(heapIs \$heap_{funcstart\_724.1},
heap_{funcstart_{-724,1}.p3, 178}, quot
\rightarrow [from term 10.0, literala < -$heap_{funcstart\_724,1}.p3 is false whenever -2 <
(0 + literala)
    Proof of rule precondition:
    [46.11.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [46.11.2] true
[46.12] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178),
[!false]: asType<integer>($heap<sub>funcstart_724,1.</sub>p3) / 178) ==
\mathbf{asType} {<} \mathbf{integer} {>} ( \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}, \\
178).quot)
\rightarrow [simplify]
[46.17] \ 0 == (-\text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p3},
178).quot + (\text{$heap}_{funcstart\_724,1}.p3 / 178))
```

```
[Take given term]
[59.0] \rho_{1745,8} == \rho_{1745,8} == \rho_{1745,8} == \rho_{1745,8}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
\mathbf{asType} \small{<} \mathbf{int} \small{>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{r1})) - (\mathbf{asType} \small{<} \mathbf{int} \small{>} (\mathbf{asType} \small{<} \mathbf{short}
int>(div1.quot)) * asType<int>($heap_{funcstart\_724.1}.b1)))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177
[59.1] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div(heapIs $heap_{funcstart_724,1},))
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}) * asType<int>(\text{Sheap}_{funcstart\_724,1}.\text{r1})) -
(asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [simplify]
[59.3] \rho_{1745,8} == \rho_{1745
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType < int > (\$heap_{funcstart\_724.1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{tuncstart\_724.1}.b1))))
\rightarrow [const static or extern object]
[59.4] \rho_{1745,8} == \rho_{1745,8} == \rho_{1745,8} == \rho_{1745,8}._replace(p1 \rightarrow \rho_{1745,8} == \rho_{1745,8})
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType < int > (\$heap_{init}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{tuncstart\_724.1}.b1))))
\rightarrow [expand definition of constant 'r1' at prang.c (15,20)]
[59.5] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType < int > (asType < short int > ((int)171))) -
(asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724.1}.b1))))
\rightarrow [simplify]
[59.8] \rho_{724,1;745,8} == \rho_{funcstart\_724,1}.\_replace(p1 \rightarrow asType < short)
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem * 171)
- (asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart_{724.1}}.b1))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177
[59.9] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
\mathbf{int} > ((171 * \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, 177).\operatorname{rem})
- (asType < int > (asType < short int > (div(heapIs $heap_{funcstart\_724,1}, 
heap_{funcstart_{724,1}}.p1, 177).quot) *
asType < int > (\$heap_{funcstart\_724.1}.b1))))
```

```
\rightarrow [simplify]
[59.11] \theta_{13} = \theta_
int>((171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).rem)
- (div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1, 177).quot *
asType < int > (\$heap_{funcstart\_724.1}.b1)))
\rightarrow [const static or extern object]
[59.12] \$ heap_{724,1;745,8} == \$ heap_{funcstart\_724,1}.\_\mathbf{replace} (p1 \to \mathbf{asType} < \mathbf{short})
\mathbf{int} > ((171 * \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, 177).\operatorname{rem})
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType < int > (\$heap_{init}.b1)))
\rightarrow [expand definition of constant 'b1' at prang.c (17,20)]
[59.13] \text{heap}_{724,1:745,8} == \text{heap}_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType<int>(asType<short int>((int)2))))
\rightarrow [simplify]
[59.19] $\text{heap}_{724,1:745,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).rem)))
[Take given term]
[63.0] $\text{heap}_{724,1:747,8} == $\text{heap}_{724,1:745,8}.$\text{replace}(p2 \rightarrow \text{asType} < \text{short}
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724,1:745,8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType< int>($heap_{724,1:745,8}.b2))))
\rightarrow [from term 59.19, $heap<sub>724.1:745.8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs p_{funcstart\_724,1}),
heap_{funcstart_{-724,1},p1, 177}, quot) + (171 * div(heapIs heap_{funcstart_{-724,1},p1, 177})
heap_{funcstart_{-724,1},p1,177,rem}
[63.1] $heap<sub>724,1:747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
(177).rem))._replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724.1:745.8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType< int>($heap_{724,1:745,8}.b2))))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{funcstart_724,1},
heap_{funcstart_{-724,1},p2,176}
[63.2] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
```

```
(177).rem))._replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},
\text{sheap}_{funcstart\_724,1.p2, 176}.\text{rem}) * asType < int > (\text{sheap}_{724,1:745,8}.\text{r2})) -
(asType<int>(asType<short int>(div2.quot)) *
asType < int > (\$heap_{724,1;745,8}.b2))))
\rightarrow [simplify]
[63.4] $heap<sub>724,1:747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
\text{Sheap}_{funcstart_{-724,1}}, \text{Sheap}_{funcstart_{-724,1}}.p2, 176).rem *
asType < int > (\$heap_{724,1:745,8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724,1:745,8</sub>.b2))))
\rightarrow [from term 59.19, $heap<sub>724,1:745.8</sub> is equal to
heap_{funcstart\_724.1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724.1}),
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1}, 177).quot) + (171 * div(heapIs $heap_{funcstart\_724,1}, 17
\$heap_{funcstart\_724,1}.p1,\ 177).rem))]
[63.5] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem *
asType < int > (\$heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * div(heapIs))))))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1, 177).quot) + (171 * div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).rem))).r2)) -
(asType<int>(asType<short int>(div2.quot)) *
asType < int > (\$heap_{724.1:745.8}.b2))))
\rightarrow [const member of object with modified fields]
[63.6] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((\operatorname{div}(\mathbf{heapIs}))))
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p_{176}.rem *
\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{r2})) - (\mathbf{asType} < \mathbf{int} > (\mathbf{asType} < \mathbf{short}))
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [const static or extern object]
[63.7] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
div(\mathbf{heapIs} \ \text{$heap}_{funcstart\_724,1}, \ \text{$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem))).replace(p2 \rightarrow asType < short int > ((div(heapIs)))
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1},p2, 176}.rem *
asType < int > (\$heap_{init}.r2)) - (asType < int > (asType < short)
```

```
int>(div2.quot)) * asType< int>($heap_{724.1:745.8}.b2))))
\rightarrow [expand definition of constant 'r2' at prang.c (20,20)]
[63.8] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 176).rem *
asType<int>(asType<short int>((int)172))) -
(asType<int>(asType<short int>(div2.quot)) *
asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [simplify]
[63.11] $\text{heap}_{724,1;747,8} == \text{$heap}_{funcstart\_724,1}._\text{$replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\label{eq:div_heap} \text{div}(\textbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1},p2, 176}.rem * 172) -
(asType<int>(asType<short int>(div2.quot)) *
asType<int>($heap<sub>724,1:745,8</sub>.b2))))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{tuncstart_{724.1}},
heap_{funcstart_{-724,1}}.p2, 176
[63.12] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, p_{176}.rem) -
(asType < int > (asType < short int > (div(heapIs $heap_{funcstart\_724,1}, 
\text{sheap}_{funcstart\_724,1.p2, 176}.\text{quot}) * asType < int > (\text{sheap}_{724,1;745,8.b2})))
\rightarrow [simplify]
[63.14] $\text{heap}_{724,1;747,8} == \text{$heap}_{funcstart\_724,1}._\text{$-replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p2, 176).quot *
asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [from term 59.19, $heap<sub>724,1;745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724,1}),
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs p_{funcstart\_724,1})
heap_{funcstart} 724.1.p1, 177).rem))]
[63.15] $\text{heap}_{724,1;747,8} == \text{$heap}_{funcstart\_724,1}._\text{$replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
```

```
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs)
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}.p2, 176).quot *
\mathbf{asType}{<}\mathbf{int}{>}(\$\text{heap}_{funcstart\_724,1}.\_\mathbf{replace}(\text{p1} \rightarrow ((\text{-2} * \text{div}(\mathbf{heapIs}
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).quot) + (171 * div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).rem))).b2))))
\rightarrow [const member of object with modified fields]
[63.16] $\text{heap}_{724,1:747,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}. p1, \ 177). \operatorname{quot}) + (171 *
\label{eq:div_heap} \text{div}(\textbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}.p2, 176).quot *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b2}))))
\rightarrow [const static or extern object]
[63.17] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart} 724.1, \$ \operatorname{heap}_{funcstart} 1.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1},p2,176}.quot *
asType < int > (\$heap_{init}.b2))))
\rightarrow [expand definition of constant 'b2' at prang.c (22,20)]
[63.18] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}.p2, 176).quot *
asType<int>(asType<short int>((int)35)))))
\rightarrow [simplify]
[63.24] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p2, 176).rem)
[Take goal term]
[1.0] (asType<int>(asType<short int>(div3.quot)) *
asType < int > (\$heap_{724,1;747,8}.b3)) \le maxof(int)
```

```
\rightarrow [from term 43.6, div3 is equal to div(heap
Is $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p3, 178)]
```

```
[1.1] (asType<int>(asType<short int>(div(heapIs \alpha_{1.724,1}), $heap<sub>funcstart_724,1</sub>, $heap<sub>funcstart_724,1</sub>, p3, 178).quot)) * asType<int>($heap<sub>724,1;747,8</sub>.b3)) \leq maxof(int)
```

 \rightarrow [simplify]

```
[1.3] (div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).quot * asType<int>(heap_{724,1;747,8}.b3)) \leq maxof(int)
```

[1.4] (div(heapIs $heap_{funcstart_724,1}$, $heap_{funcstart_724,1}.p3$, 178).quot * asType<int>($heap_{funcstart_724,1}$.replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart_724,1}$, $heap_{funcstart_724,1}.p1$, 177).quot) + (171 * div(heapIs $heap_{funcstart_724,1}$, $heap_{funcstart_724,1}.p1$, 177).rem))).replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724,1}$, $heap_{funcstart_724,1}.p2$, 176).quot) + (172 * div(heapIs $heap_{funcstart_724,1}$, $heap_{funcstart_724,1}.p2$, 176).rem))).b3)) $heap_{funcstart_724,1}$, $heap_{funcstart_724,1}.p2$, 176).rem))).b3)) $heap_{funcstart_724,1}$

 \rightarrow [const member of object with modified fields]

```
[1.6] (div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.
```

 \rightarrow [const static or extern object]

```
[1.7] (div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).quot * asType<int>(heap_{init}.b3)) \leq maxof(int)
```

 \rightarrow [expand definition of constant 'b3' at prang.c (27,20)]

```
[1.8] (div(heapIs \theta_{funcstart\_724,1}, \theta_
```

 \rightarrow [simplify]

[1.21] -32768 < (-63 * div(heapIs $heapIs = f_{uncstart_{-724,1}}$, $heap_{funcstart_{-724,1}}$.p3, 178).quot)

 \rightarrow [literal comparison of product]

```
[1.22] ([-63 < 0]: (-32768 / 63) < -\text{div}(\mathbf{heapIs} \ \text{heap}_{funcstart\_724,1}, \ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot}, [0 < -63]: (-32768 / -63) < \text{div}(\text{heapIs} \ \text{heap}_{funcstart\_724,1}, \ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot}, [-63 == 0]: -32768 < 0)
```

→ [explicitly assert falsehood of skipped guards in subsequent guards]

```
[1.23] ([-63 < 0]: (-32768 / 63) < -\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1},
heap_{funcstart\_724,1}.p3, 178).quot, [(0 < -63) \land !(-63 < 0)]: (-32768 / -63) < 0
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).quot, \ [(-63 == 0)]
\land !(-63 < 0) \land !(0 < -63)]: -32768 < 0)
\rightarrow [simplify]
[1.27] -521 < -\text{div}(\text{heapIs } \text{\$heap}_{funcstart\_724,1}, \text{\$heap}_{funcstart\_724,1}.\text{p3},
178).quot
\rightarrow [negate goal and search for contradiction]
[1.28] ! (-521 < -\text{div}(\textbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3},
178).quot)
\rightarrow [simplify]
[1.31] 520 < div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p3, 178).quot
[Create new term from terms 1.31, 46.17 using rule: transitivity 16]
[85.0] \; (0 + 520) < (\$ heap_{funcstart\_724,1}.p3 \; / \; 178)
\rightarrow [simplify]
[85.8] \ 92737 < \$ heap_{funcstart\_724,1}.p3
\rightarrow [from term 5.41, literala < $heap_{funcstart_724.1}.p3 is false whenever -2 <
(-30323 + literala)
        Proof of rule precondition:
        [85.8.0] - 2 < (-30323 + 92737)
        \rightarrow [simplify]
        [85.8.2] true
[85.9] false
Proof of verification condition: Type constraint satisfied in implicit
conversion from 'int' to 'short int'
Condition generated at: C:\Escher\Customers\prang\prang.c (65,33)
Condition defined at:
To prove: minof(short\ int) \le ((asType < int > (asType < short\ int) < (asTy
int>(div3.rem)) * asType<int>($heap<sub>724.1:747.8</sub>.r3)) -
(asType<int>(asType<short int>(div3.quot)) *
asType < int > (\$heap_{724,1;747,8}.b3)))
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
```

```
heap_{init}.a1 == asType < short int > ((int)177)
\theta = asType < short int > ((int)2)
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
\theta_{init}.a2 == asType<short int>((int)176)
heap_{init}.b2 == asType<short int>((int)35)
\theta = asType < short int > ((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta
\theta
\theta = asType < short int > ((int)3)
invariant
1(heap<br/>Is \rho_{funcstart\_724,1}
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
(asType<integer>(asType<int>($heap_{funcstart\_724,1}.p1)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p1) = =
asType<integer>(div1.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a1) \le
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}),
asType < int > (\$heap_{funcstart\_724,1}.a2))
(asType<integer>(asType<int>($heap_{tuncstart\_724,1}.p2)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
```

```
asType<integer>(div2.quot)
(asType < int > (asType < int > (\$heap_{funcstart\_724,1}.p2)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{a2})) = >
(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p2) ==
asType<integer>(div2.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a2}) \leq
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2})) = > !(0 = =
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
\label{eq:div3} \text{div3} == \text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1},
\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}),
asType < int > (\$heap_{funcstart\_724.1}.a3))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) \%
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a3}))) = =
asType<integer>(div3.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a3) \le
asType < integer > (\$heap_{funcstart\_724,1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
\$heap_{724,1;745,8} == \$heap_{funcstart\_724,1}.\_\mathbf{replace}(p1 \to \mathbf{asType} {<} \mathbf{short}
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType<int>($heap_{funcstart\_724,1}.b1)))
-asType<integer const>($heap_{724,1:745,8}.M1) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{p1})
!(0 == asType < integer > (\$heap_{724,1;745,8}.p1))
asType<integer>($heap<sub>724.1:745.8</sub>.p1) <
asType<integer>($heap<sub>724.1:745.8</sub>.M1)
```

```
\text{heap}_{724.1:747.8} == \text{heap}_{724.1:745.8}._replace(p2 \rightarrow asType<short)
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724,1:745,8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType< int>($heap_{724,1:745,8}.b2))))
-asType<integer const>($heap<sub>724.1:747.8</sub>.M2) <
asType<integer>($heap<sub>724.1:747.8</sub>.p2)
!(0 == asType < integer > (\$heap_{724,1:747.8} \cdot p2))
asType<integer>($heap<sub>724.1:747.8</sub>.p2) <
asType<integer>($heap<sub>724,1:747,8</sub>.M2)
Proof:
[Take given term]
[5.0] invariant1(heapIs $heap_{tuncstart_724.1})
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
 \texttt{[5.1]} \left( \left( \left( \left( (0 < \mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p1) \right) \& \& \right. \right. \right. 
(asType<integer>($heap_funcstart_724.1.p1) <
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})))\ \&\&
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart_{-724.1}}.M3))
\rightarrow [simplify]
[5.3] \ (((((0 < \$heap_{funcstart\_724,1}.p1) \&\& \ (\$heap_{funcstart\_724,1}.p1 < 
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})))\ \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.4] \ (((((0 < \text{\$heap}_{funcstart\_724,1}.\text{p1}) \&\& \ (\text{\$heap}_{funcstart\_724,1}.\text{p1} <
asType<integer>($heap<sub>init</sub>.M1))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType<integer>(heap_{funcstart\_724,1}.M2))) && (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})))\ \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M3}))
```

```
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < $heap_{funcstart_724,1}.p1) && ($heap_{funcstart_724,1}.p1 < 
asType<integer>(asType<short int>((int)30269)))) && (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})))\ \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType<integer>($heap_{funcstart\_724,1}.M2))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724.1}.M3))
\rightarrow [simplify]
[5.16] \left( \left( \left( \left( -30269 < -\$ \text{heap}_{funcstart\_724,1}.\text{p1} \right) \right. \wedge \left. \left( 0 < \$ \text{heap}_{funcstart\_724,1}.\text{p1} \right) \right. \wedge \right. \right)
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType<integer>(heap_{funcstart\_724,1}.M2))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType<integer>($heap_{tuncstart\_724.1}.p3) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.17] \left( \left( \left( \left( -30269 < -\$ \text{heap}_{funcstart\_724,1}.\text{p1} \right) \right. \wedge \left. \left( 0 < \$ \text{heap}_{funcstart\_724,1}.\text{p1} \right) \right. \wedge \right. \right)
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType < integer > (\$heap_{init}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M3}))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < \mathrm{\$heap}_{funcstart\_724,1}.\mathrm{p2})) && (\mathrm{\$heap}_{funcstart\_724,1}.\mathrm{p2} <
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > (\$heap_{funcstart\_724.1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.30] ((-30307 < -$heap_funcstart_724,1.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{-724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{-724,1}.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.p3 < asType < integer > (\text{\$heap}_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -$heap_funcstart_724,1.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1.p2}) \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\text{\$heap}_{funcstart\_724.1}.\text{p3} < \text{asType} < \text{integer} > (\text{\$heap}_{init}.\text{M3}))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
```

```
[5.32] ((-30307 < -$heap_funcstart_724,1.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.p2) \land (0 < \text{Sheap}_{funcstart\_724,1}.p3)) \&\&
(\text{sheap}_{funcstart\_724,1}.p3 < asType < integer > (asType < short)
int > ((int)30323)))
\rightarrow [simplify]
[5.40] (-30323 < -$heap<sub>funcstart_724,1.</sub>p3) \land (-30307 <
-\$heap_{funcstart\_724,1}.p2) \wedge (-30269 < -\$heap_{funcstart\_724,1}.p1) \wedge (0 <
\text{Sheap}_{funcstart_{-724,1}.p1} \land (0 < \text{Sheap}_{funcstart_{-724,1}.p2}) \land (0 <
heap_{funcstart_{724,1}.p3}
\rightarrow [separate conjunction and work on first sub-term]
[5.41] -30323 < -\$heap_{funcstart\_724,1}.p3
[Work on sub-term 6 of conjunction in term 5.40]
[10.0] 0 < $\text{heap}_{funcstart_724,1}.p3
[Take given term]
[11.0] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
\rightarrow [simplify]
[11.1] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
\rightarrow [const static or extern object]
[11.2]~{\rm div1} == {\rm div}(\mathbf{heapIs}~\$ \mathrm{heap}_{funcstart\_724,1},\,\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType < int > (\$heap_{init}.a1))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
[11.3] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType<int>(asType<short int>((int)177)))
\rightarrow [simplify]
[11.6] \text{ div1} == \text{div}(\mathbf{heapIs} \$ heap_{funcstart\_724,1}, \$ heap_{funcstart\_724,1}.p1, 177)
[Take given term]
[27.0] \operatorname{div2} == \operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
\rightarrow [simplify]
[27.1] div2 == div(heapIs \theta_{funcstart_{-724,1}}, \theta_{funcstart_{-724,1}}.p2,
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
\rightarrow [const static or extern object]
```

```
[27.2] \ \mathrm{div2} == \ \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2},
asType < int > (\$heap_{init}.a2))
\rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
[27.3]~{\rm div2} == {\rm div}(\mathbf{heapIs}~\$ \mathrm{heap}_{funcstart\_724,1},~\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2},
asType < int > (asType < short int > ((int)176)))
\rightarrow [simplify]
[27.6] div2 == div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p2, 176)
[Take given term]
[43.0] div3 == div(heapIs $heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724.1}.p3),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
\rightarrow [simplify]
[43.1] \ \mathrm{div3} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3},
asType < int > (\$heap_{funcstart\_724,1}.a3))
\rightarrow [const static or extern object]
[43.2] div3 == div(heapIs $heap_{funcstart\_724.1}, $heap_{funcstart\_724.1}.p3,
asType < int > (\$heap_{init}.a3))
\rightarrow [expand definition of constant 'a3' at prang.c (26,20)]
[43.3] \ \mathrm{div3} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3},
asType<int>(asType<short int>((int)178)))
\rightarrow [simplify]
[43.6] \ \mathrm{div3} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}, \ 178)
[Assume known post-assertion, class invariant or type constraint for term 43.6]
[46.0] \; (\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) \; / \\
asType<integer>(178)) == asType<integer>(div(heapIs
\$heap_{funcstart\_724,1},\,\$heap_{funcstart\_724,1}.p3,\,178).quot)
\rightarrow [simplify]
[46.2] \; (\$heap_{funcstart\_724,1}.p3 \; / \; 178) == \mathbf{asType} < \mathbf{integer} > (\mathrm{div}(\mathbf{heapIs}))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p3, 178).quot
→ [expand definition of operator './' in class 'int' at built in declaration]
[46.3] ([asType<integer>(heap_{funcstart\_724,1}.p3) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178), []:
asType < integer > (\$heap_{funcstart\_724.1}.p3) / 178) = =
\mathbf{asType} {<} \mathbf{integer} {>} ( \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}, \\
178).quot)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
```

```
[46.4] ([asType<integer>(sheap_{funcstart\_724,1}.p3) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178) = =
asType<integer>(div(heapIs p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}),
178).quot)
\rightarrow [simplify]
[46.7] ([0 < -$heap<sub>funcstart_724,1.</sub>p3]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 0)]:
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})~/~178) ==
asType<integer>(div(heapIs p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}),
178).quot)
\rightarrow [from term 10.0, literala < -$heap<sub>funcstart_724.1</sub>.p3 is false whenever -2 <
(0 + literala)
    Proof of rule precondition:
    [46.7.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [46.7.2] true
[46.8] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) \; / \; 178),
[!(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) < 0)]:
asType < integer > (\$heap_{funcstart\_724.1}.p3) / 178) = =
asType<integer>(div(heapIs $heap_funcstart_724.1, $heap_funcstart_724.1.p3,
178).quot)
\rightarrow [simplify]
[46.11] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178), [!(0 < integer > (\$heap_{funcstart\_724,1}.p3) / 178)]
-\$heap_{funcstart\_724,1}.p3)]: asType<integer>(\$heap_{funcstart\_724,1}.p3) / 178)
== asType < integer > (div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p3, 178).quot
\rightarrow [from term 10.0, literala < -$heap<sub>funcstart_724,1</sub>.p3 is false whenever -2 <
(0 + literala)
    Proof of rule precondition:
    [46.11.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [46.11.2] true
[46.12] \; ([{\bf false}]: \; -({\bf -asType} < {\bf integer} > (\$ {\bf heap}_{funcstart\_724,1}.{\bf p3}) \; / \; 178),
[!false]: asType<integer>($heap<sub>funcstart_724,1.</sub>p3) / 178) ==
\mathbf{asType} < \mathbf{integer} > (\mathbf{div}(\mathbf{heapIs} \ \$ \mathbf{heap}_{funcstart\_724,1}, \ \$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}, \\
178).quot)
```

```
\rightarrow [simplify]
[46.17] \ 0 == (-\text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p3},
178).quot + (\text{$heap}_{funcstart\_724,1}.p3 / 178))
[Assume known post-assertion, class invariant or type constraint for term 43.6]
[47.0] (as
Type<integer>($heap_{funcstart\_724,1}.p3) \%
asType<integer>(178)) == asType<integer>(div(heapIs
\$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem)
\rightarrow [simplify]
[47.2] ($heap<sub>funcstart_724,1.</sub>p3 % 178) == asType<integer>(div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{rem}
→ [expand definition of operator '.%' in class 'int' at built in declaration]
[47.3] ([asType<integer>(sheap_{funcstart\_724,1}.p3) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178), []:
asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178) ==
asType<integer>(div(heapIs $heap_{tuncstart\_724.1}, $heap_{tuncstart\_724.1}.p3,
178).rem)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[47.4] \; ([\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) < 0] :
-(-asType < integer > (\$heap_{funcstart\_724.1}.p3) \% 178),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178) ==
\mathbf{asType} {<} \mathbf{integer} {>} ( \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}, \\
178).rem)
\rightarrow [simplify]
[47.7] ([0 < -$heap<sub>funcstart_724,1</sub>.p3]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178) ==
asType<integer>(div(heapIs $heap_{tuncstart\_724.1}, $heap_{tuncstart\_724.1}.p3,
178).rem)
\rightarrow [from term 10.0, literala < -$heap<sub>funcstart_724,1</sub>.p3 is false whenever -2 <
(0 + literala)
   Proof of rule precondition:
   [47.7.0] - 2 < (0 + 0)
   \rightarrow [simplify]
   [47.7.2] true
[47.8] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 0)]:
```

```
asType < integer > (\$heap_{funcstart-724,1}.p3) \% 178) ==
\mathbf{asType} < \mathbf{integer} > (\mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3},
178).rem)
\rightarrow [simplify]
[47.11] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178), [!(0)]
<-$heap<sub>funcstart_724.1</sub>.p3)]: asType<integer>($heap<sub>funcstart_724,1</sub>.p3) %
178) == asType<integer>(div(heapIs heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p3, 178}.rem
\rightarrow [from term 10.0, literala < -$heap<sub>funcstart_724,1</sub>.p3 is false whenever -2 <
(0 + literala)
        Proof of rule precondition:
        [47.11.0] - 2 < (0 + 0)
        \rightarrow [simplify]
        [47.11.2] true
[47.12] ([false]: -(-asType < integer > (\$heap_{funcstart\_724.1}.p3) \% 178),
[!false]: asType<integer>(sheap_{funcstart\_724,1.p3}) \% 178 ==
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3,
178).rem)
\rightarrow [simplify]
[47.17] 0 == (-\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p3},
178).rem + (\text{$heap}_{funcstart\_724,1}.p3 \% 178))
[Take given term]
[59.0] \rho_{1745,8} == \rho_{1745,8} == \rho_{1745,8} == \rho_{1745,8}._replace(p1 \rightarrow \rho_{1745,8} == \rho_{1745,8})
int>((asType<int>(asType<short int>(div1.rem)) *
\mathbf{asType} \small{<} \mathbf{int} \small{>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{r1})) \\ - (\mathbf{asType} \small{<} \mathbf{int} \small{>} (\mathbf{asType} \small{<} \mathbf{short}
int>(div1.quot)) * asType< int>($heap_{tuncstart\_724.1}.b1))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177)
[59.1] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},))
\theta_{funcstart\_724,1.p1, 177}.rem) * asType < int > (\theta_{funcstart\_724,1.p1, 177}.rem) - (\theta_{funcstart\_
(asType<int>(asType<short int>(div1.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [simplify]
[59.3] \rho_{1745,8} == \rho_{1745,8} == \rho_{1745,8} == \rho_{1745,8}._replace(p1 \rightarrow \rho_{1745,8} == \rho_{1745,8}
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType < int > (\$heap_{tuncstart\_724.1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{tuncstart\_724.1}.b1))))
```

```
\rightarrow [const static or extern object]
[59.4] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType < int > (\$heap_{init}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1.quot})) * \mathbf{asType}{<} \mathbf{int}{>} (\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
\rightarrow [expand definition of constant 'r1' at prang.c (15,20)]
[59.5] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType < int > (asType < short int > ((int)171))) -
(asType < int > (asType < short int > (div1.quot)) *
asType < int > (\$heap_{funcstart\_724.1}.b1)))
\rightarrow [simplify]
[59.8] \rho_{724,1;745,8} == \rho_{funcstart\_724,1}.\_replace(p1 \rightarrow asType < short)
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem * 171)
- (asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177)
[59.9] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
\mathbf{int} > ((171 * \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, 177).\operatorname{rem})
- (asType<int>(asType<short int>(div(heapIs $heap_{funcstart_724.1},
heap_{funcstart_{724,1},p1, 177}, quot)) *
asType < int > (\$heap_{funcstart\_724.1}.b1)))
\rightarrow [simplify]
[59.11] \$ heap_{724,1;745,8} == \$ heap_{funcstart\_724,1}.\_\mathbf{replace} (p1 \to \mathbf{asType} < \mathbf{short})
int > ((171 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724.1}, \$ \text{heap}_{funcstart\_724.1}. \text{p1}, 177).\text{quot} *
asType < int > (\$heap_{funcstart\_724.1}.b1)))
\rightarrow [const static or extern object]
[59.12] \theta_{12} = \theta_{124,1;745,8} = \theta_{124,1;74
int>((171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType < int > (\$heap_{init}.b1)))
\rightarrow [expand definition of constant 'b1' at prang.c (17,20)]
[59.13] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType<int>(asType<short int>((int)2))))
\rightarrow [simplify]
```

```
[59.19] $heap<sub>724,1;745,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).rem)))
[Take given term]
[63.0] $\text{heap}_{724,1:747,8} == $\text{heap}_{724,1:745,8}._\text{replace}(p2 \to \text{asType} < \text{short}
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724,1:745,8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType< int>($heap_{724,1:745.8}.b2))))
\rightarrow [from term 59.19, $heap<sub>724,1;745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177).rem)
[63.1] heap_{724,1;747,8} == heap_{funcstart\_724,1}.\_replace(p1 \to ((-2 * 
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
(177).rem))._replace(p2 \rightarrow asType < short)
int>((asType<int>(asType<short\ int>(div2.rem))*
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{r2})) - (\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{short}
int>(div2.quot)) * asType< int>($heap_{724.1:745.8}.b2))))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p2, 176
[63.2] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
(177).rem))._replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724.1},
\text{sheap}_{funcstart\_724,1.p2, 176}.\text{rem}) * asType < int > (\text{sheap}_{724,1;745,8.r2})) -
(asType<int>(asType<short int>(div2.quot)) *
asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [simplify]
[63.4] $heap<sub>724,1:747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 176).rem *
\mathbf{asType} \small{<} \mathbf{int} \small{>} (\$ \mathrm{heap}_{724,1;745,8}.\mathrm{r2})) \\ - (\mathbf{asType} \small{<} \mathbf{int} \small{>} (\mathbf{asType} \small{<} \mathbf{short}
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [from term 59.19, $heap<sub>724,1:745,8</sub> is equal to
heap_{funcstart\ 724.1}._replace(p1 \rightarrow (-2 * div(heapIs \$heap_{funcstart\ 724.1},
\text{Sheap}_{funcstart\_724,1.p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p1, 177).rem}
```

```
[63.5] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\label{eq:div_heap} \text{div}(\textbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
(177).rem))._replace(p2 \rightarrow asType<short int>((div(heapIs)))._replace(p2 \rightarrow asType
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem} *
asType < int > (\$heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * div(heapIs))))))
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1},p1, 177}.rem)).r2)) -
(asType<int>(asType<short int>(div2.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\${\rm heap}_{724,1;745,8}.{\rm b2}))))
→ [const member of object with modified fields]
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((\operatorname{div}(\mathbf{heapIs}))))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem *
asType < int > (\$heap_{funcstart\_724,1}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [const static or extern object]
[63.7] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ ^*
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem *
asType < int > (\$heap_{init}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [expand definition of constant 'r2' at prang.c (20,20)]
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((\operatorname{div}(\mathbf{heapIs}))))
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p_{176}.rem *
asType<int>(asType<short int>((int)172))) -
(asType<int>(asType<short int>(div2.quot)) *
asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [simplify]
[63.11] $\text{heap}_{724,1;747,8} == \text{$heap}_{funcstart\_724,1}._\text{$replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((\operatorname{div}(\mathbf{heapIs}))))
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}.p2, 176).rem * 172) -
(asType<int>(asType<short int>(div2.quot)) *
```

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asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p2, 176
[63.12] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem) -
(asType < int > (asType < short int > (div(heapIs $heap_{funcstart\_724,1}, 
\text{Sheap}_{funcstart\ 724,1}.p2,\ 176).quot) * asType<int>(\text{Sheap}_{724,1:745,8}.b2))))
\rightarrow [simplify]
[63.14] $\text{heap}_{724,1;747,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).quot *
asType < int > (\$heap_{724,1;745,8}.b2))))
\rightarrow [from term 59.19, $heap<sub>724.1:745.8</sub> is equal to
heap_{funcstart\_724.1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724.1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177).rem)
[63.15] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs)
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1},p2, 176}.quot *
asType < int > (\$heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * div(heapIs)))))))
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.pl, 177).quot) + (171 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).rem))).b2))))
\rightarrow [const member of object with modified fields]
[63.16] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b2}))))
\rightarrow [const static or extern object]
[63.17] $\text{heap}_{724,1;747,8} == \text{$heap}_{funcstart\_724,1}._\text{$replace}(p1 \to ((-2 *
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\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1},p2,176}, quot *
asType < int > (\$heap_{init}.b2))))
\rightarrow [expand definition of constant 'b2' at prang.c (22,20)]
[63.18] $\text{heap}_{724,1:747,8} == \text{$heap}_{funcstart\_724,1}._\text{$replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 2, 176).quot *
asType<int>(asType<short int>((int)35)))))
\rightarrow [simplify]
[63.24] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{tuncstart_724.1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p2, 176).rem)
[Take goal term]
[1.0] minof(short int) \leq ((asType<int>(asType<short int>(div3.rem)) *
asType < int > (\$heap_{724,1:747,8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType< int>($heap_{724,1;747,8}.b3)))
\rightarrow [simplify]
[1.1] -32768 \leq ((asType\leqint>(asType\leqshort int>(div3.rem)) *
asType < int > (\$heap_{724,1:747,8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap<sub>724,1:747.8</sub>.b3)))
\rightarrow [from term 43.6, div3 is equal to div(heapIs $heap_{funcstart\_724.1},
heap_{funcstart_{-724,1}}.p3, 178
[1.2] -32768 \leq ((asType<int>(asType<short int>(div(heapIs))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p3, 178).rem)) *
asType < int > (\$heap_{724,1:747,8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap<sub>724,1:747.8</sub>.b3)))
\rightarrow [simplify]
[1.4] - 32768 \le ((\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p3},
178).rem * asType < int > (\$heap_{724,1;747,8}.r3)) -
(asType<int>(asType<short int>(div3.quot)) *
asType<int>($heap<sub>724,1:747,8</sub>.b3)))
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\rightarrow [from term 63.24, $heap<sub>724.1:747.8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs p_{funcstart\_724,1}),
heap_{funcstart_724,1}.p1, 177).quot + (171 * div(heapIs p_{funcstart_724,1})
heap_{funcstart\_724,1}.p1, 177).rem)._replace(p2 \rightarrow (-35 * div(heapIs)))._
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p2, 176).rem)
[1.5] -32768 \leq ((div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p3,
178).rem * asType<int>($heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724.1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724.1},
\frac{\text{sheap}_{funcstart=724,1.p2, 176}.\text{rem}}{\text{short}} - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap<sub>724,1:747.8</sub>.b3)))
\rightarrow [const member of object with modified fields]
[1.7] -32768 \leq ((div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p3,
178).rem * asType < int > (\$heap_{funcstart\_724,1}.r3)) -
(asType<int>(asType<short int>(div3.quot)) *
asType<int>($heap<sub>724.1:747.8</sub>.b3)))
\rightarrow [const static or extern object]
[1.8] - 32768 \le ((\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p3},
178).rem * asType < int > (\$heap_{init}.r3)) - (asType < int > (asType < short)
int > (div3.quot)) * asType < int > ($heap_{724,1;747.8}.b3)))
\rightarrow [expand definition of constant 'r3' at prang.c (25,20)]
[1.9] -32768 \le ((\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3},
178).rem * asType<int>(asType<short int>((int)170))) -
(asType<int>(asType<short int>(div3.quot)) *
asType<int>($heap<sub>724.1:747.8</sub>.b3)))
\rightarrow [simplify]
\textit{[1.12] -32768} \leq ((\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p3},
178).rem * 170) - (asType<int>(asType<short int>(div3.quot)) *
asType<int>($heap<sub>724,1:747,8</sub>.b3)))
\rightarrow [from term 43.6, div3 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p3, 178
[1.13] -32768 \leq ((170 * div(heapIs $heap_{funcstart\_724,1},)
\theta_{funcstart\_724,1.p3}, 178).rem) - (asType<int>(asType<short)
int>(div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).quot)) *
asType<int>($heap<sub>724.1:747.8</sub>.b3)))
\rightarrow [simplify]
[1.15] -32768 \leq ((170 * div(heapIs $heap_{funcstart\_724,1},)
```

```
\text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{rem}) - (\text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{tuncstart_{724,1},p3,178} quot * asType<int>($\rho_{124,1.747.8}$.b3)))
\rightarrow [from term 63.24, $heap<sub>724,1;747,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1},p1, 177}, quot) + (171 * div(heapIs heap_{funcstart_{-724,1},p1, 177})
\rho_{funcstart\_724.1}.p1, 177).rem)._replace\rho_{funcstart\_724.1}.p1, 177).rem)._replace
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem))
[1.16] -32768 \leq ((170 * div(heapIs $heap_{funcstart\_724,1},
\rho_{funcstart\_724,1.p3}, 178).rem) - (div(heapIs \rho_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p3, 178}.quot *
\mathbf{asType}{<}\mathbf{int}{>}(\$\text{heap}_{funcstart\_724,1}.\mathbf{\_replace}(\text{p1} \rightarrow ((\text{-}2 * \text{div}(\mathbf{heapIs}
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).quot) + (171 * div(heapIs)
* div(\mathbf{heapIs} \ \$ heap_{funcstart\_724,1}, \ \$ heap_{funcstart\_724,1}.p2, \ 176).quot) + (172 \ *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p2, \ 176).rem))).b3)))
\rightarrow [const member of object with modified fields]
[1.18] -32768 \leq ((170 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{rem}) - (\text{div}(\text{heapIs }\text{Sheap}_{funcstart\_724,1},
\theta_{funcstart\_724,1.p3}, 178).quot * asType<int>(\theta_{funcstart\_724,1.p3})))
\rightarrow [const static or extern object]
[1.19] -32768 \leq ((170 * div(heapIs $heap_{funcstart\_724,1},)
\text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{rem}) - (div(heapIs \text{Sheap}_{funcstart\_724,1},
\theta_{funcstart_{724,1},p3,178}.quot * asType<int>(\theta_{init})
\rightarrow [expand definition of constant 'b3' at prang.c (27,20)]
[1.20] -32768 \leq ((170 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p3,
178).rem) – (div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3,
178).quot * asType<int>(asType<short int>((int)63))))
\rightarrow [simplify]
 \label{eq:continuous} \mbox{$[1.27]$ -32769} < ((-63 * \mbox{div}(\mathbf{heapIs} \ \$ \mbox{$heap}_{funcstart\_724,1}, \ \$ \mbox{$heap}_{funcstart\_724,1}.\mbox{$p$} 3, 
178).quot) + (170 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3,
178).rem))
\rightarrow [negate goal and search for contradiction]
[1.28] ! (-32769 < ((-63 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p3}, 178).\text{quot} + (170 * \text{div}(\text{heapIs} \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p3, 178.rem})
\rightarrow [simplify]
 [1.33] \ 32768 < ((63 * div(\textbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3,
178).quot) + (-170 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart\_724.1}, \text{\$heap}_{funcstart\_724.1}.p3,
178).rem))
```

```
[Copy term 1.33]
[96.0] 32768 < ((-170 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{rem} + (63 * \text{div}(\text{heapIs} \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p3, 178}, quot))
\rightarrow [from term 47.17, div(heapIs $heap_{funcstart\_724,1}$, $heap_{funcstart\_724,1}$.p3,
178).rem is equal to heap_{funcstart\_724,1}.p3 \% 178
[96.1] 32768 < ((-170 * ($heap_{funcstart\_724,1}.p3 % 178)) + (63 * div(heapIs
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, 178).quot)
[Create new term from term 46.17 using rule: condition for equality of division]
[147.0] ((178 * (0 + -(-\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1},
\text{Sheap}_{funcstart_{-724,1}.p3}, 178).\text{quot}))) < (1 + \text{Sheap}_{funcstart_{-724,1}.p3})) \land
(\text{$heap}_{funcstart\_724,1}.p3 < (178 * (0 + 1 + -(-div(\textbf{heapIs}))))
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 178).quot))))
\rightarrow [simplify]
[147.15] \ (-1 < ((-178 * {\rm div}(\mathbf{heapIs} \ \$ {\rm heap}_{funcstart\_724,1}, \ \$ {\rm heap}_{funcstart\_724,1}.{\rm p3},
178).quot) + heap_{funcstart_724,1.p3}) \land (-178 < (-heap_{funcstart_724,1.p3} + funcstart_724,1.p3)
(178 * \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p3}, 178).\operatorname{quot})))
[Work on sub-term 2 of conjunction in term 147.15]
178).quot) + $heap<sub>funcstart_724,1.</sub>p3)
[Create new term from terms 148.0, 5.41 using rule: transitivity 2]
[204.0] (-30323 + -1 + 1) < (-178 * div(heapIs $heap_{tuncstart\_724,1},
heap_{funcstart_{-724,1}}.p3, 178).quot
\rightarrow [simplify]
[204.1] -30323 < (-178 * div(heapIs $heap<sub>funcstart_724,1</sub>,
heap_{funcstart_{-724,1}.p3}, 178).quot
\rightarrow [literal comparison of product]
[204.2] ([-178 < 0]: (-30323 / 178) < -\text{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1},
\theta_{funcstart_{-724,1}.p3, 178}, quot, [0 < -178]: (-30323 / -178) < \text{div}(\mathbf{heapIs})
0)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[204.3] ([-178 < 0]: (-30323 / 178) < -\text{div}(\text{heapIs } \text{$heap}_{funcstart\_724.1},
\rho_{tuncstart_{-724,1},p3,178}, quot, [(0 < -178) \land !(-178 < 0)]: (-30323 / -178)
< div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).quot, [(-178)
==0) \land !(-178 < 0) \land !(0 < -178)]: -30323 < 0)
\rightarrow [simplify]
[204.7] - 171 < -\text{div}(\text{heapIs } \text{heap}_{funcstart\_724,1}, \text{heap}_{funcstart\_724,1}.p3,
```

```
178).quot
[Create new term from terms 204.7, 96.1 using rule: transitivity 5]
[214.0] 32768 < ((-170 * (\text{$heap}_{funcstart\_724.1}.p3 \% 178)) + (63 * -(-171 + 1)))
\rightarrow [simplify]
[214.5] 22058 < (-170 * (\$heap_{funcstart\_724,1}.p3 \% 178))
\rightarrow [literal comparison of product]
[214.6] ([-170 < 0]: (22058 / 170) < –($heap_{funcstart\_724,1}.p3 % 178), [0 <
-170]: (22058 / -170) < (\text{$heap}_{funcstart\_724,1}.\text{p3} \% 178), [-170 == 0]: 22058 <
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[214.7] ([-170 < 0]: (22058 / 170) < -(\text{\$heap}_{funcstart\_724,1}.\text{p3 }\% 178), [(0 <
-170) \wedge !(-170 < 0)]: (22058 / -170) < ($heap_{funcstart_724,1}.p3 % 178), [(-170)]
==0) \land !(-170 < 0) \land !(0 < -170)]: 22058 < 0)
\rightarrow [simplify]
[214.12] false
Proof of verification condition: Type constraint satisfied in implicit
conversion from 'int' to 'short int'
Condition generated at: C:\Escher\Customers\prang\prang.c (65,33)
Condition defined at:
To prove: ((asType<int>(asType<short int>(div3.rem)) *
asType < int > (\$heap_{724,1:747,8}.r3)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathrm{div3.quot})) \ * \ \mathbf{asType}{<} \mathbf{int}{>} (\$\mathrm{heap}_{724,1;747,8}.\mathrm{b3}))) \leq \mathbf{maxof}(\mathbf{short} \ \mathbf{int})
Given:
heap_{init}.LIMIT == (int)80
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
\theta
\theta
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
heap_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta sheap<sub>init</sub>.b2 == asType<short int>((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType < short int > ((int)170)
```

```
heap_{init}.a3 == asType < short int > ((int)178)
heap_{init}.b3 == asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart\_724,1})
\mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(asType<int>(asType<int>($heap_{tuncstart\_724.1}.p1)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))) ==
asType<integer>(div1.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p1) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p1) = =
asType<integer>(div1.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a1) \le
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart\_724.1},
asType < int > (\$heap_{funcstart\_724.1}.p2),
asType < int > (\$heap_{funcstart\_724.1}.a2))
(asType<integer>(asType<int>($heap_{funcstart\_724.1}.p2)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.quot)
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2})) \ \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(asType < integer > ($heap_{funcstart\_724,1}.p2) = =
asType<integer>(div2.rem))
(asType < integer > (\$heap_{funcstart\_724.1}.a2) \le
\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})) = > !(0 ==
```

```
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
asType < int > (\$heap_{funcstart\_724,1}.a3))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p3})) \ / \\
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(asType<integer>(asType<int>($heap_{tuncstart\_724.1}.p3)) %
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.rem)
(asType<integer>($heap_{tuncstart\_724,1}.p3) <
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}) ==
asType<integer>(div3.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a3}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
\$heap_{724,1;745,8} == \$heap_{funcstart\_724,1}.\_\mathbf{replace}(p1 \to \mathbf{asType} < \mathbf{short}
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
-asType < integer\ const > (\$heap_{724,1;745,8}.M1) < 1
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{p1})
!(0 == asType < integer > (\$heap_{724,1;745,8}.p1))
asType<integer>($heap<sub>724.1:745.8</sub>.p1) <
asType<integer>($heap<sub>724.1:745.8</sub>.M1)
\text{$heap}_{724,1;747,8} == \text{$heap}_{724,1;745,8}.\mathbf{replace}(p2 \to \mathbf{asType} < \mathbf{short})
int>((asType<int>(asType<short int>(div2.rem)) *
\mathbf{asType} < \mathbf{int} > (\$ heap_{724,1;745,8}.r2)) - (\mathbf{asType} < \mathbf{int} > (\mathbf{asType} < \mathbf{short})
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
-asType<integer const>($heap_{724,1:747,8}.M2) <
asType<integer>($heap<sub>724,1:747,8</sub>.p2)
!(0 == asType < integer > (\$heap_{724,1;747,8}.p2))
asType<integer>($heap<sub>724,1:747,8</sub>.p2) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;747,8}.\mathrm{M2})
```

Proof:

```
[Take given term]
[5.0] invariant1(heapIs heap_{funcstart\_724,1})
\rightarrow [expand definition of function 'invariant1' at prang.c (34.1)]
 \texttt{[5.1]} \left( \left( \left( \left( \left( 0 < \mathbf{asType} < \mathbf{integer} > \left( \$ \mathsf{heap}_{funcstart\_724,1}.\mathsf{p1} \right) \right) \right. \&\& \right. \right. 
(asType < integer > ($heap_{funcstart\_724,1}.p1) < 
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M2})))~\&\&~(0<
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType<integer>($heap_{tuncstart_724.1}.p3) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.3] \ (((((0 < \$heap_{funcstart\_724,1}.p1) \&\& \ (\$heap_{funcstart\_724,1}.p1 < (((((((1.5) + (1.5) + (1.5) + ((1.5) + (1.5) + (1.5) + ((1.5) + (1.5) + (1.5) + ((1.5) + (1.5) + (1.5) + ((1.5) + (1.5) + ((1.5) + (1.5) + ((1.5) + (1.5) + ((1.5) + (1.5) + ((1.5) + (1.5) + ((1.5) + (1.5) + ((1.5) + (1.5) + ((1.5) + (1.5) + ((1.5) + (1.5) + ((1.5) + (1.5) + ((1.5) + (1.5) + ((1.5) + (1.5) + ((1.5) + (1.5) + ((1.5) + (1.5) + ((1.5) + (1.5) + ((1.5) + ((1.5) + (1.5) + ((1.5) + ((1.5) + (1.5) + ((1.5) + ((1.5) + (1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5) + ((1.5
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M1})))~\&\&~(0<
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType<integer>($heap_{tuncstart}, 724.1.p3) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [const static or extern object]
[5.4] (((((0 < \theta_{funcstart\_724,1.p1) && (\theta_{funcstart\_724,1.p1)
asType < integer > (\$heap_{init}.M1))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})))\ \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] (((((0 < $heap_{funcstart_724,1}.p1) && ($heap_{funcstart_724,1}.p1 < function for the content of the 
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p2) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M2})))~\&\&~(0<
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})))\ \&\&
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart_{-724.1}}.M3))
\rightarrow [simplify]
```

```
[5.16] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M2})))~\&\&~(0<
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType<integer>($heap_funcstart_724,1.M3))
\rightarrow [const static or extern object]
[5.17] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \; \land \; (0 < \$heap_{funcstart\_724,1}.p1) \; \land 
(0 < \text{$heap}_{funcstart\_724,1}.p2)) \&\& (\text{$heap}_{funcstart\_724,1}.p2 < 
asType < integer > (\$heap_{init}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType<integer>($heap_{tuncstart\_724,1}.p3) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > (\$heap_{funcstart_{-724,1}}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.30] ((-30307 < -\$heap_{funcstart\_724,1}.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{724,1}.p2} \land (0 < \text{Sheap}_{funcstart_{724,1}.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.p3 < asType < integer > (\text{\$heap}_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1.p2}) \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.\text{p3} < \mathbf{asType} < \mathbf{integer} > (\text{\$heap}_{init}.\text{M3}))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap<sub>funcstart_724,1.</sub>p2) \wedge (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1.p2} \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\$heap_{funcstart\_724,1}.p3 < \mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{short}
int > ((int)30323)))
\rightarrow [simplify]
[5.40] (-30323 < -\$heap_{funcstart\_724,1}.p3) \land (-30307 < -30307)
-\$heap_{funcstart\_724,1}.p2) \land (-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < -\$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.\text{p1}) \land (0 < \text{Sheap}_{funcstart\_724,1}.\text{p2}) \land (0 <
heap_{funcstart_{-724,1}.p3}
```

```
[Work on sub-term 6 of conjunction in term 5.40]
\textit{[10.0]}~0 < \$ heap_{funcstart\_724,1}.p3
[Take given term]
[11.0] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
\rightarrow [simplify]
[11.1] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
\rightarrow [const static or extern object]
[11.2] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType < int > (\$heap_{init}.a1))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
[11.3] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType < int > (asType < short int > ((int)177)))
\rightarrow [simplify]
[11.6] div1 == div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p1, 177)
[Take given term]
[27.0] \operatorname{div2} == \operatorname{div}(\mathbf{heapIs} \ \operatorname{\$heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
\rightarrow [simplify]
\label{eq:continuous} \textit{[27.1]} \ \text{div2} == \ \text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p2},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
\rightarrow [const static or extern object]
[27.2] div2 == div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2,
asType < int > (\$heap_{init}.a2))
\rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
[27.3]~{\rm div2} == {\rm div}(\mathbf{heapIs}~\$ \mathrm{heap}_{funcstart\_724,1},\,\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2},
asType<int>(asType<short int>((int)176)))
\rightarrow [simplify]
[27.6] div2 == div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2, 176)
[Take given term]
[43.0] div3 == div(heapIs $heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
asType < int > (\$heap_{funcstart\_724,1}.a3))
```

```
\rightarrow [simplify]
[43.1] \ \mathrm{div3} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
\rightarrow [const static or extern object]
[43.2] \ \mathrm{div3} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3},
asType < int > (\$heap_{init}.a3))
\rightarrow [expand definition of constant 'a3' at prang.c (26,20)]
[43.3] div3 == div(heapIs $heap_{funcstart\_724.1}, $heap_{funcstart\_724.1}.p3,
asType<int>(asType<short int>((int)178)))
\rightarrow [simplify]
[43.6] \text{ div3} == \text{div}(\mathbf{heapIs} \$ heap_{funcstart\_724,1}, \$ heap_{funcstart\_724,1}.p3, 178)
[Assume known post-assertion, class invariant or type constraint for term 43.6]
\textit{[46.0]} \ (\textbf{asType}{<}\textbf{integer}{>}(\$\text{heap}_{funcstart\_724,1}.\text{p3}) \ / \\
asType<integer>(178)) == asType<integer>(div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p3, 178).quot)
\rightarrow [simplify]
[46.2] ($heap<sub>funcstart_724.1.</sub>p3 / 178) == asType<integer>(div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p3, 178).quot
→ [expand definition of operator './' in class 'int' at built in declaration]
[46.3] ([asType<integer>(peq: funcstart_{-724,1}.p3) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178), []:
asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178) = =
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3,
178).quot)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[46.4] ([asType<integer>(heap_{funcstart\_724,1}.p3) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178) = =
\mathbf{asType} < \mathbf{integer} > (\mathbf{div}(\mathbf{heapIs} \ \$ \mathbf{heap}_{funcstart\_724,1}, \ \$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}, \\
178).quot)
\rightarrow [simplify]
[46.7] ([0 < -$heap<sub>funcstart_724,1</sub>.p3]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178) = =
\mathbf{asType} < \mathbf{integer} > (\mathbf{div}(\mathbf{heapIs} \ \$ \mathbf{heap}_{funcstart\_724,1}, \ \$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}, \\
178).quot)
```

```
\rightarrow [from term 10.0, literala < -$heap<sub>funcstart_724,1</sub>.p3 is false whenever -2 <
(0 + literala)
    Proof of rule precondition:
    [46.7.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [46.7.2] true
[46.8] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178),
[!(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})<0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178) = =
\mathbf{asType} {<} \mathbf{integer} {>} ( \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}, \\
178).quot)
\rightarrow [simplify]
[46.11] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178), [!(0 < integer > (\$heap_{funcstart\_724,1}.p3) / 178)]
-\$heap_{funcstart\_724,1}.p3)]: asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178)
== asType < integer > (div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p3, 178).quot
\rightarrow [from term 10.0, literala < -$heap<sub>funcstart_724,1</sub>.p3 is false whenever -2 <
(0 + literala)
    Proof of rule precondition:
    [46.11.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [46.11.2] true
[46.12] ([false]: -(-asType < integer > (\$heap_{funcstart\_724.1}.p3) / 178),
[!false]: asType<integer>(heap_{funcstart\_724,1}.p3) / 178) ==
\mathbf{asType} < \mathbf{integer} > (\mathbf{div}(\mathbf{heapIs} \ \$ \mathbf{heap}_{funcstart\_724,1}, \ \$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3},
178).quot)
\rightarrow [simplify]
[46.17] 0 == (-\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p3},
178).quot + (\text{$heap}_{funcstart\_724,1}.p3 / 178)
[Assume known post-assertion, class invariant or type constraint for term 43.6]
[47.0] (asType<integer>(sheap_{funcstart_{-724.1}.p3}) %
asType<integer>(178)) == asType<integer>(div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{rem}
\rightarrow [simplify]
[47.2] (heap_{funcstart\_724,1}.p3 \% 178) == asType<integer>(div(heapIs
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem
→ [expand definition of operator '.%' in class 'int' at built in declaration]
```

```
[47.3] \; ([\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178), []:
asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178) ==
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3,
178).rem)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[47.4] \; ([\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) < 0] :
-(-\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}) \% \ 178),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178) ==
asType<integer>(div(heapIs $heap_{tuncstart\_724.1}, $heap_{tuncstart\_724.1}.p3,
178).rem)
\rightarrow [simplify]
[47.7] ([0 < -$heap<sub>funcstart_724,1</sub>.p3]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178),
[!(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178) = =
asType<integer>(div(heapIs p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}),
178).rem)
\rightarrow [from term 10.0, literala < -$heap<sub>funcstart_724.1</sub>.p3 is false whenever -2 <
(0 + literala)
   Proof of rule precondition:
   [47.7.0] - 2 < (0 + 0)
   \rightarrow [simplify]
   [47.7.2] true
[47.8] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 0)]:
asType < integer > (\$heap_{funcstart\_724.1}.p3) \% 178) = =
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3,
178).rem)
\rightarrow [simplify]
[47.11] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178), [!(0
< -$heap<sub>funcstart_724.1.</sub>p3)]: asType<integer>($heap<sub>funcstart_724.1.</sub>p3) %
178) == asType < integer > (div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p3, 178}.rem
\rightarrow [from term 10.0, literala < -$heap<sub>funcstart_724,1</sub>.p3 is false whenever -2 <
(0 + literala)
   Proof of rule precondition:
   [47.11.0] - 2 < (0 + 0)
```

```
\rightarrow [simplify]
         [47.11.2] true
[47.12] \; ([\mathbf{false}]: \; -(\mathbf{-asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}) \; \% \; 178),
[!false]: asType<integer>(\ensuremath{\text{sheap}}_{funcstart\_724,1}.p3) \% 178) ==
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3,
178).rem)
\rightarrow [simplify]
[47.17] 0 == (-\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p3},
178).rem + (\text{$heap}_{funcstart\_724,1}.p3 \% 178))
[Take given term]
\textit{[56.0]} \; (\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
\rightarrow [simplify]
[56.1] (\text{$heap}_{funcstart\_724,1}.p3 < asType < integer > (\\\text{$heap}_{funcstart\_724,1}.a3))
=> (asType < integer > (\$heap_{funcstart\_724,1}.p3) ==
asType<integer>(div3.rem))
\rightarrow [const static or extern object]
[56.2] ($heap<sub>funcstart_724,1</sub>.p3 < asType<integer>($heap<sub>init</sub>.a3)) =>
(asType < integer > (\$heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
\rightarrow [expand definition of constant 'a3' at prang.c (26,20)]
[56.3] \ (\$heap_{funcstart\_724,1}.p3 < \mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{short})
int>((int)178))) => (asType< integer>($heap_{funcstart\_724,1}.p3) ==
asType<integer>(div3.rem))
\rightarrow [simplify]
[56.10] (-178 < -\$heap_{funcstart\_724,1}.p3) => (\$heap_{funcstart\_724,1}.p3) ==
asType<integer>(div3.rem))
\rightarrow [from term 43.6, div3 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p3, 178
[56.11] \; (\text{-}178 < -\$ \text{heap}_{funcstart\_724,1}.\text{p3}) => (\$ \text{heap}_{funcstart\_724,1}.\text{p3}
\mathbf{asType} < \mathbf{integer} > (\mathbf{div}(\mathbf{heapIs} \ \$ \mathbf{heap}_{funcstart\_724,1}, \ \$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}, \\
178).rem))
\rightarrow [simplify]
[56.17] (0 == (-$heap_{funcstart_724,1}.p3 + div(heapIs $heap_{funcstart_724,1},
\text{Sheap}_{funcstart\_724,1.p3}, 178).rem)) \lor (177 < \text{Sheap}_{funcstart\_724,1.p3})
[Take given term]
```

```
[59.0] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart_724.1},
heap_{funcstart_{724,1}}.p1, 177
[59.1] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div(heapIs $heap_{funcstart_724,1},))
\theta_{funcstart\_724,1}.p1, 177).rem ** asType<int>($\text{heap}_{funcstart\_724,1}.r1)) -
(asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [simplify]
[59.3] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
\mathbf{int}{>}((\mathrm{div}(\mathbf{heapIs}\ \$\mathrm{heap}_{funcstart\_724,1},\ \$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},\ 177).\mathrm{rem}\ *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
\rightarrow [const static or extern object]
[59.4] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType < int > (\$heap_{init}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType<int>($heap_{tuncstart, 724,1}.b1))))
\rightarrow [expand definition of constant 'r1' at prang.c (15,20)]
[59.5] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType<int>(asType<short int>((int)171))) -
(asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [simplify]
[59.8] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem * 171)
- (asType < int > (asType < short int > (div1.quot)) *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177
[59.9] \rho_{1745,8} == \rho_{1745,8} == \rho_{1745,8} == \rho_{1745,8}
int>((171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).rem)
- (asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177).quot)
asType < int > (\$heap_{funcstart\_724,1}.b1)))
\rightarrow [simplify]
```

```
[59.11] \theta == 
int>((171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).rem)
 - (div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1, 177).quot *
asType < int > (\$heap_{funcstart\_724,1}.b1)))
\rightarrow [const static or extern object]
[59.12] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((171 * div(heapIs $heap_{funcstart_724,1}, $heap_{funcstart_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType < int > (\$heap_{init}.b1))))
\rightarrow [expand definition of constant 'b1' at prang.c (17,20)]
[59.13] \text{sheap}_{724.1:745.8} == \text{sheap}_{funcstart\_724.1}.replace(p1 \rightarrow asType<short
int>((171 * div(heapIs \$heap_{tuncstart\_724.1}, \$heap_{tuncstart\_724.1}, p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType<int>(asType<short int>((int)2))))
\rightarrow [simplify]
[59.19] $\text{heap}_{724,1;745,8} == \text{$heap}_{funcstart\_724,1}._\text{$replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, \ 177).\operatorname{rem})))
[Take given term]
[63.0] $\text{heap}_{724,1;747,8} == $\text{heap}_{724,1;745,8}._\text{replace}(p2 \rightarrow asType < short)
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724.1:745.8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [from term 59.19, $heap<sub>724,1:745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724,1}),
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs p_{funcstart\_724,1}),
heap_{funcstart_{724.1}}.p1, 177).rem)
[63.1] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724,1:745,8}.r2)) - (asType < int > (asType < short)
\mathbf{int}{>}(\text{div2.quot})) * \mathbf{asType}{<} \mathbf{int}{>} (\$\text{heap}_{724,1;745,8}.\text{b2}))))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1}}.p2, 176)
[63.2] $heap<sub>724,1:747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem))).\_replace(p2 \rightarrow asType < short
int>((asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},
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\text{Sheap}_{funcstart_724,1}.\text{p2}, 176).\text{rem}) * asType < int > (\text{Sheap}_{724,1:745,8}.\text{r2})) -
(asType<int>(asType<short int>(div2.quot)) *
asType<int>($heap<sub>724,1;745,8</sub>.b2))))
\rightarrow [simplify]
[63.4] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
\rho_{funcstart_{724,1}}, \rho_{funcstart_{724,1}}, \rho_{funcstart_{724,1}}, \rho_{funcstart_{724,1}}, \rho_{funcstart_{724,1}}
asType < int > (\$heap_{724,1:745,8}.r2)) - (asType < int > (asType < short)
\mathbf{int}{>}(\text{div2.quot})) \ * \ \mathbf{asType}{<} \mathbf{int}{>} (\$\text{heap}_{724,1;745,8}.\text{b2}))))
\rightarrow [from term 59.19, $heap<sub>724,1;745,8</sub> is equal to
heap_{funcstart\_724.1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724.1}),
heap_{funcstart_724,1}.p1, 177).quot + (171 * div(heapIs p_{funcstart_724,1})
heap_{funcstart_{724,1}}.p1, 177).rem)
[63.5] \rho_{724,1;747,8} == \rho_{11,747,8} == \rho_{12,11,124,1} ._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((\operatorname{div}(\mathbf{heapIs}))))
\rho_{funcstart_{-724,1}}, \rho_{funcstart_{-724,1}}, \rho_{funcstart_{-724,1}}, \rho_{funcstart_{-724,1}}, \rho_{funcstart_{-724,1}}
\mathbf{asType} \small{<} \mathbf{int} \small{>} (\$ \mathbf{heap}_{funcstart\_724,1}. \_\mathbf{replace} (\mathtt{p1} \rightarrow ((-2 \ ^* \ \mathrm{div} (\mathbf{heapIs}
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}. p1, 177).quot) + (171 * div(heapIs
heap_{funcstart_{724.1}}, heap_{funcstart_{724.1}}, 177).rem)).r2)) -
(asType<int>(asType<short int>(div2.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{b2}))))
\rightarrow [const member of object with modified fields]
[63.6] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((\operatorname{div}(\mathbf{heapIs}))))
e_{funcstart\_724,1}, e_{funcstart\_724,1.p2, 176}.rem *
asType < int > (\$heap_{funcstart\_724.1}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [const static or extern object]
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
(177).rem))._replace(p2 \rightarrow asType<short int>((div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem *
asType < int > (\$heap_{init}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType< int>($heap_{724,1:745,8}.b2))))
\rightarrow [expand definition of constant 'r2' at prang.c (20,20)]
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[63.8] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\label{eq:div_heap} \text{div}(\textbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
(177).rem)._replace(p2 \rightarrow asType<short int>((div(heapIs
\rho_{funcstart_{724,1}}, \rho_{funcstart_{724,1}}, \rho_{funcstart_{724,1}}, \rho_{funcstart_{724,1}}
asType<int>(asType<short int>((int)172))) -
(asType<int>(asType<short int>(div2.quot)) *
asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [simplify]
[63.11] $\text{heap}_{724,1;747,8} == \text{$heap}_{funcstart\_724,1}.$\text{$_{-}}replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem))).\_\mathbf{replace}(p2 \to \mathbf{asType} < \mathbf{short\ int} > ((div(\mathbf{heapIs}
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}.p2, 176).rem * 172) -
(asType<int>(asType<short int>(div2.quot)) *
asType<int>($heap<sub>724,1;745,8</sub>.b2))))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{tuncstart_724.1},
heap_{funcstart_{-724,1}}.p2, 176
[63.12] \rho_{724,1;747,8} == \rho_{124,1,747,8} == \rho_{
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\text{Sheap}_{funcstart_{724,1}}, \text{Sheap}_{funcstart_{724,1}}, \text{p2}, 176).rem) -
(asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},))
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot}) * asType<int>(\text{Sheap}_{724,1;745,8.b2}))))
\rightarrow [simplify]
[63.14] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((172 * div(\mathbf{heapIs}))))
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
\text{Sheap}_{funcstart_{724,1}}, \text{Sheap}_{funcstart_{724,1}}, p2, 176).quot *
asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [from term 59.19, $heap<sub>724,1:745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724,1}),
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1}, 177).quot) + (171 * div(heapIs $heap_{funcstart\_724,1}, 17
heap_{funcstart_{-724,1},p1,177,rem}
[63.15] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem}) - (\text{div}(\text{heapIs})
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heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}.p2, 176).quot *
\mathbf{asType}{<}\mathbf{int}{>}(\$\text{heap}_{funcstart\_724,1}.\_\mathbf{replace}(\text{p1} \rightarrow ((\text{-2} * \text{div}(\mathbf{heapIs}
\$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).quot) + (171 * div(\textbf{heapIs}) + (171 * div(\textbf{heapIs})) + (171
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 177).rem)).b2))))
\rightarrow [const member of object with modified fields]
[63.16] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 2, 176).quot *
asType < int > (\$heap_{funcstart\_724,1}.b2))))
\rightarrow [const static or extern object]
[63.17] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
\text{Sheap}_{funcstart_{-724,1}}, \text{Sheap}_{funcstart_{-724,1}}.p2, 176).quot *
asType < int > (\$heap_{init}.b2))))
\rightarrow [expand definition of constant 'b2' at prang.c (22,20)]
[63.18] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}
asType<int>(asType<short int>((int)35)))))
\rightarrow [simplify]
[63.24] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724.1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724.1},
heap_{funcstart_{-724,1}}.p2, 176).rem)
[Take goal term]
[1.0] ((asType<int>(asType<short int>(div3.rem)) *
\mathbf{asType} \small{<} \mathbf{int} \small{>} (\$ \mathrm{heap}_{724,1;747,8}.\mathrm{r3})) \\ - (\mathbf{asType} \small{<} \mathbf{int} \small{>} (\mathbf{asType} \small{<} \mathbf{short}
\mathbf{int}{>}(\mathrm{div3.quot})) \ * \ \mathbf{asType}{<} \mathbf{int}{>} (\$\mathrm{heap}_{724,1;747,8}.\mathrm{b3}))) \leq \mathbf{maxof}(\mathbf{short} \ \mathbf{int})
\rightarrow [from term 43.6, div3 is equal to div(heapIs $heap_{funcstart_{724.1}},
heap_{funcstart_{724,1}}.p3, 178
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[1.1] ((asType<int>(asType<short int>(div(heapIs $heap_{tuncstart\_724.1},
\text{Sheap}_{funcstart\_724,1.p3}, 178).\text{rem}) * asType < int > (\text{Sheap}_{724,1:747,8.r3})) -
(asType<int>(asType<short int>(div3.quot)) *
asType < int > (\$heap_{724,1;747,8}.b3))) \le maxof(short int)
\rightarrow [simplify]
[1.3] ((div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1.p3}, 178).rem *
asType < int > (\$heap_{724,1:747,8}.r3)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathrm{div3.quot})) \ * \ \mathbf{asType}{<} \mathbf{int}{>} (\$\mathrm{heap}_{724,1;747,8}.\mathrm{b3}))) \leq \mathbf{maxof}(\mathbf{short} \ \mathbf{int})
\rightarrow [from term 63.24, $heap<sub>724,1;747,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs *heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724.1}.p1, 177).quot) + (171 * div(\text{heapIs } \text{Sheap}_{funcstart\_724.1},
\rho_{funcstart\_724,1}.p1, 177).rem))._replace(\rho_{funcstart\_724,1}.p1, 177).rem))
heap_{funcstart\_724.1}, heap_{funcstart\_724.1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart_{724.1}}, heap_{funcstart_{724.1}}, 2, 176).rem
[1.4] ((div(heapIs \theta_{funcstart\_724,1}, \theta_{funcst
asType < int > (\$heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * div(heapIs)))))))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs})
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
* div(heapIs heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 176).quot) + (172 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p2, 176).rem))).r3)) -
(asType<int>(asType<short int>(div3.quot)) *
asType < int > (\$heap_{724.1:747.8}.b3))) \le maxof(short int)
→ [const member of object with modified fields]
[1.6] ((div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, 178).rem *
\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{r3})) - (\mathbf{asType} < \mathbf{int} > (\mathbf{asType} < \mathbf{short}))
int>(div3.quot)) * asType< int>($heap_{724,1:747,8}.b3))) \le maxof(short int)
\rightarrow [const static or extern object]
[1.7] ((div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}.p3, 178).rem *
asType < int > (\$heap_{init}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType< int>($heap_{724,1:747,8}.b3))) \le maxof(short int)
\rightarrow [expand definition of constant 'r3' at prang.c (25,20)]
[1.8] ((div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1.p3}, 178).rem *
asType<int>(asType<short int>((int)170))) -
(asType<int>(asType<short int>(div3.quot)) *
asType < int > (\$heap_{724,1:747,8}.b3))) \le maxof(short int)
\rightarrow [simplify]
[1.11] ((div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem *
170) - (asType<int>(asType<short int>(div3.quot))
asType < int > (\$heap_{724,1;747,8}.b3))) \le maxof(short int)
\rightarrow [from term 43.6, div3 is equal to div(heapIs $heap_{funcstart\_724,1},
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heap_{funcstart_{-724,1}}.p3, 178
[1.12] ((170 * div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}),
178).rem) - (asType<int>(asType<short int>(div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p3, 178).quot)) *
asType < int > (\$heap_{724.1:747.8}.b3))) \le maxof(short int)
\rightarrow [simplify]
[1.14] ((170 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3,
178).rem) – (div(heapIs \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}},
178).quot * asType < int > (\$heap_{724,1;747,8}.b3))) \le maxof(short int)
\rightarrow [from term 63.24, $heap<sub>724,1;747,8</sub> is equal to
heap_{funcstart\_724.1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724.1},
heap_{funcstart_{724,1},p1, 177}, quot) + (171 * div(heapIs p_{funcstart_{724,1},p1, 177}), quot)
\theta_{funcstart\_724,1}.p1, 177).rem))._replace(p2 \rightarrow (-35 * div(\mathbf{heapIs})))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 2, 176).rem
[1.15] ((170 * div(heapIs $heap_{tuncstart\_724.1}, $heap_{tuncstart\_724.1}.p3,
178).rem) – (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.p3,
178).quot * asType<int>($heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem})).\text{b3})) \leq \text{maxof}(\text{short int})
\rightarrow [const member of object with modified fields]
[1.17] ((170 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3,
178).rem) - (div(heapIs heap_{funcstart\_724.1}, heap_{funcstart\_724.1}.p3,
178).quot * asType<int>(heap_{funcstart\_724,1}.b3)) \leq maxof(short int)
\rightarrow [const static or extern object]
[1.18] ((170 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3,
178).rem) – (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3},
178).quot * asType < int > (\$heap_{init}.b3))) \le maxof(short int)
\rightarrow [expand definition of constant 'b3' at prang.c (27,20)]
[1.19] ((170 * div(heapIs $heap_{tuncstart_724.1}, $heap_{tuncstart_724.1}.p3,
178).rem) – (div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3,
178).quot * asType<int>(asType<short int>((int)63)))) \leq maxof(short
int)
\rightarrow [simplify]
[1.38] -32768 < ((-170 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{rem} + (63 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p3, 178).quot)
```

```
\rightarrow [negate goal and search for contradiction]
[1.39]!(-32768 < ((-170 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p3}, 178).\text{rem} + (63 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{724,1}.p3, 178, quot)}
\rightarrow [simplify]
[1.44] 32767 < ((170 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3,
178).rem) + (-63 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart\_724,1}, \text{\$heap}_{funcstart\_724,1}.p3,
178).quot))
[Branch on disjunction or conditional in term 56.17]
[81.0] (0 == (-$heap_{funcstart_{724,1}}.p3 + div(heapIs $heap_{funcstart_{724,1}},
\text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{rem})) \lor (177 < \text{Sheap}_{funcstart\_724,1}.\text{p3}) \lor !(0 ==
(-\text{\$heap}_{funcstart\_724,1}.\text{p3} + \text{div}(\text{heapIs} \, \text{\$heap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p3, 178.rem}
[Copy term 1.44]
[82.0] (32767 < ((-63 * div(heapIs $heap_{funcstart\_724,1},
\rho_{tuncstart_{-724,1},p3,178} = 178 \cdot 17
\{\text{heap}_{funcstart\_724,1}.\text{p3}, 178\}.\text{rem}\} \forall (177 < \{\text{heap}_{funcstart\_724,1}.\text{p3}\} \lor !(0 = = 178)
(-\text{\$heap}_{funcstart\_724,1}.\text{p3} + \text{div}(\text{heapIs} \, \text{\$heap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p3, 178.rem}
\rightarrow [from\ term\ 81.0,\ div(\textbf{heapIs}\ \$heap_{funcstart\_724,1},\ \$heap_{funcstart\_724,1}.p3,
178).rem is equal to heap_{funcstart\_724,1.p3}
[82.1] (32767 < ((-63 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot}) + (170 * \text{Sheap}_{funcstart\_724,1}.\text{p3}))) \vee ...
[Copy term 47.17]
[83.0] \ (0 == (-\text{div}(\mathbf{heapIs} \ \$ heap_{funcstart\_724,1}, \ \$ heap_{funcstart\_724,1}.p3,
178).rem + (\text{$heap_{funcstart\_724,1.p3} \% 178})) \vee (177 < \text{$heap_{funcstart\_724,1.p3}})
\vee !(0 == (-\$heap_{funcstart\_724,1}.p3 + div(heapIs \$heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p3, 178).rem}
\rightarrow [from term 81.0, div(heapIs $heap_{funcstart\_724,1}$, $heap_{funcstart\_724,1}$.p3,
178).rem is equal to $heap_funcstart_724,1.p3]
[83.1] (0 == (-$heap_{funcstart_{724,1}}.p3 + ($heap_{funcstart_{724,1}}.p3 % 178))) \vee \dots
[Assume known post-assertion, class invariant or type constraint for term 83.1]
[88.0] (\text{$heap_{funcstart\_724,1.p3} < 178}) \lor (177 < \text{$heap_{funcstart\_724,1.p3}}) \lor!(0
== (-\$heap_{funcstart\_724,1}.p3 + div(heapIs \$heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p3, 178).rem}
\rightarrow [simplify]
[88.3] (-178 < -\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}) \vee ...
[Copy term 1.44]
```

```
[90.0] 32767 < ((-63 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p3,
178).quot) + (170 * div(heapIs heapIs = f_{uncstart_{724,1}}, heap_{funcstart_{724,1}}.p3,
178).rem))
\rightarrow [from\ term\ 47.17,\ div(\textbf{heapIs}\ \$heap_{funcstart\_724,1},\ \$heap_{funcstart\_724,1}.p3,
178).rem is equal to heap_{funcstart_{-724.1}}.p3 % 178
\label{eq:funcstart_724,1} \textit{1} \ 32767 < ((-63 \ ^* \ \text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p3},
178).quot) + (170 * (\text{$heap}_{funcstart\_724,1.p3} \% 178)))
[Copy term 82.1]
[91.0] (32767 < ((-63 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} + (170 * \text{Sheap}_{funcstart\_724,1}.\text{p3}))) \lor (177 <
\$heap_{funcstart\_724,1}.p3) \lor !(0 == (-\$heap_{funcstart\_724,1}.p3 + div(\textbf{heapIs})) \land (-\$heap_{funcstart\_724,1}.p3 + div(\textbf{heapIs}))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{rem}))
\rightarrow [from\ term\ 46.17,\ div(\textbf{heapIs}\ \$heap_{funcstart\_724,1},\ \$heap_{funcstart\_724,1}.p3,
178).quot is equal to heap_{funcstart\_724,1}.p3 / 178
[91.1] (32767 < ((-63 * (\$heap_{funcstart\_724,1}.p3 / 178)) + (170 * (-63 * (\$heap_{funcstart\_724,1}.p3 / 178))))
heap_{funcstart_{-724,1}.p3)}  \vee \dots
\rightarrow [division by larger divisor]
    Proof of rule precondition 1:
    [91.1.0.0] literald < -\$heap_{funcstart\_724,1}.p3
    \rightarrow [unify with term 88.3]
    [91.1.0.1] true
    Proof of rule precondition 2:
    [91.1.1.0]~\mathrm{literalc} < \$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}
    \rightarrow [unify with term 10.0]
    [91.1.1.1] true
    Proof of rule precondition 3:
    [91.1.2.0] --178 \le 178
    \rightarrow [simplify]
    [91.1.2.2] true
    Proof of rule precondition 4:
    [91.1.3.0] - 2 < 0
    \rightarrow [simplify]
    [91.1.3.1] true
[91.2] (32767 < ((-63 * \rho_{tart\_724,1.p3}) + (170 * \rho_{tart\_724,1.p3})
heap_{funcstart_{-724,1}.p3})) \vee ...
```

```
\rightarrow [simplify]
[91.4] (32767 < (107 * $heap_{funcstart\_724,1}.p3)) \vee ...
\rightarrow [literal comparison of product]
[91.5] ([107 < 0]: (32767 / -107) < -\text{$heap}_{funcstart\_724,1}.p3, [0 < 107]: (32767)
/ 107) < $heap_funcstart_724,1.p3, [0 == 107]: 32767 < 0) \vee ...
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[91.6] ([107 < 0]: (32767 / -107) < -\$heap_{funcstart\_724,1}.p3, [(0 < 107) \wedge !(107
< 0): (32767 / 107) < \text{$heap}_{funcstart\_724,1}.p3, [(0 == 107) \land !(0 < 107) \land !(0 < 107) \land !(0 < 107)]
!(107 < 0)]: 32767 < 0) \lor ...
\rightarrow [simplify]
[91.13] (true \land (306 < $heap_{funcstart\_724,1}.p3)) \lor ...
\rightarrow [from term 88.3, literala < $heap_{funcstart\_724,1}.p3 is false whenever -2 <
(-178 + literala)
       Proof of rule precondition:
       [91.13.0] - 2 < (-178 + 306)
       \rightarrow [simplify]
       [91.13.2] true
[91.14] (true \wedge false) \vee \dots
\rightarrow [simplify]
[91.15] false \vee ...
[Remove 'false' term 91.15 and fetch new term from containing clause]
[92.0] 177 < \text{$heap}_{funcstart\_724,1}.p3
[Create new term from term 46.17 using rule: condition for equality of division]
[147.0] ((178 * (0 + -(-div(heapIs $heap_{funcstart\_724.1}), 147.0])
\text{Sheap}_{funcstart\_724,1}.p3, 178).quot))) < (1 + \text{Sheap}_{funcstart\_724,1}.p3)) \land
(\text{\$heap}_{funcstart\_724,1}.\text{p3} < (178 * (0 + 1 + -(-\text{div}(\text{heapIs}))))
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 178).quot))))
\rightarrow [simplify]
[147.15] \ (-1 < ((-178 * {\rm div}(\mathbf{heapIs} \ \$ {\rm heap}_{funcstart\_724,1}, \ \$ {\rm heap}_{funcstart\_724,1}.{\rm p3},
178).quot) + $\text{heap}_{funcstart_724,1.p3}) \land (-178 < (-\text{$heap}_{funcstart_724,1.p3}) + \text{$heap}_{funcstart_724,1.p3} + \text{$heap}_{funcstart_724,1.p3}) \land (-178 < (-\text{$heap}_{funcstart_724,1.p3})) \land (-178 < (-\text{$heap}_{funcstart_724,1.p3}))
(178 * \text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot})))
\rightarrow [separate conjunction and work on first sub-term]
[147.16] -178 < (-\$heap_{funcstart\_724,1}.p3 + (178 * div(heapIs))
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 178).quot)
[Create new term from terms 147.16, 92.0 using rule: transitivity 2]
```

```
[201.0] (-178 + 1 + 177) < (178 * div(heapIs $heap_{funcstart,724.1})
heap_{funcstart_{-724,1}}.p3, 178).quot
\rightarrow [simplify]
[201.1] 0 < (178 * div(heapIs p_{funcstart_{-724,1}}, p_{funcstart_{-724,1}},
178).quot)
\rightarrow [product is positive]
[201.2] ((0 < 178) \wedge (0 < div(heapIs $heap_{funcstart\_724,1},
\text{heap}_{funcstart\_724.1.p3}, 178).\text{quot})) \lor ((178 < 0) \land (\text{div}(\textbf{heapIs}))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p3, 178).quot < 0)
\rightarrow [simplify]
[201.7] 0 < \text{div}(\text{heapIs } \text{$heap}_{funcstart\_724,1}, \text{$heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot}
[Create new term from terms 201.7, 90.1 using rule: transitivity 11]
\label{eq:condition} \textit{[204.0]}\;(1\,+\,32767\,+\,(0\,\,^*\,63))\,<\,(170\,\,^*\,(\text{\$heap}_{funcstart\_724,1}.\text{p3}\,\,\%\,\,178))
\rightarrow [simplify]
[204.2] 32768 < (170 * (\text{$heap}_{funcstart\_724,1}.\text{p3} \% 178))
\rightarrow [literal comparison of product]
[204.3] ([170 < 0]: (32768 / -170) < -($heap_{funcstart\_724,1}.p3 % 178), [0 < -0.5]
170]: (32768 / 170) < (\text{$heap}_{funcstart\_724,1.p3} \% 178), [0 == 170]: 32768 < 0)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[204.4] ([170 < 0]: (32768 / -170) < -($heap_{tuncstart\_724.1}.p3 % 178), [(0 <
170) \land !(170 < 0): (32768 / 170) < (\$heap_{tuncstart\_724,1}.p3 \% 178), [(0 ==
170) \land !(0 < 170) \land !(170 < 0)]: 32768 < 0)
\rightarrow [simplify]
[204.13] false
Proof of verification condition: Assertion valid
Condition generated at: C:\Escher\Customers\prang\prang.c (66,31)
To prove: asType<integer>($heap<sub>724,1;749,8</sub>.p3) <
asType<integer>($heap<sub>724,1:749,8</sub>.M3)
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta = asType < short int > ((int)2)
```

```
heap_{init}.M2 == asType < short int > ((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
\theta
heap_{init}.b2 == asType<short int>((int)35)
\theta sheap<sub>init</sub>.M3 == asType<short int>((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\rho = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart_{-724,1}})
div1 == div(\mathbf{heapIs} \$ heap_{funcstart\_724.1},
asType < int > (\$heap_{funcstart\_724.1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) ==
asType<integer>(div1.quot)
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \%
asType < integer > (asType < int > (\$heap_{funcstart_{-724.1}}.a1))) = =
asType<integer>(div1.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1})) =>
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}) ==
asType<integer>(div1.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a1) \le
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart_{-724.1}},
asType < int > (\$heap_{funcstart\_724,1}.p2),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p2})) \ / \\
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) \%
```

```
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(asType < integer > ($heap_{funcstart\_724.1}.p2) = =
asType<integer>(div2.rem))
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a3}))
(asType<integer>(asType<int>($heap_{tuncstart\_724.1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724.1}.a3))) = =
asType<integer>(div3.quot)
(asType < integer > (asType < int > (\$heap_{tuncstart\_724,1}.p3)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) ==
asType<integer>(div3.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a3}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
\$heap_{724,1;745,8} == \$heap_{funcstart\_724,1}.\_\mathbf{replace}(p1 \rightarrow \mathbf{asType} < \mathbf{short}
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
-\mathbf{asType} {<} \mathbf{integer\ const} {>} (\$ \mathbf{heap}_{724,1;745,8}.\mathbf{M1}) <
asType<integer>($heap<sub>724,1;745,8</sub>.p1)
!(0 == asType < integer > (\$heap_{724,1;745,8}.p1))
asType<integer>($heap<sub>724,1;745,8</sub>.p1) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{M1})
\rho_{724,1:747.8} == \rho_{724,1:745.8} replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div2.rem))
```

```
asType < int > (\$heap_{724.1:745.8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724,1:745,8</sub>.b2))))
-asType<integer const>($heap<sub>724.1:747.8</sub>.M2) <
asType<integer>($heap<sub>724.1:747.8</sub>.p2)
!(0 == asType < integer > (\$heap_{724,1;747,8}.p2))
asType<integer>($heap<sub>724,1:747,8</sub>.p2) <
asType<integer>($heap<sub>724.1:747.8</sub>.M2)
\text{heap}_{724.1:749.8} == \text{heap}_{724.1:747.8}._replace(p3 \rightarrow asType<short)
int>((asType<int>(asType<short int>(div3.rem))
asType < int > (\$heap_{724.1:747.8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap<sub>724.1:747.8</sub>.b3))))
-asType<integer const>($heap_{724,1:749,8}.M3) <
asType<integer>($heap<sub>724,1:749,8</sub>.p3)
!(0 == asType < integer > (\$heap_{724,1;749,8}.p3))
Proof:
[Take given term]
[5.0] invariant1(heapIs heap_{funcstart\_724,1})
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
 \texttt{[5.1]} \left( \left( \left( \left( (0 < \mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p1) \right) \& \& \right. \right. \right. 
(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 
asType < integer > (\$heap_{funcstart_{-724,1}}.M1))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M2})))~\&\&~(0<
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType<integer>($heap_funcstart_724,1.M3))
\rightarrow [simplify]
[5.3] (((((0 < $heap_{funcstart\_724,1}.p1) && ($heap_{funcstart\_724,1}.p1 < 
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 <
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M2})))~\&\&~(0<
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.4] (((((0 < $heap_{funcstart\_724,1}.p1) && ($heap_{funcstart\_724,1}.p1 <
asType < integer > (\$heap_{init}.M1))) \&\& (0 <
```

```
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
 (asType < integer > (\$heap_{funcstart\_724,1}.p2) < 
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M2}))) \ \&\& \ (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
 (asType<integer>($heap_{tuncstart\_724,1}.p3) <
asType<integer>($heap_funcstart_724,1.M3))
 \rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
 [5.5] (((((0 < $heap_{funcstart_724,1}.p1) && ($heap_{funcstart_724,1}.p1 < footnote{in the content of the c
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
 (\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
\mathbf{asType} \small{<} \mathbf{integer} \small{>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M2}))) \ \&\& \ (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
 (\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M3}))
 \rightarrow [simplify]
 [5.16] \; ((((-30269 < -\$ heap_{funcstart\_724,1}.p1) \; \land \; (0 < \$ heap_{funcstart\_724
 (0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType < integer > (\$heap_{funcstart\_724,1}.M2))) \&\& (0 <
asType < integer > ($heap_{funcstart\_724,1}.p3))) &&
 (\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{M3}))
 \rightarrow [const static or extern object]
 |5.17| \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \; \land \; (0 < \$heap_{funcstart\_724,1}.p1) \; \land 
 (0 < \text{$heap}_{funcstart\_724,1}.p2)) \&\& (\text{$heap}_{funcstart\_724,1}.p2 <
asType < integer > (\$heap_{init}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
 (\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
 \rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
 [5.18] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < \text{$heap}_{funcstart\_724,1}.p2)) \&\& (\text{$heap}_{funcstart\_724,1}.p2 <
asType < integer > (asType < short int > ((int)30307)))) && (0 < integer) && (0 < integer
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
 (\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M3}))
 \rightarrow [simplify]
 [5.30] ((-30307 < -$heap_{funcstart\_724,1}.p2) \land (-30269 <
 -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart_{724,1},p2} \land (0 < \text{Sheap}_{funcstart_{724,1},p3})) \&\&
 (\text{\$heap}_{funcstart\_724,1}.p3 < asType < integer > (\text{\$heap}_{funcstart\_724,1}.M3))
```

```
\rightarrow [const static or extern object]
[5.31] ((-30307 < -$heap_funcstart_724,1.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.p2) \land (0 < \text{Sheap}_{funcstart\_724,1}.p3)) \&\&
(\$heap_{funcstart\_724,1}.p3 < \textbf{asType} < \textbf{integer} > (\$heap_{init}.M3))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap_funcstart_724,1.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.p2) \land (0 < \text{Sheap}_{funcstart\_724,1}.p3)) \&\&
(\text{sheap}_{funcstart\_724,1}.\text{p3} < \text{asType} < \text{integer} > (\text{asType} < \text{short})
int > ((int)30323)))
\rightarrow [simplify]
[5.40] (-30323 < -\$heap_{funcstart\_724,1}.p3) \land (-30307 < -30307)
-\$heap_{funcstart\_724,1}.p2) \land (-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < -\$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.\text{p1}) \land (0 < \text{Sheap}_{funcstart\_724,1}.\text{p2}) \land (0 <
heap_{funcstart_{724.1}.p3}
[Work on sub-term 6 of conjunction in term 5.40]
[10.0] 0 < \text{$heap}_{funcstart\_724,1}.p3
[Take given term]
[11.0] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
\rightarrow [simplify]
[11.1] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType < int > (\$heap_{funcstart\_724,1}.a1))
\rightarrow [const static or extern object]
[11.2] div1 == div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
asType < int > (\$heap_{init}.a1))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
\textit{[11.3]} \ \text{div1} == \text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
asType < int > (asType < short int > ((int)177)))
\rightarrow [simplify]
[11.6] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}, \ 177)
[Take given term]
[27.0] \operatorname{div2} == \operatorname{div}(\mathbf{heapIs} \ \operatorname{\$heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
```

```
\rightarrow [simplify]
[27.1]~{\rm div2} == {\rm div}(\mathbf{heapIs}~\$ \mathrm{heap}_{funcstart\_724,1},~\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2},
asType < int > (\$heap_{funcstart\_724,1}.a2))
\rightarrow [const static or extern object]
\label{eq:continuous} \mbox{\sc [27.2] div2} == \mbox{\sc div}(\mathbf{heapIs} \ \$\mbox{\sc heap}_{funcstart\_724,1}, \ \$\mbox{\sc heap}_{funcstart\_724,1}.\mbox{\sc p2},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{init}.\mathrm{a2}))
\rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
[27.3] \text{ div2} == \text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724.1}, \$ \text{heap}_{funcstart\_724.1}.\text{p2},
asType<int>(asType<short int>((int)176)))
\rightarrow [simplify]
[27.6] div2 == div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p2, 176)
[Take given term]
[43.0] \operatorname{div3} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
asType < int > (\$heap_{funcstart\_724,1}.a3))
\rightarrow [simplify]
[43.1] \text{div3} == \text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
\rightarrow [const static or extern object]
[43.2] \operatorname{div3} == \operatorname{div}(\mathbf{heapIs} \operatorname{\$heap}_{funcstart\_724,1}, \operatorname{\$heap}_{funcstart\_724,1}.p3,
asType < int > (\$heap_{init}.a3))
\rightarrow [expand definition of constant 'a3' at prang.c (26,20)]
[43.3] \ \mathrm{div3} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3},
asType<int>(asType<short int>((int)178)))
\rightarrow [simplify]
[43.6] \operatorname{div3} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p3, 178)
[Assume known post-assertion, class invariant or type constraint for term 43.6]
[46.0] (asType<integer>($heap_{funcstart\_724,1}.p3) /
asType < integer > (178)) == asType < integer > (div(heapIs))
\$heap_{funcstart\_724,1},\,\$heap_{funcstart\_724,1}.p3,\,178).quot)
\rightarrow [simplify]
[46.2] ($heap<sub>funcstart_724.1.</sub>p3 / 178) == asType<integer>(div(heapIs)
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 178).quot
→ [expand definition of operator './' in class 'int' at built in declaration]
[46.3] ([asType<integer>(heap_{funcstart}_724.1.p3) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178), []:
```

```
asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178) = =
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3,
178).quot)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[46.4] \; ([\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178),
[!(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178) = =
\mathbf{asType} {<} \mathbf{integer} {>} ( \mathbf{div} (\mathbf{heapIs} \ \$ \mathbf{heap}_{funcstart\_724,1}, \ \$ \mathbf{heap}_{funcstart\_724,1}. \mathbf{p3}, \\
178).quot)
\rightarrow [simplify]
[46.7] ([0 < -$heap<sub>funcstart_724,1</sub>.p3]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178),
[!(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178) = =
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3,
178).quot)
\rightarrow [from term 10.0, literala < -$heap<sub>funcstart_724,1</sub>.p3 is false whenever -2 <
(0 + literala)
    Proof of rule precondition:
    [46.7.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [46.7.2] true
[46.8] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178) = =
\mathbf{asType} \small{<} \mathbf{integer} \small{>} ( \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}, \\
178).quot)
\rightarrow [simplify]
[46.11] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178), [!(0 < integer) < integer)
-\$heap_{funcstart\_724,1}.p3)]: \ \mathbf{asType} < \mathbf{integer} > (\$heap_{funcstart\_724,1}.p3) \ / \ 178)
== asType < integer > (div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724.1}}.p3, 178).quot
\rightarrow [from term 10.0, literala < -$heap<sub>funcstart_724,1</sub>.p3 is false whenever -2 <
(0 + literala)
    Proof of rule precondition:
    [46.11.0] - 2 < (0 + 0)
    \rightarrow [simplify]
```

```
[46.11.2] true
[46.12] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178),
[!false]: asType<integer>($heap<sub>funcstart_724,1.</sub>p3) / 178) ==
\mathbf{asType} < \mathbf{integer} > (\mathbf{div}(\mathbf{heapIs} \ \$ \mathbf{heap}_{funcstart\_724,1}, \ \$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}, \\
178).quot)
\rightarrow [simplify]
[46.17] 0 == (-\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3},
178).quot + (\text{$heap}_{funcstart\_724,1}.p3 / 178))
[Assume known post-assertion, class invariant or type constraint for term 43.6]
[47.0] (asType<integer>(heap_{funcstart\_724,1}.p3) %
asType<integer>(178)) == asType<integer>(div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{rem}
\rightarrow [simplify]
[47.2] ($heap<sub>funcstart_724,1.</sub>p3 % 178) == asType<integer>(div(heapIs)
\text{Sheap}_{funcstart\_724.1}, \text{Sheap}_{funcstart\_724.1}.p3, 178).rem
→ [expand definition of operator '.%' in class 'int' at built in declaration]
[47.3] \; ([\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) < 0] :
-(-asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178), []:
asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178) ==
asType<integer>(div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p3,
178).rem)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[47.4] \; ([\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) < 0] :
-(-asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178) ==
asType<integer>(div(heapIs $heap_{tuncstart\_724.1}, $heap_{tuncstart\_724.1}.p3,
178).rem)
\rightarrow [simplify]
[47.7] ([0 < -$heap<sub>funcstart_724,1.</sub>p3]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178),
[!(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})<0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178) ==
asType<integer>(div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3,
\rightarrow [from term 10.0, literala < -$heap<sub>funcstart_724.1</sub>.p3 is false whenever -2 <
(0 + literala)
    Proof of rule precondition:
    [47.7.0] - 2 < (0 + 0)
```

```
\rightarrow [simplify]
            [47.7.2] true
[47.8] ([\mathbf{false}]: -(-\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}) \% 178),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178) ==
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3,
178).rem)
\rightarrow [simplify]
[47.11] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) \; \% \; 178), \; [!(0.11)] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) \; \% \; 178), \; [!(0.11)] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) \; \% \; 178), \; [!(0.11)] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) \; \% \; 178), \; [!(0.11)] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) \; \% \; 178), \; [!(0.11)] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) \; \% \; 178), \; [!(0.11)] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) \; \% \; 178), \; [!(0.11)] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) \; \% \; 178), \; [!(0.11)] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) \; \% \; 178), \; [!(0.11)] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) \; \% \; 178), \; [!(0.11)] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) \; \% \; 178), \; [!(0.11)] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) \; \% \; 178), \; [!(0.11)] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) \; \% \; 178), \; [!(0.11)] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) \; \% \; 178), \; [!(0.11)] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) \; \% \; 178), \; [!(0.11)] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) \; \% \; 178), \; [!(0.11)] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) \; \% \; 178), \; [!(0.11)] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) \; \% \; 178), \; [!(0.11)] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3)) \; \% \; 178), \; [!(0.11)] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3)) \; \% \; 178), \; [!(0.11)] \; ([\mathbf{false}]: \; -(-\mathbf{integer} > (\$ heap_{funcstart\_72
<-$heap<sub>funcstart_724,1.</sub>p3)]: asType<integer>($heap<sub>funcstart_724,1.</sub>p3) %
178) == asType<integer>(div(heapIs $heap_{tuncstart_724.1},
heap_{funcstart_{-724,1}.p3, 178}.rem
\rightarrow [from term 10.0, literala < -$heap<sub>funcstart_724,1</sub>.p3 is false whenever -2 <
(0 + literala)
            Proof of rule precondition:
            [47.11.0] - 2 < (0 + 0)
            \rightarrow [simplify]
            [47.11.2] true
[47.12] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178),
[!false]: asType<integer>(person{1}{2}) (person{1}{2}) (person{1}{2}
\mathbf{asType} \small{<} \mathbf{integer} \small{>} ( \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}, \\
178).rem)
\rightarrow [simplify]
[47.17] \ 0 == (-\text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p3},
178).rem + (\text{$heap}_{funcstart\_724,1.p3} \% 178))
[Take given term]
[56.0] (asType<integer>(parton = 1.00) (sheapparton = 1.00)
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}) ==
asType<integer>(div3.rem))
\rightarrow [simplify]
[56.1] (\text{$heap}_{funcstart\_724,1}.p3 < asType < integer > (\\\text{$heap}_{funcstart\_724,1}.a3))
=> (asType < integer > (\$heap_{funcstart\_724,1}.p3) ==
asType<integer>(div3.rem))
\rightarrow [const static or extern object]
[56.2] ($heap<sub>funcstart_724,1.</sub>p3 < asType<integer>($heap<sub>init.</sub>a3)) =>
(asType < integer > (\$heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
```

```
\rightarrow [expand definition of constant 'a3' at prang.c (26,20)]
[56.3] \ (\$heap_{funcstart\_724,1}.p3 < \mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{short})
int>((int)178))) => (asType < integer>($heap_{funcstart\_724,1}.p3) ==
asType<integer>(div3.rem))
\rightarrow [simplify]
[56.10] (-178 < -\$heap_{funcstart\_724,1}.p3) => (\$heap_{funcstart\_724,1}.p3) ==
asType<integer>(div3.rem))
\rightarrow [from term 43.6, div3 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p3, 178
[56.11] \; (\text{-}178 < -\$ \text{heap}_{funcstart\_724,1}.\text{p3}) => (\$ \text{heap}_{funcstart\_724,1}.\text{p3}
\mathbf{asType} < \mathbf{integer} > (\mathbf{div}(\mathbf{heapIs} \ \$\mathbf{heap}_{funcstart\_724,1}, \ \$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p3},
178).rem))
\rightarrow [simplify]
[56.17] (0 == (-$heap_{funcstart_724,1}.p3 + div(heapIs $heap_{funcstart_724,1},
\text{Sheap}_{funcstart\_724,1.p3}, 178).rem)) \lor (177 < \text{Sheap}_{funcstart\_724,1.p3})
[Take given term]
[59.0] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177
[59.1] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}) * asType < int > (\text{Sheap}_{funcstart\_724,1}.\text{r1})) -
(asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [simplify]
[59.3] \rho_{1745,8} == \rho_{1745
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
\mathbf{asType} \hspace{-0.1em}<\hspace{-0.1em} \mathbf{int} \hspace{-0.1em}> \hspace{-0.1em} (\$ heap_{funcstart\_724,1}.r1)) - (\mathbf{asType} \hspace{-0.1em}<\hspace{-0.1em} \mathbf{int} \hspace{-0.1em}> \hspace{-0.1em} (\mathbf{asType} \hspace{-0.1em}<\hspace{-0.1em} \mathbf{short})
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
\rightarrow [const static or extern object]
\text{[59.4] \$heap}_{724,1;745,8} == \$heap_{funcstart\_724,1}.\_\textbf{replace}(p1 \rightarrow \textbf{asType} < \textbf{short}
\mathbf{int}{>}((\mathrm{div}(\mathbf{heapIs}\ \$\mathrm{heap}_{funcstart\_724,1},\ \$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},\ 177).\mathrm{rem}\ *
asType < int > (\$heap_{init}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1.quot})) \ * \ \mathbf{asType}{<} \mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
\rightarrow [expand definition of constant 'r1' at prang.c (15,20)]
```

```
[59.5] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType<int>(asType<short int>((int)171))) -
(asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [simplify]
[59.8] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem * 171)
- (asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\ 724.1}.b1))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177)
\text{[59.9] \$heap}_{724,1;745,8} == \$heap_{funcstart\_724,1}.\_\textbf{replace}(p1 \rightarrow \textbf{asType} < \textbf{short}
\mathbf{int} > ((171 * \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, 177).\operatorname{rem})
- (asType<int>(asType<short int>(div(heapIs $heap_{funcstart_724,1},))
heap_{funcstart_{-724,1}}.p1, 177).quot)
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [simplify]
[59.11] \theta_{13} = \theta_
int>((171 * div(heapIs $heap_{funcstart_724,1}, $heap_{funcstart_724,1}.p1, 177).rem)
- (\text{div}(\textbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [const static or extern object]
[59.12] \theta_{12} = \theta_{124,1;745,8} = \theta_{124,1;74
\mathbf{int} > ((171 * \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, 177).\operatorname{rem})
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType < int > (\$heap_{init}.b1)))
\rightarrow [expand definition of constant 'b1' at prang.c (17,20)]
[59.13] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType<int>(asType<short int>((int)2))))
\rightarrow [simplify]
[59.19] $\text{heap}_{724,1:745,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).rem)))
[Take given term]
[63.0] $\text{heap}_{724,1;747,8} == $\text{heap}_{724,1;745,8}.$\text{replace}(p2 \to \text{asType} < \text{short}
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724,1:745,8}.r2)) - (asType < int > (asType < short)
```

```
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [from term 59.19, $heap<sub>724,1:745.8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot) + (171 * div(heapIs $heap_{funcstart\_724,1}, 1
heap_{funcstart_{-724,1}}.p1, 177).rem)
[63.1] $\text{heap}_{724,1:747,8} == $\text{heap}_{funcstart_724,1}._\text{replace}(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724,1:745,8}.r2)) - (asType < int > (asType < short)
\mathbf{int}{>}(\text{div2.quot})) \ * \ \mathbf{asType}{<} \mathbf{int}{>} (\$\text{heap}_{724,1;745,8}.\text{b2}))))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{tuncstart_{724.1}},
heap_{funcstart_{724,1}}.p2, 176
[63.2] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem))).\_replace(p2 \rightarrow asType < short
int>((asType<int>(asType<short int>(div(heapIs $heap_{tuncstart_724.1},
\text{sheap}_{funcstart_{724,1},p2, 176}.\text{rem}) * asType < int > (\text{sheap}_{724,1:745,8}.\text{r2})) -
(asType<int>(asType<short int>(div2.quot)) *
asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [simplify]
[63.4] $heap<sub>724,1:747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((\operatorname{div}(\mathbf{heapIs}))))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem *
asType < int > (\$heap_{724.1:745.8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType< int>($heap_{724,1;745,8}.b2))))
\rightarrow [from term 59.19, $heap<sub>724,1;745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724,1}),
\text{Sheap}_{funcstart\_724,1}.p1, 177).quot) + (171 * div(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177).rem)
[63.5] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem *
asType < int > (\$heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * div(heapIs))))))
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).rem))).r2)) -
```

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(asType<int>(asType<short int>(div2.quot)) *
asType < int > (\$heap_{724,1:745,8}.b2))))
\rightarrow [const member of object with modified fields]
[63.6] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
\rho_{funcstart_{724,1}}, \rho_{funcstart_{724,1}}, \rho_{funcstart_{724,1}}, \rho_{funcstart_{724,1}}, \rho_{funcstart_{724,1}}
\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{r2})) - (\mathbf{asType} < \mathbf{int} > (\mathbf{asType} < \mathbf{short}))
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [const static or extern object]
[63.7] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem *
asType < int > (\$heap_{init}.r2)) - (asType < int > (asType < short)
int > (div2.quot)) * asType < int > (\$heap_{724,1:745,8}.b2))))
\rightarrow [expand definition of constant 'r2' at prang.c (20,20)]
div(\mathbf{heapIs} \ \text{$heap}_{funcstart\_724,1}, \ \text{$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
\text{Sheap}_{funcstart_{-724,1}}, \text{Sheap}_{funcstart_{-724,1}}.p2, 176).rem *
asType<int>(asType<short int>((int)172))) -
(asType<int>(asType<short int>(div2.quot)) *
asType<int>($heap<sub>724,1;745,8</sub>.b2))))
\rightarrow [simplify]
[63.11] $\text{heap}_{724,1;747,8} == \text{$heap}_{funcstart\_724,1}._\text{$_$replace}(p1 \to ((-2 * )
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem * 172) -
(asType<int>(asType<short int>(div2.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{b2}))))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{funcstart_724,1},
heap_{funcstart_{724,1}}.p2, 176)
[63.12] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
```

```
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem) -
(asType<int>(asType<short int>(div(heapIs $heap_{funcstart_724,1},))
\text{sheap}_{funcstart\_724,1.p2}, 176).\text{quot}) * asType<int>(\text{sheap}_{724,1:745,8}.\text{b2}))))
\rightarrow [simplify]
[63.14] $\text{heap}_{724,1;747,8} == \text{$heap}_{funcstart\_724,1}._\text{$replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 2, 176.quot *
asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [from term 59.19, $heap<sub>724,1;745,8</sub> is equal to
heap_{funcstart\_724.1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724.1}),
heap_{funcstart,724,1}.p1, 177).quot + (171 * div(heapIs p_{funcstart,724,1})
heap_{funcstart_{724,1}}.p1, 177).rem)
[63.15] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p_{176}.quot *
asType < int > (\$heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * div(heapIs))))))
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).rem))).b2))))
\rightarrow [const member of object with modified fields]
[63.16] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{$heap}_{funcstart\_724,1}, \ \text{$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b2}))))
\rightarrow [const static or extern object]
[63.17] $\text{heap}_{724.1:747.8} == \text{$heap}_{funcstart\_724.1}._\text{$replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem}) - (\text{div}(\text{heapIs})
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}.p2, 176).quot *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{init}.\mathrm{b2}))))
\rightarrow [expand definition of constant 'b2' at prang.c (22,20)]
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[63.18] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\label{eq:div_heap} \text{div}(\textbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}
asType<int>(asType<short int>((int)35)))))
\rightarrow [simplify]
[63.24] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p2, 176).rem)
[Take given term]
[67.0] $\text{heap}_{724,1;749,8} == \text{$heap}_{724,1;747,8}.$\text{$replace}(p3 \to asType < short)$
int>((asType<int>(asType<short\ int>(div3.rem))*
\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{724,1;747,8}.\mathbf{r3})) - (\mathbf{asType} < \mathbf{int} > (\mathbf{asType} < \mathbf{short}))
int>(div3.quot)) * asType< int>($heap_{724,1:747.8}.b3))))
\rightarrow [from term 63.24, $heap<sub>724.1:747.8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs *heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1}, 177).quot) + (171 * div(heapIs $heap_{funcstart\_724,1}, 17
heap_{funcstart\_724,1}.p1, 177).rem))._replace(p2 \rightarrow (-35 * div(heapIs)))._
heap_{funcstart-724,1}, heap_{funcstart-724,1}, p_{funcstart-724,1}, p_{funcstart-724,1}, p_{funcstart-724,1}
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p2, 176).rem)
[67.1] $\text{heap}_{724,1;749,8} == $\text{heap}_{funcstart_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{$heap}_{funcstart\_724,1}, \ \text{$heap}_{funcstart\_724,1.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{tuncstart_{724,1},p2,176,rem})._replace(p3 \rightarrow asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType < int > (\$heap_{724 \cdot 1.747 \cdot 8.173})) - (asType < int > (asType < short)
int>(div3.quot)) * asType< int>($heap_{724.1:747.8}.b3))))
\rightarrow [from term 43.6, div3 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p3, 178
[67.2] $\text{heap}_{724,1;749,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724,1},
\theta_{funcstart_{-724,1},p2,176}.quot) + (172 * div(heapIs \theta_{funcstart_{-724,1},p2}
\theta_{funcstart_{724,1},p2,176,rem})._replace(p3 \rightarrow asType<short
```

```
int>((asType<int>(asType<short int>(div(heapIs $heap_{tuncstart\_724.1},
\text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{rem}) * asType < int > (\text{Sheap}_{724,1;747,8}.\text{r3})) -
(asType<int>(asType<short int>(div3.quot)) *
asType < int > (\$heap_{724,1;747,8}.b3))))
\rightarrow [simplify]
[67.4] $\text{heap}_{724,1;749,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\rho_{tuncstart_{-724.1},p2, 176} + (172 * div(heapIs $heap_{tuncstart_{-724.1},p2})
\rho_{uncstart\_724,1.p2, 176).rem}))._replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem *
asType < int > (\$heap_{724,1:747,8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap<sub>724,1:747,8</sub>.b3))))
\rightarrow [from term 63.24, $heap<sub>724.1:747.8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724.1}.p1, 177).rem)._replace(p2 \rightarrow (-35 * div(heapIs)))._
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1},p2, 176}.rem)
[67.5] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{uncstart\_724,1.p2, 176).rem}).replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem *
asType < int > (\$heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * div(heapIs)))))))
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p1, 177).quot) + (171 * div(heapIs
\rho_{tuncstart=724.1}, \rho_{tuncstart=724.1}, \rho_{tuncstart=724.1}, \rho_{tuncstart=724.1}, \rho_{tuncstart=724.1}, \rho_{tuncstart=724.1}
* div(heapIs heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p2, 176).quot) + (172 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p2}, \ 176).\operatorname{rem}))).\operatorname{r3})) \ -
(asType<int>(asType<short int>(div3.quot)) *
asType < int > (\$heap_{724,1;747,8}.b3))))
→ [const member of object with modified fields]
[67.7] $\text{heap}_{724,1;749,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs} \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2, 176}.rem))._replace(p3 \rightarrow asType<short
int>((div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p3, 178).rem *
asType < int > (\$heap_{funcstart\_724,1}.r3)) - (asType < int > (asType < short)
```

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int>(div3.quot)) * asType< int>($heap_{724.1:747.8}.b3))))
\rightarrow [const static or extern object]
[67.8] heap_{724,1;749,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{1} = \theta_{1} - \theta_{2} = \theta_{1} - \theta_{2} = \theta_{2} - \theta_{3} - \theta_{4} = \theta_{1} - \theta_{2} - \theta_{4} = \theta_{1} - \theta_{2} - \theta_{4} = \theta_{4} - \theta_{4} - \theta_{4} - \theta_{4} - \theta_{4} = \theta_{4} - \theta_{4
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem *
asType < int > (\$heap_{init}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap<sub>724.1:747.8</sub>.b3))))
\rightarrow [expand definition of constant 'r3' at prang.c (25,20)]
[67.9] \rho_{7.9,1749,8} == \rho_{1.749,1...} = \rho_{1.749,1...
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2, 176}.rem))._replace(p3 \rightarrow asType<short
int>((div(heapIs $heap_tuncstart_724.1, $heap_tuncstart_724.1.p3, 178).rem *
asType<int>(asType<short int>((int)170))) -
(asType<int>(asType<short int>(div3.quot)) *
asType<int>($heap<sub>724.1:747.8</sub>.b3))))
\rightarrow [simplify]
[67.12] $\text{heap}_{724,1:749.8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{uncstart_724.1.p2, 176}.rem)._replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem * 170)
- (asType < int > (asType < short int > (div3.quot)) *
asType < int > (\$heap_{724,1;747,8}.b3))))
\rightarrow [from term 43.6, div3 is equal to div(heapIs $heap_{funcstart_724,1},
heap_{funcstart_{724,1}}.p3, 178
[67.13] \rho_{7.24,1;749,8} == \rho_{1.724,1}.\_replace(p1 \rightarrow ((-2 * p1.24,1)))
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
(-35 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{tuncstart\_724,1.p2, 176}.rem)._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) –
(asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},
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\text{sheap}_{funcstart_{-724,1},p3, 178,quot}) * asType < int > (\text{sheap}_{724,1:747,8},b3))))
\rightarrow [simplify]
[67.15] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{tuncstart\_724,1.p2, 176}.rem)._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) –
(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} *
asType < int > (\$heap_{724,1:747,8}.b3))))
\rightarrow [from term 63.24, $heap<sub>724,1;747,8</sub> is equal to
heap_{funcstart\_724.1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724.1},
heap_{funcstart\_724.1.p1}, 177).quot + (171 * div(heapIs $heap_{funcstart\_724.1}, 177).quot) + (171 * div(heapIs $heap_{funcstart\_724.1}, 17
\rho_{funcstart\_724.1}.p1, 177).rem)._replace\rho_{funcstart\_724.1}.p1, 177).rem)._replace
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p2, 176).rem
[67.16] $\text{heap}_{724,1;749,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}. p1, \ 177). \operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{tuncstart_724.1}.p2, 176).rem))._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) –
(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} *
asType < int > (\$heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * div(heapIs))))))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs})
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p1, 177).rem))).\_replace(p2 \rightarrow ((-35))
* div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}.p2, 176).quot) + (172 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724.1}, \ \$ \operatorname{heap}_{funcstart\_724.1}, \operatorname{p2}, 176).\operatorname{rem}))).\operatorname{b3}))))
\rightarrow [const member of object with modified fields]
[67.18] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724.1.p2, 176}.rem)._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) –
(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} *
asType < int > (\$heap_{funcstart\_724,1}.b3)))
\rightarrow [const static or extern object]
[67.19] $\text{heap}_{724,1:749.8} == \text{$heap}_{funcstart\_724,1}._\text{$\bf replace}(p1 \to ((-2 *
```

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\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{tuncstart\_724,1.p2, 176}.rem)._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) –
(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} *
asType < int > (\$heap_{init}.b3))))
\rightarrow [expand definition of constant 'b3' at prang.c (27,20)]
[67.20] heap_{724,1;749,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\label{eq:div_heap} \text{div}(\textbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart_{-724,1},p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart_{-724,1}},
\rho_{uncstart_{-724,1},p2, 176,rem})._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) –
(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} *
asType<int>(asType<short int>((int)63)))))
\rightarrow [simplify]
[67.26] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{tuncstart_724.1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2, 176}.rem)._replace(p3 \rightarrow ((-63 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs}))
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, 178).rem
[Take goal term]
[1.0] asType<integer>($heap<sub>724.1:749.8</sub>.p3) <
asType<integer>($heap<sub>724.1:749.8</sub>.M3)
\rightarrow [from term 67.26, $heap<sub>724,1;749,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.p1, 177).quot) + (171 * div(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).rem))._replace(p2 \rightarrow ((-35 * div(heapIs)))._
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
$heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p2, 176).rem))).\_replace(p3 \rightarrow (-63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -63 * -6
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).quot) + (170 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p3, \ 178).\operatorname{rem}))]
[1.1] asType<integer>(heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
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\text{Sheap}_{funcstart_{-724,1},p2, 176}.quot) + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart_{-724,1}},
\rho_{uncstart\_724,1.p2, 176).rem}))._replace(p3 \rightarrow ((-63 * div(heapIs
\$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).quot) + (170 * div(\textbf{heapIs}))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p3, 178).rem))).p3) <
asType<integer>($heap<sub>724,1:749,8</sub>.M3)
\rightarrow [simplify]
[1.3] ((-63 * div(heapIs heap_{funcstart_{724,1}}, heap_{funcstart_{724,1},p3})
178).quot) + (170 * \text{div}(\text{heapIs } \text{heap}_{funcstart\_724,1}, \text{heap}_{funcstart\_724,1}.p3,
(178).rem) < asType < integer > (\$heap_{724,1:749.8}.M3)
\rightarrow [from term 67.26, heap_{724,1;749,8} is equal to
\text{Sheap}_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(\text{heapIs} \$\text{heap}_{funcstart\_724,1},
heap_{funcstart_{724,1},p1, 177}, quot) + (171 * div(heapIs p_{funcstart_{724,1},p1, 177}), quot)
\rho_{funcstart\_724.1}.p1, 177).rem))).\_replace(p2 \rightarrow ((-35 * div(heapIs))).\_replace(p2 \rightarrow ((-35 * div(heapIs))))._replace(p2 \rightarrow ((-35 * div(heapIs))))._replace(p2 \rightarrow ((-35 * div(heapIs)))))._replace(p2 \rightarrow ((-35 * div(heapIs)))))._replace(p2 \rightarrow ((-35 * div(heapIs)))))._replace(p2 \rightarrow ((-35 * div(heapIs)))))
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p_{funcstart_{724,1}}, p_{funcstart_{724,1}}, p_{funcstart_{724,1}}, p_{funcstart_{724,1}}
heap_{funcstart\_724.1}, heap_{funcstart\_724.1}, p2, p2, p3, p4, p3, p4, p3, p4, p3, p4, 
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).quot) + (170 \ *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).rem))]
[1.4] ((-63 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3,
178).quot) + (170 * \text{div}(\textbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3},
178).rem)) < asType<integer>(p1 \rightarrow ((-2 * place))
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2, 176}.rem)._replace(p3 \rightarrow ((-63 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs}))
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, 178).rem)).M3)
\rightarrow [const member of object with modified fields]
[1.7] ((-63 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3,
178).quot) + (170 * div(heapIs heapI_{tuncstart\_724,1}, heap_{funcstart\_724,1}.p3,
178).rem)) < asType<integer>($heap_{funcstart\_724,1}.M3)
\rightarrow [const static or extern object]
 [1.8] \; ((-63 \; * \; \mathrm{div}(\mathbf{heapIs} \; \$ \mathrm{heap}_{funcstart\_724,1}, \; \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}, \\
178).quot) + (170 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3,
(178).rem) < asType < integer > (\$heap_{init}.M3)
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[1.9] ((-63 * div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1},p3},
178).quot) + (170 * div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p3,
(178).rem < asType < integer > (asType < short int > ((int)30323))
\rightarrow [simplify]
[1.19] -30323 < ((-170 * div(heapIs $heap_{funcstart\_724,1},
```

```
\text{Sheap}_{funcstart\_724,1.p3}, 178).\text{rem} + (63 * \text{div}(\text{heapIs} \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{724,1}.p3, 178}.quot)
\rightarrow [negate goal and search for contradiction]
[1.20]!(-30323 < ((-170 * div(heapIs $heap_{funcstart\_724,1},
\rho_{funcstart\_724,1.p3}, 178).rem) + (63 * div(heapIs \rho_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p3, 178).quot))
\rightarrow [simplify]
[1.25] 30322 < ((170 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3,
178).rem) + (-63 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3,
178).quot))
[Branch on disjunction or conditional in term 56.17]
[87.0] (0 == (-$heap<sub>funcstart_724,1</sub>.p3 + div(heapIs $heap<sub>funcstart_724,1</sub>,
\text{Sheap}_{funcstart,724,1.p3}, 178).\text{rem})) \lor (177 < \text{Sheap}_{funcstart,724,1.p3}) \lor !(0 ==
(-\text{\$heap}_{funcstart\_724,1}.\text{p3} + \text{div}(\text{\textbf{heapIs}} \text{\$heap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p3, 178.rem}
[Copy term 1.25]
[92.0] (30322 < ((-63 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} + (170 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\{\text{heap}_{funcstart\_724,1.p3}, 178\}.\text{rem}\} \lor (177 < \{\text{heap}_{funcstart\_724,1.p3}\} \lor !(0 = = 178)
(-\$heap_{funcstart\_724,1}.p3 + div(heapIs \$heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p3, 178).rem}
\rightarrow [from term 87.0, div(heapIs $heap_{funcstart\_724,1}$, $heap_{funcstart\_724,1}.p3,
178).rem is equal to heap_{funcstart_{724,1}}.p3
[92.1] (30322 < ((-63 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p3}, 178).\text{quot}) + (170 * \text{Sheap}_{funcstart\_724,1.p3}))) \vee ...
[Copy term 47.17]
[93.0] (0 == (-\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.p3,
178).rem + (\text{$heap}_{funcstart\_724,1}.p3 \% 178))) \vee (177 < \text{$heap}_{funcstart\_724,1}.p3)
\vee !(0 == (-\$heap_{funcstart\_724,1}.p3 + div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p3, 178).rem
\rightarrow [from term 87.0, div(heapIs $heap_{funcstart\_724,1}$, $heap_{funcstart\_724,1}.p3,
178).rem is equal to heap_{funcstart\_724,1}.p3
[93.1] \; (0 == (-\$ heap_{funcstart\_724,1}.p3 + (\$ heap_{funcstart\_724,1}.p3 \% 178))) \vee \dots
[Assume known post-assertion, class invariant or type constraint for term 93.1]
[97.0] ($\text{heap}_{funcstart_724,1}.p3 < 178) \times (177 < \text{$heap}_{funcstart_724,1}.p3) \times !(0)
== (-\$heap_{funcstart\_724,1}.p3 + div(heapIs \$heap_{funcstart\_724,1},
heap_{funcstart_{-724.1}.p3, 178.rem}
\rightarrow [simplify]
```

```
[97.3] (-178 < -\$heap_{funcstart\_724,1}.p3) \vee ...
[Copy term 1.25]
[102.0] 30322 < ((-63 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs} \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p3, 178.rem}
\rightarrow [from term 47.17, div(heapIs $heap_{funcstart\_724,1}$, $heap_{funcstart\_724,1}$.p3,
178).rem is equal to heap_{funcstart\_724,1}.p3 \% 178
[102.1] 30322 < ((-63 * div(heapIs heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p3}, 178).\text{quot} + (170 * (\text{Sheap}_{funcstart\_724,1.p3} \% 178)))
[Copy term 92.1]
[103.0] (30322 < ((-63 * div(heapIs heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} + (170 * \text{Sheap}_{funcstart\_724,1}.\text{p3}))) \lor (177 <
\$heap_{funcstart\_724,1}.p3) \lor !(0 == (-\$heap_{funcstart\_724,1}.p3 + div(\textbf{heapIs})) \lor !(0 == (-\$heap_{funcstart\_724,1}.p3 + div(\textbf{heapIs}))) \lor !(0 == (-\$heap_{funcstart\_724,1}.p3 + div(\textbf{heapIs}))) \lor !(0 == (-\$heap_{funcstart\_724,1}.p3 + div(\textbf{heapIs})))) \lor !(0 == (-\$heap_{funcstart\_724,1}.p3 + div(\textbf{heapIs})))
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, 178).rem
\rightarrow [from term 46.17, div(heap
Is \rho_{funcstart\_724,1} , \rho_{funcstart\_724,1} , \rho_{funcstart\_724,1}
178).<br/>quot is equal to p_{funcstart\_724,1}.p3\ /\ 178]
[103.1] (30322 < ((-63 * (\$heap_{funcstart\_724,1}.p3 / 178)) + (170 * (-63 * (\$heap_{funcstart\_724,1}.p3 / 178))) + (170 * (-63 * (-63 * (\$heap_{funcstart\_724,1}.p3 / 178))))
\mathrm{\$heap}_{funcstart\_724,1}.\mathrm{p3}))) \vee \dots
\rightarrow [division by larger divisor]
     Proof of rule precondition 1:
     \label{eq:constant_724,1.p3} \textit{[103.1.0.0]} \ \text{literald} < -\$ \text{heap}_{funcstart\_724,1}.\text{p3}
     \rightarrow [unify with term 97.3]
     [103.1.0.1] true
     Proof of rule precondition 2:
     [103.1.1.0] literalc < $heap<sub>funcstart_724,1.</sub>p3
     \rightarrow [unify with term 10.0]
     [103.1.1.1] true
     Proof of rule precondition 3:
     [103.1.2.0] --178 \le 178
     \rightarrow [simplify]
     [103.1.2.2] true
     Proof of rule precondition 4:
     [103.1.3.0] - 2 < 0
     \rightarrow [simplify]
     [103.1.3.1] true
```

```
[103.2] (30322 < ((-63 * p_{funcstart\_724,1.p3}) + (170 * p_{funcstart\_724,1.p3})
heap_{funcstart_{724,1}.p3})) \vee ...
\rightarrow [simplify]
[103.4] (30322 < (107 * $heap_{funcstart\_724,1}.p3)) \vee ...
\rightarrow [literal comparison of product]
[103.5] ([107 < 0]: (30322 / -107) < -\$heap_{funcstart\_724,1}.p3, [0 < 107]:
(30322 / 107) < \text{$heap}_{funcstart\_724,1}.p3, [0 == 107]: 30322 < 0) \lor \dots
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[103.6] ([107 < 0]: (30322 / -107) < -\$heap_{funcstart\_724,1}.p3, [(0 < 107) \land
!(107 < 0)]: (30322 / 107) < \text{$heap}_{funcstart\_724,1}.p3, [(0 == 107) \land !(0 < 107)]
\land !(107 < 0)]: 30322 < 0) \lor ...
\rightarrow [simplify]
[103.13] (true \land (283 < $heap_{funcstart_724,1}.p3)) \lor ...
\rightarrow [from term 97.3, literala < $heap_{funcstart\_724,1}.p3 is false whenever -2 <
(-178 + literala)
    Proof of rule precondition:
    [103.13.0] - 2 < (-178 + 283)
    \rightarrow [simplify]
    [103.13.2] true
[103.14] (true \wedge false) \vee \dots
\rightarrow [simplify]
[103.15] false \vee ...
[Remove 'false' term 103.15 and fetch new term from containing clause]
[104.0] 177 < $heap_{tuncstart_724.1}.p3
[Create new term from term 46.17 using rule: condition for equality of division]
[159.0] ((178 * (0 + -(-\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1},
\text{Sheap}_{funcstart_{-724,1},p3}, 178).\text{quot}))) < (1 + \text{Sheap}_{funcstart_{-724,1},p3})) \land
(heap_{funcstart\_724,1}.p3 < (178 * (0 + 1 + -(-div(heapIs)))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p3, 178).quot))))
\rightarrow [simplify]
\label{eq:continuous} \textit{[159.15]} \ (-1 < ((-178 \ ^* \ \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3},
178).quot) + heap_{funcstart_{-724,1}.p3}) \land (-178 < (-heap_{funcstart_{-724,1}.p3} + -heap_{funcstart_{-724,1}.p3})
(178*\operatorname{div}(\mathbf{heapIs}\ \$\operatorname{heap}_{funcstart\_724,1},\ \$\operatorname{heap}_{funcstart\_724,1}.\operatorname{p3},\ 178).\operatorname{quot})))
\rightarrow [separate conjunction and work on first sub-term]
[159.16] - 178 < (-\$heap_{funcstart\_724,1}.p3 + (178 * div(heapIs))]
\text{Sheap}_{funcstart_{-724,1}}, \text{Sheap}_{funcstart_{-724,1}}.p3, 178).quot)
```

```
[Create new term from terms 159.16, 104.0 using rule: transitivity 2]
[213.0] (-178 + 1 + 177) < (178 * div(heapIs $heap_{funcstart\_724,1},)
heap_{funcstart_{-724,1}}.p3, 178).quot
\rightarrow [simplify]
[213.1] 0 < (178 * div(heapIs $heap_{funcstart\_724.1}, $heap_{funcstart\_724.1}.p3,]
178).quot)
\rightarrow [product is positive]
[213.2] ((0 < 178) \wedge (0 < div(heapIs $heap<sub>funcstart_724,1</sub>,
\text{Sheap}_{funcstart\_724,1}.p3, 178).quot)) \lor ((178 < 0) \land (div(\textbf{heapIs}))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p3, 178).quot < 0)
\rightarrow [simplify]
[213.7]~0 < \mathrm{div}(\mathbf{heapIs}~\$\mathrm{heap}_{funcstart\_724,1},\,\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3},\,178).\mathrm{quot}
[Create new term from terms 213.7, 102.1 using rule: transitivity 11]
[217.0] (1 + 30322 + (0 * 63)) < (170 * ($heap_{funcstart\_724,1}.p3 % 178))
\rightarrow [simplify]
[217.2] 30323 < (170 * (\text{$heap}_{funcstart\_724,1}.p3 \% 178))
\rightarrow [literal comparison of product]
[217.3] ([170 < 0]: (30323 / -170) < -($heap_{funcstart\_724,1}.p3 % 178), [0 < -0.5]
170]: (30323 / 170) < (\text{$heap}_{tuncstart\_724,1}.\text{p3} \% 178), [0 == 170]: 30323 < 0)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[217.4] ([170 < 0]: (30323 / -170) < -($heap_{tuncstart_724.1}.p3 % 178), [(0 <
170) \land !(170 < 0)]: (30323 / 170) < (\$heap_{funcstart\_724,1}.p3 \% 178), [(0 ==
170) \land !(0 < 170) \land !(170 < 0)]: 30323 < 0)
\rightarrow [simplify]
[217.13] false
Proof of verification condition: Assertion valid
Condition generated at: C:\Escher\Customers\prang\prang.c (66,12)
To prove: -asType<integer const>($heap<sub>724.1:749.8</sub>.M3) <
asType<integer>($heap<sub>724.1:749.8</sub>.p3)
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
```

```
heap_{init}.M2 == asType < short int > ((int)30307)
\theta_{init}.r2 == asType<short int>((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
heap_{init}.b2 == asType < short int > ((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
heap_{init}.a3 == asType<short int>((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\rho = asType < short int > ((int)2)
\theta = asType < short int > ((int)3)
invariant1(heapIs $heap_{tuncstart_724.1})
div1 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1})) =>
(asType < integer > (\$heap_{funcstart\_724,1}.p1) = =
asType<integer>(div1.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathtt{a1}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) /
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))) ==
asType<integer>(div2.quot)
```

```
(asType < int > (asType < int > (\$heap_{funcstart\_724,1}.p2)) \%
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(asType < integer > ($heap_{funcstart\_724.1}.p2) = =
asType<integer>(div2.rem))
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}) \leq
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})) => !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}),
asType < int > (\$heap_{funcstart\_724,1}.a3))
(asType<integer>(asType<int>($heap_{tuncstart\_724.1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(\mathbf{asType} {<} \mathbf{integer} {>} (\mathbf{asType} {<} \mathbf{int} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3})) \ \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathtt{a3}))) ==
asType<integer>(div3.rem)
(asType<integer>($heap_funcstart_724.1.p3) <
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a3) \le
asType < integer > (\$heap_{funcstart\_724,1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
heap_{724,1;745,8} == heap_{funcstart\_724,1}.\_replace(p1 \rightarrow asType < short)
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1}.\mathbf{quot})) * \mathbf{asType}{<} \mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
-asType<integer const>($heap<sub>724,1;745,8</sub>.M1) <
asType < integer > ($heap_{724,1;745,8}.p1)
!(0 == \mathbf{asType} < \mathbf{integer} > (\$ heap_{724,1;745,8}.p1))
asType < integer > (\$heap_{724,1;745,8}.p1) <
asType<integer>($heap<sub>724.1:745.8</sub>.M1)
\text{Sheap}_{724,1;747,8} == \text{Sheap}_{724,1;745,8}. \text{replace}(p2 \to asType < short)
```

```
int>((asType<int>(asType<short int>(div2.rem)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{r2})) - (\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{short}
int>(div2.quot)) * asType<int>($heap<sub>724,1:745,8</sub>.b2))))
-asType<integer const>($heap<sub>724.1:747.8</sub>.M2) <
asType<integer>($heap<sub>724.1:747.8</sub>.p2)
!(0 == asType < integer > (\$heap_{724,1;747,8}.p2))
asType<integer>($heap<sub>724,1:747,8</sub>.p2) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;747,8}.\mathrm{M2})
\text{$heap}_{724,1;749,8} == \text{$heap}_{724,1;747,8}.\mathbf{replace}(p3 \to \mathbf{asType} < \mathbf{short}
int>((asType<int>(asType<short int>(div3.rem)) *
asType < int > (\$heap_{724.1:747.8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap<sub>724.1:747.8</sub>.b3))))
Proof:
[Take given term]
[5.0] invariant1(heapIs heap_{funcstart\_724,1})
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
[5.1] \; (((((0 < \mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p1)) \; \&\& \\
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M1})))~\&\&~(0<
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{M2})))~\&\&~(0<
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [simplify]
[5.3] (((((0 < $heap_{funcstart_724,1}.p1) && ($heap_{funcstart_724,1}.p1 < footnote{in the content of the c
asType < integer > (\$heap_{funcstart\_724,1}.M1))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
\mathbf{asType} \small{<} \mathbf{integer} \small{>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M2}))) \ \&\& \ (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})))\ \&\&
(asType < integer > (\$heap_{funcstart_{-724.1}}.p3) < 
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M3}))
\rightarrow [const static or extern object]
[5.4] (((((0 < $heap_{funcstart\_724,1}.p1) && ($heap_{funcstart\_724,1}.p1 < 
asType < integer > (\$heap_{init}.M1))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p2) <
asType<integer>(heap_{funcstart\_724,1}.M2))) && (0 <
```

```
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[5.5] \ (((((0 < \$heap_{funcstart\_724,1}.p1) \&\& \ (\$heap_{funcstart\_724,1}.p1 < (
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p2))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p2) <
asType<integer>(heap_{funcstart\_724,1}.M2))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{M3}))
\rightarrow [simplify]
[5.16] \; ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \; \land \; (0 < \$heap_{funcstart\_724,1}.p1) \; \land 
(0 < \text{$heap}_{funcstart\_724,1}.p2)) \&\& (\text{$heap}_{funcstart\_724,1}.p2 <
asType<integer>($heap_{funcstart\_724,1}.M2))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.17] \left( \left( \left( \left( -30269 < -\$ \text{heap}_{funcstart\_724,1}.\text{p1} \right) \right. \wedge \left. \left( 0 < \$ \text{heap}_{funcstart\_724,1}.\text{p1} \right) \right. \wedge \right. \right)
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType < integer > (\$heap_{init}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > ($heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.M3))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[5.18] ((((-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) 
(0 < \text{\$heap}_{funcstart\_724,1}.p2)) \&\& (\text{\$heap}_{funcstart\_724,1}.p2 <
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType < integer > (\$heap_{funcstart\_724,1}.p3))) \&\&
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{M3}))
\rightarrow [simplify]
[5.30] ((-30307 < -$heap_funcstart_724,1.p2) \land (-30269 <
 -\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.p2) \land (0 < \text{Sheap}_{funcstart\_724,1}.p3)) \&\&
(\text{\$heap}_{funcstart\_724,1}.p3 < asType < integer > (\text{\$heap}_{funcstart\_724,1}.M3))
\rightarrow [const static or extern object]
[5.31] ((-30307 < -\$heap_{funcstart\_724,1}.p2) \land (-30269 <
-\text{Sheap}_{funcstart\_724,1}.\text{p1}) \wedge (0 < \text{Sheap}_{funcstart\_724,1}.\text{p1}) \wedge (0 <
```

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\text{Sheap}_{funcstart\_724,1.p2}) \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\text{\$heap}_{funcstart\_724,1}.\text{p3} < \mathbf{asType} < \mathbf{integer} > (\text{\$heap}_{init}.\text{M3}))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[5.32] ((-30307 < -$heap_funcstart_724,1.p2) \land (-30269 <
-\$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1) \land (0 < \$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1.p2} \land (0 < \text{Sheap}_{funcstart\_724,1.p3})) \&\&
(\text{sheap}_{funcstart\_724,1}.\text{p3} < \text{asType} < \text{integer} > (\text{asType} < \text{short})
int > ((int)30323)))
\rightarrow [simplify]
[5.40] (-30323 < -\$heap_{funcstart\_724,1}.p3) \land (-30307 <
-\$heap_{funcstart\_724,1}.p2) \land (-30269 < -\$heap_{funcstart\_724,1}.p1) \land (0 < -\$heap_{funcstart\_724,1}.p1)
\text{Sheap}_{funcstart\_724,1}.\text{p1}) \land (0 < \text{Sheap}_{funcstart\_724,1}.\text{p2}) \land (0 <
heap_{funcstart_{-724,1}.p3}
\rightarrow [separate conjunction and work on first sub-term]
\label{eq:fine_start_724,1.p3} [5.41] \mbox{ -30323} < -\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}
[Work on sub-term 6 of conjunction in term 5.40]
[10.0] 0 < $heap_{tuncstart\_724,1}.p3
[Take given term]
[11.0] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
\rightarrow [simplify]
[11.1] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
\rightarrow [const static or extern object]
[11.2]~{\rm div1} == {\rm div}(\mathbf{heapIs}~\$ \mathrm{heap}_{funcstart\_724,1},\,\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType < int > (\$heap_{init}.a1))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
[11.3] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
asType<int>(asType<short int>((int)177)))
\rightarrow [simplify]
[11.6] div1 == div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177)
[Take given term]
[27.0] div2 == div(heapIs heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
\rightarrow [simplify]
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[27.1] \ \mathrm{div2} == \ \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2},
asType < int > (\$heap_{funcstart\_724,1}.a2))
\rightarrow [const static or extern object]
[27.2]~{\rm div2} == {\rm div}(\mathbf{heapIs}~\$ \mathrm{heap}_{funcstart\_724,1},\,\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2},
asType < int > (\$heap_{init}.a2))
\rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
[27.3] \operatorname{div2} == \operatorname{div}(\mathbf{heapIs} \ \text{$heap}_{funcstart\_724,1}, \ \text{$heap}_{funcstart\_724,1}.p2,
asType<int>(asType<short int>((int)176)))
\rightarrow [simplify]
[27.6] div2 == div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176)
[Take given term]
[43.0] \operatorname{div3} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a3}))
\rightarrow [simplify]
[43.1] div3 == div(heapIs $heap_{funcstart\_724.1}, $heap_{funcstart\_724.1}.p3,
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
\rightarrow [const static or extern object]
[43.2] \ \mathrm{div3} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3},
asType < int > (\$heap_{init}.a3))
\rightarrow [expand definition of constant 'a3' at prang.c (26,20)]
[43.3] \ \mathrm{div3} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3},
asType<int>(asType<short int>((int)178)))
\rightarrow [simplify]
[43.6] \text{ div3} == \text{div}(\mathbf{heapIs} \$ heap_{funcstart\_724,1}, \$ heap_{funcstart\_724,1}.p3, 178)
[Assume known post-assertion, class invariant or type constraint for term 43.6]
[46.0] (asType<integer>($heap_{tuncstart\_724.1}.p3) /
asType<integer>(178)) == asType<integer>(div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p3, 178).quot
\rightarrow [simplify]
[46.2] ($heap<sub>funcstart_724,1.</sub>p3 / 178) == asType<integer>(div(heapIs)
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).quot
→ [expand definition of operator './' in class 'int' at built in declaration]
[46.3] ([asType<integer>(sheap_{funcstart\_724,1}.p3) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724.1}.p3) / 178), []:
\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) \ / \ 178) = =
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\mathbf{asType} {<} \mathbf{integer} {>} ( \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}, \\
178).quot)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[46.4] \; ([\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178) = =
asType<integer>(div(heapIs $heap_{tuncstart\_724.1}, $heap_{tuncstart\_724.1}.p3,
178).quot)
\rightarrow [simplify]
[46.7] ([0 < -$heap<sub>funcstart_724.1</sub>.p3]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178),
[!(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) < 0)]:
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})~/~178) ==
asType<integer>(div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3,
178).quot)
\rightarrow [from term 10.0, literala < -$heap<sub>funcstart_724,1</sub>.p3 is false whenever -2 <
(0 + literala)
    Proof of rule precondition:
    [46.7.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [46.7.2] true
[46.8] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) \; / \; 178),
[!(asType < integer > (\$heap_{funcstart\_724.1}.p3) < 0)]:
asType < integer > (\$heap_{funcstart\_724.1}.p3) / 178) = =
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3,
178).quot)
\rightarrow [simplify]
[46.11] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p3) / 178), [!(0 < integer > (\$heap_{funcstart\_724,1}.p3) / 178)]
-\$heap_{funcstart\_724,1}.p3)]: asType<integer>(\$heap_{funcstart\_724,1}.p3) / 178)
== asType<integer>(div(heapIs $heap_{funcstart_724,1},
heap_{funcstart_{-724,1}.p3, 178}, quot
\rightarrow [from term 10.0, literala < -$heap<sub>funcstart_724,1</sub>.p3 is false whenever -2 <
(0 + literala)
    Proof of rule precondition:
    [46.11.0] - 2 < (0 + 0)
    \rightarrow [simplify]
    [46.11.2] true
```

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[46.12] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}) \; / \; 178),
[!false]: asType<integer>(\theta_{funcstart\_724,1.p3}) / 178) ==
\mathbf{asType} \small{<} \mathbf{integer} \small{>} ( \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}, \\
178).quot)
\rightarrow [simplify]
[46.17] 0 == (-\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3},
178).quot + (\text{$heap}_{funcstart\_724,1}.p3 / 178))
[Assume known post-assertion, class invariant or type constraint for term 43.6]
[47.0] (as
Type<integer>($heap_{funcstart\_724,1}.p3) \%
asType<integer>(178)) == asType<integer>(div(heapIs
heap_{funcstart_{-724.1}}, heap_{funcstart_{-724.1}}, 178).rem
\rightarrow [simplify]
[47.2] ($heap<sub>funcstart_724.1</sub>.p3 % 178) == asType<integer>(div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{rem}
→ [expand definition of operator '.%' in class 'int' at built in declaration]
[47.3] ([asType<integer>(sheap_{funcstart\_724,1}.p3) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178), []:
asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178) ==
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3,
178).rem)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[47.4] ([asType<integer>(heap_{funcstart\_724,1}.p3) < 0]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178),
[!(asType < integer > (\$heap_{funcstart\_724.1}.p3) < 0)]:
asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178) = =
asType<integer>(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3,
178).rem)
\rightarrow [simplify]
[47.7] ([0 < -$heap<sub>funcstart_724,1.</sub>p3]:
-(-asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 0)]:
\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) \% 178) = =
asType<integer>(div(heapIs $heap_{tuncstart_724.1}, $heap_{tuncstart_724.1.p3},
178).rem)
\rightarrow [from term 10.0, literala < -$heap<sub>funcstart_724,1</sub>.p3 is false whenever -2 <
(0 + literala)
    Proof of rule precondition:
    [47.7.0] - 2 < (0 + 0)
    \rightarrow [simplify]
```

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[47.7.2] true
[47.8] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178),
[!(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 0)]:
\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) \% 178) = =
asType<integer>(div(heapIs $heap_{tuncstart\_724.1}, $heap_{tuncstart\_724.1}.p3,
178).rem)
\rightarrow [simplify]
[47.11] \; ([\mathbf{false}]: \; -(-\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}) \; \% \; 178), \; [!(0.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.11)] \; ((1.
<-$heap<sub>funcstart_724,1.</sub>p3)]: asType<integer>($heap<sub>funcstart_724,1.</sub>p3) %
178) == asType < integer > (div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p3}, 178).rem
\rightarrow [from term 10.0, literala < -$heap<sub>funcstart-724.1</sub>.p3 is false whenever -2 <
(0 + literala)
           Proof of rule precondition:
           [47.11.0] - 2 < (0 + 0)
           \rightarrow [simplify]
           [47.11.2] true
[47.12] ([false]: -(-asType < integer > (\$heap_{funcstart\_724,1}.p3) \% 178),
[!false]: asType<integer>(sheap_{funcstart_724,1.p3}) \% 178 ==
asType<integer>(div(heapIs $heap_funcstart_724,1, $heap_funcstart_724,1.p3,
178).rem)
\rightarrow [simplify]
[47.17] \ 0 == (-\text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p3},
178).rem + (\text{$heap}_{funcstart\_724,1}.p3 \% 178))
[Take given term]
[59.0] \rho === \rho_{1.745,8} == 
int>((asType<int>(asType<short int>(div1.rem))
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1.quot})) * \mathbf{asType}{<} \mathbf{int}{>} (\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart_{724,1}},
heap_{funcstart_{-724,1}}.p1, 177
[59.1] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div(heapIs $heap_{funcstart_724,1},))
\text{sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}) * asType<int>(\text{sheap}_{funcstart\_724,1}.\text{r1})) -
(asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724,1}.b1)))
\rightarrow [simplify]
[59.3] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
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int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
\rightarrow [const static or extern object]
[59.4] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType < int > (\$heap_{init}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1.quot})) * \mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
\rightarrow [expand definition of constant 'r1' at prang.c (15,20)]
[59.5] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType<int>(asType<short int>((int)171))) -
(asType<int>(asType<short int>(div1.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [simplify]
[59.8] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem * 171)
- (asType<int>(asType<short int>(div1.quot))
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724.1},
heap_{funcstart_{724,1}}.p1, 177
[59.9] heap_{724,1:745,8} == heap_{funcstart\_724,1}-replace(p1 \rightarrow asType<short
int>((171 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)
- (asType<int>(asType<short int>(div(heapIs $heap_{funcstart 724.1},
heap_{funcstart_{724,1}}.p1, 177).quot) *
asType < int > (\$heap_{funcstart\_724,1}.b1)))
\rightarrow [simplify]
[59.11] \text{heap}_{724,1;745,8} == \text{heap}_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [const static or extern object]
[59.12] $\text{heap}_{724.1:745.8} == $\text{heap}_{funcstart\_724.1}._\text{replace}(p1 \rightarrow \text{asType} < \text{short}
int>((171 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{init}.\mathrm{b1}))))
\rightarrow [expand definition of constant 'b1' at prang.c (17,20)]
[59.13] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((171 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\textbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
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asType<int>(asType<short int>((int)2))))
\rightarrow [simplify]
[59.19] $\text{heap}_{724,1;745,8} == \text{$heap}_{funcstart\_724,1}._\text{$replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, \ 177).\operatorname{rem})))
[Take given term]
[63.0] $\text{heap}_{724,1;747,8} == $\text{heap}_{724,1;745,8}._\text{replace}(p2 \rightarrow \text{asType} < \text{short}
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724,1:745,8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [from term 59.19, $heap<sub>724,1:745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs \$heap_{funcstart\_724,1},
heap_{funcstart_{724,1},p1, 177}, quot) + (171 * div(heapIs p_{funcstart_{724,1},p1, 177}).
heap_{funcstart_{-724,1}.p1, 177).rem}
[63.1] \theta == 
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
(177).rem))._replace(p2 \rightarrow asType < short)
int>((asType<int>(asType<short int>(div2.rem)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\text{heap}_{724,1;745,8}.\text{r2})) - (\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{short}
int>(div2.quot)) * asType< int>($heap_{724,1:745.8}.b2))))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{funcstart_724.1},
heap_{funcstart_{724,1}}.p2, 176
[63.2] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short
\mathbf{int}{>}((\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{short}\ \mathbf{int}{>}(\mathbf{div}(\mathbf{heapIs}\ \$\mathbf{heap}_{funcstart\_724,1},
\text{sheap}_{funcstart\_724,1.p2, 176}.\text{rem}) * asType < int > (\text{sheap}_{724,1;745,8.r2})) -
(asType<int>(asType<short int>(div2.quot)) *
asType<int>($heap<sub>724,1:745,8</sub>.b2))))
\rightarrow [simplify]
[63.4] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, 176).rem *
\mathbf{asType} \small{<} \mathbf{int} \small{>} (\$ \mathrm{heap}_{724,1;745,8}.\mathrm{r2})) \\ - (\mathbf{asType} \small{<} \mathbf{int} \small{>} (\mathbf{asType} \small{<} \mathbf{short}
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [from term 59.19, $heap<sub>724,1;745,8</sub> is equal to
heap_{funcstart\_724.1}._replace(p1 \rightarrow (-2 * div(heapIs $heap_{funcstart\_724.1},
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\text{Sheap}_{funcstart_{-724,1},p1, 177}.\text{quot}) + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart_{-724,1}})
heap_{funcstart_{-724,1}}.p1, 177).rem)
[63.5] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724.1}, \ \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}.p2, 176).rem *
\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}. \mathbf{\_replace} (\mathtt{p1} \rightarrow ((-2 * \operatorname{div}(\mathbf{heapIs}
\text{Sheap}_{funcstart\_724.1}, \text{Sheap}_{funcstart\_724.1}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs})
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).rem))).r2)) -
(asType<int>(asType<short int>(div2.quot)) *
asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [const member of object with modified fields]
[63.6] $heap<sub>724.1:747.8</sub> == $heap<sub>funcstart_724.1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((\operatorname{div}(\mathbf{heapIs}))))
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1},p2, 176}.rem *
asType < int > (\$heap_{funcstart\_724,1}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724,1:745,8</sub>.b2))))
\rightarrow [const static or extern object]
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}.p2, 176).rem *
asType < int > (\$heap_{init}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [expand definition of constant 'r2' at prang.c (20,20)]
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
(177).rem)._replace(p2 \rightarrow asType<short int>((div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem *
asType<int>(asType<short int>((int)172))) -
(asType<int>(asType<short int>(div2.quot)) *
asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [simplify]
[63.11] $\text{heap}_{724,1:747,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem))).replace(p2 \rightarrow asType < short int > ((div(heapIs)))
```

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heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}.p2, 176).rem * 172) -
(asType<int>(asType<short int>(div2.quot)) *
asType < int > (\$heap_{724,1:745,8}.b2))))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{tuncstart_{724.1}},
heap_{funcstart_{-724,1},p2,176}
[63.12] $\text{heap}_{724,1;747,8} == $\text{heap}_{funcstart_724,1}.$\text{-replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 2, 176).rem –
(asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724.1},
\text{sheap}_{funcstart\_724,1.p2}, 176).\text{quot}) * asType<int>(\text{sheap}_{724,1;745,8}.\text{b2}))))
\rightarrow [simplify]
[63.14] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 2, 176).quot *
asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [from term 59.19, $heap<sub>724.1:745.8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs p_{funcstart\_724,1}),
heap_{funcstart_{-724,1}.p1, 177).rem}
[63.15] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1},p2,176}.quot *
asType < int > (\$heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * div(heapIs)))))))
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1},p1, 177).rem)).b2)))
\rightarrow [const member of object with modified fields]
[63.16] $\text{heap}_{724,1;747,8} == \text{$heap}_{funcstart\_724,1}._\text{$replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
(177).rem)._replace(p2 \rightarrow asType<short int>((172 * div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem}) - (\text{div}(\text{heapIs})
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1},p2,176}.quot *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b2}))))
\rightarrow [const static or extern object]
```

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[63.17] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\label{eq:div_heap} \text{div}(\textbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 176).quot *
asType < int > (\$heap_{init}.b2))))
\rightarrow [expand definition of constant 'b2' at prang.c (22,20)]
[63.18] $\text{heap}_{724,1:747,8} == \text{$heap}_{funcstart\_724,1}._\text{$replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 2, 176, quot
asType<int>(asType<short int>((int)35)))))
\rightarrow [simplify]
[63.24] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart} \ 724.1, \ \$ \operatorname{heap}_{funcstart} \ 724.1, \ p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\rho_{tuncstart_{-724,1},p2,176}, quot) + (172 * div(heapIs \rho_{tuncstart_{-724,1},p2}
heap_{funcstart_{-724,1}}.p2, 176).rem))
[Take given term]
[67.0] $\text{heap}_{724,1:749,8} == $\text{heap}_{724,1:747.8}._\text{replace}(p3 \to \text{asType} < \text{short}
int>((asType<int>(asType<short int>(div3.rem)) *
asType < int > (\$heap_{724,1:747,8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap<sub>724,1;747,8</sub>.b3))))
\rightarrow [from term 63.24, $heap<sub>724,1;747,8</sub> is equal to
heap_{funcstart_{724,1}}._replace(p1 \rightarrow ((-2 * div(heapIs heap_{funcstart_{724,1}}), + (-2 * div(heapIs heap_{funcstart_{724,1}})))
\text{Sheap}_{funcstart\_724,1}.p1, 177).quot) + (171 * div(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).rem)._replace(p2 \rightarrow (-35 * div(heapIs)))._replace
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem)
[67.1] \theta == 
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{uncstart_724.1.p2, 176}.rem)._replace(p3 \rightarrow asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType < int > (\$heap_{724.1:747.8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap<sub>724,1:747,8</sub>.b3))))
```

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\rightarrow [from term 43.6, div3 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1}}.p3, 178
[67.2] $heap<sub>724,1:749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{uncstart_{724.1},p2,176}.rem)._replace(p3 \rightarrow asType<short
int>((asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},))
\text{sheap}_{funcstart\_724,1.p3}, 178).rem) * asType < int > (\text{sheap}_{724,1:747,8}.r3)) -
(asType<int>(asType<short int>(div3.quot)) *
asType<int>($heap<sub>724.1:747.8</sub>.b3))))
\rightarrow [simplify]
[67.4] $\text{heap}_{724.1:749.8} == $\text{heap}_{funcstart_724.1}._\text{replace}(p1 \to ((-2 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724.1}, \ \$heap_{funcstart\_724.1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\theta_{funcstart_{-724,1},p2,176}.quot) + (172 * div(heapIs \theta_{funcstart_{-724,1},p2,176}).
\theta_{funcstart_{724,1},p2,176,rem})._replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem *
asType < int > (\$heap_{724,1:747,8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType< int>($heap_{724,1:747,8}.b3))))
\rightarrow [from term 63.24, $\$heap_{724,1;747,8}$ is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs *heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).rem))._replace(p2 \rightarrow (-35 * div(heapIs)))._
\text{Sheap}_{funcstart\_724.1}, \text{Sheap}_{funcstart\_724.1}.p2, 176).quot) + (172 * div(\textbf{heapIs})
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p2, 176).rem)
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2, 176}.rem))._replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem *
asType < int > (\$heap_{tuncstart\_724,1}.\_replace(p1 \rightarrow ((-2 * div(heapIs))))))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs}))
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p2, \ 176).rem))).r3)) -
(asType<int>(asType<short int>(div3.quot)) *
asType < int > (\$heap_{724.1:747.8}.b3)))
\rightarrow [const member of object with modified fields]
```

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[67.7] $\text{heap}_{724,1;749,8} == $\text{heap}_{funcstart\_724,1}._\text{-replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{funcstart\_724,1}.p2, 176).rem))._replace(p3 \rightarrow asType<short
int>((div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p3, 178).rem *
asType < int > (\$heap_{tuncstart\_724.1}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap<sub>724.1:747.8</sub>.b3))))
\rightarrow [const static or extern object]
[67.8] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\$ heap_{funcstart\_724,1}.p2,\,176).rem))).\_\textbf{replace}(p3 \rightarrow \textbf{asType} < \textbf{short}
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem *
asType < int > (\$heap_{init}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap<sub>724.1:747.8</sub>.b3))))
\rightarrow [expand definition of constant 'r3' at prang.c (25,20)]
[67.9] $\text{heap}_{724,1;749,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{uncstart\_724,1.p2, 176).rem}).replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem *
asType<int>(asType<short int>((int)170))) -
(asType<int>(asType<short int>(div3.quot)) *
asType < int > (\$heap_{724,1;747,8}.b3))))
\rightarrow [simplify]
[67.12] $\text{heap}_{724.1:749.8} == $\text{heap}_{funcstart\_724.1}. \text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart_{-724,1},p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart_{-724,1}},
\theta_{funcstart_{724,1},p2,176,rem})._replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem * 170)
- (asType < int > (asType < short int > (div3.quot))*
asType < int > (\$heap_{724,1;747,8}.b3))))
\rightarrow [from term 43.6, div3 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1}}.p3, 178
```

```
[67.13] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{uncstart\_724,1}.p2, 176).rem))._replace(p3 \rightarrow asType<short int>((170
* \operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p3, \ 178).rem) -
(asType<int>(asType<short int>(div(heapIs $heap_{tuncstart\_724.1},
\text{sheap}_{funcstart\_724,1.p3}, 178).\text{quot}) * asType<int>(\text{sheap}_{724,1:747,8.b3}))))
[67.15] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{uncstart_{-724,1},p2, 176,rem})._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) –
(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724.1}, \$ \text{heap}_{funcstart\_724.1}. \text{p3}, 178).\text{quot} *
asType<int>($heap<sub>724.1:747.8</sub>.b3))))
\rightarrow [from term 63.24, heap_{724,1;747,8} is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs heap_{funcstart\_724,1}),
\text{Sheap}_{funcstart\_724,1}.p1, 177).quot) + (171 * div(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{uncstart\_724,1}.p1, 177).rem))._replace\rho_{uncstart\_724,1}.p1, 177).rem))._replace
heap_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p2, 176).rem)
[67.16] heap_{724,1;749,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724.1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724.1},
\theta_{170} = \theta_{1
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) –
(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} *
asType < int > (\$heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * div(heapIs))))))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1, 177).quot) + (171 * div(heapIs)
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
* div(\mathbf{heapIs} \ \$ heap_{funcstart\_724,1}, \ \$ heap_{funcstart\_724,1}.p2, \ 176).quot) + (172 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p2}, \ 176).\operatorname{rem}))).\operatorname{b3}))))
→ [const member of object with modified fields]
[67.18] heap_{724,1;749,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
```

```
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs} \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2, 176}.rem)._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) –
(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} *
asType < int > (\$heap_{funcstart\_724,1}.b3))))
\rightarrow [const static or extern object]
[67.19] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs} \text{Sheap}_{funcstart\_724,1}),
\theta_{funcstart\_724,1.p2, 176}.rem)._replace(p3 \rightarrow asType<short int>((170
* \operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p3, \ 178).rem) -
(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} *
asType < int > (\$heap_{init}.b3))))
\rightarrow [expand definition of constant 'b3' at prang.c (27,20)]
[67.20] heap_{724,1;749,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart} \ 724.1, \ \$ \operatorname{heap}_{funcstart} \ 724.1, \ p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{tuncstart_724.1}.p2, 176).rem))._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart\_724.1}, heap_{funcstart\_724.1}, n_{funcstart\_724.1}, n_{funcstart\_724.1}
(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} *
asType<int>(asType<short int>((int)63)))))
\rightarrow [simplify]
[67.26] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724.1}, \ \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724.1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724.1},
\rho_{funcstart\_724,1}.p2, 176).rem))._replace(p3 \rightarrow ((-63 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}. \theta_{funcstart\_724,1}. \theta_{funcstart\_724,1}. \theta_{funcstart\_724,1}. \theta_{funcstart\_724,1}.
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 178).rem)
[Take goal term]
[1.0] -asType<integer const>($heap_{724.1:749.8}.M3) <
asType<integer>($heap<sub>724.1:749.8</sub>.p3)
\rightarrow [from term 67.26, $heap<sub>724,1;749,8</sub> is equal to
heap_{funcstart\ 724.1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\ 724.1}), heap_{funcstart\ 724.1})
\text{Sheap}_{funcstart\_724,1.p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p1, 177}.rem))._replace\rho_{funcstart\_724,1.p1, 177}.rem))._replace
heap_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}
```

```
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem)))._replace(p3 \rightarrow (-63 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).quot) + (170 \ *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).rem))]
[1.1] -asType < integer const > (\$heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * funcstart\_724,1)))))
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724.1.p2}, 176).rem))._replace(p3 \rightarrow ((-63 * div(heapIs)
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).quot) + (170 * div(heapIs
\rho_{funcstart_{724,1}}, \rho_{funcstart_{724,1}}, 178).rem))
asType<integer>($heap<sub>724.1:749.8</sub>.p3)
\rightarrow [const member of object with modified fields]
[1.4] -asType<integer const>($heap_{tuncstart\_724.1}.M3) <
asType<integer>($heap<sub>724.1:749.8</sub>.p3)
\rightarrow [const static or extern object]
[1.5] -asType<integer const>($heap_{init}.M3) <
asType<integer>($heap<sub>724.1:749.8</sub>.p3)
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[1.6] -asType<integer const>(asType<short int>((int)30323)) <
asType<integer>($heap<sub>724.1:749.8</sub>.p3)
\rightarrow [simplify]
[1.10] -30323 < asType<integer>($heap<sub>724,1:749,8</sub>.p3)
\rightarrow [from term 67.26, $heap<sub>724,1;749,8</sub> is equal to
\text{Sheap}_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1}), the sheap_{funcstart\_724,1}).
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1}, 177).quot) + (171 * div(heapIs $heap_{funcstart\_724,1}, 17
\rho_{uncstart\_724,1}.p1, 177).rem))).\_replace(p2 \rightarrow ((-35 * div(heapIs))).\_replace(p2 \rightarrow ((-35 * div(heapIs)))).\_replace(p2 \rightarrow ((-35 * div(heapIs)))).\_replace(p2 \rightarrow ((-35 * div(heapIs)))))
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, p_{funcstart_{-724,1}}, p_{funcstart_{-724,1}}, p_{funcstart_{-724,1}}, p_{funcstart_{-724,1}}
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}, p2, p3, p3, p4, 
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).quot) + (170 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).rem))]
[1.11] -30323 < asType<integer>($heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\label{eq:div_heapIs} \text{$heap}_{funcstart\_724,1}, \\ \text{$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2, 176}.rem)._replace(p3 \rightarrow ((-63 * div(heapIs
\text{Sheap}_{funcstart\_724.1}, \text{Sheap}_{funcstart\_724.1}.p3, 178).quot) + (170 * div(heapIs)
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1},p3, 178).rem))).p3)
\rightarrow [simplify]
```

```
[1.13] -30323 < ((-63 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p3,
178).quot) + (170 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3,
178).rem))
\rightarrow [negate goal and search for contradiction]
[1.14] !(-30323 < ((-63 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{724,1}.p3, 178.rem}
\rightarrow [simplify]
 [1.19] \ 30322 < ((63 * \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}, 
178).quot) + (-170 * \text{div}(\textbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3},
178).rem))
[Copy term 1.19]
[100.0] 30322 < ((-170 * div(heapIs $heap_{tuncstart\_724.1},
\text{Sheap}_{funcstart_724,1.p3}, 178).\text{rem} + (63 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart_724,1},
heap_{funcstart_{-724,1}}.p3, 178).quot)
\rightarrow [from\ term\ 47.17,\ div(\textbf{heapIs}\ \$heap_{funcstart\_724,1},\ \$heap_{funcstart\_724,1}.p3,
178).rem is equal to heap_{funcstart\_724,1}.p3 \% 178
[100.1] 30322 < ((-170 * (\$heap_{funcstart\_724,1}.p3 \% 178)) + (63 * div(heapIs))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p3, 178).quot))
[Create new term from term 46.17 using rule: condition for equality of division]
[155.0] ((178 * (0 + -(-\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1},
\$ heap_{funcstart\_724,1}.p3,\ 178).quot))) < (1 + \$ heap_{funcstart\_724,1}.p3)) \ \land
(\text{\$heap}_{funcstart\_724.1}.p3 < (178 * (0 + 1 + -(-div(\mathbf{heapIs}))))
\$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).quot))))
\rightarrow [simplify]
[155.15] (-1 < ((-178 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3,
178).quot) + \text{$heap}_{funcstart\_724,1}.p3)) \land (-178 < (-\text{$heap}_{funcstart\_724,1}.p3 + \text{$heap}_{funcstart\_724,1}.p3)
(178 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).quot)))
[Work on sub-term 2 of conjunction in term 155.15]
[156.0] -1 < ((-178 * div(\mathbf{heapIs} \$ heap_{funcstart\_724,1}, \$ heap_{funcstart\_724,1}.p3,
178).quot) + $heap<sub>funcstart_724,1</sub>.p3)
[Create new term from terms 156.0, 5.41 using rule: transitivity 2]
[214.0] (-30323 + -1 + 1) < (-178 * div(heapIs $heap_{funcstart\_724.1},
heap_{funcstart_{-724,1}.p3, 178}, quot
\rightarrow [simplify]
[214.1] -30323 < (-178 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p3, 178).quot
\rightarrow [literal comparison of product]
```

```
[214.2] ([-178 < 0]: (-30323 / 178) < -\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1},
\theta_{funcstart\_724,1}.p3, 178, quot, [0 < -178]: (-30323 / -178) < \text{div}(\hat{heapIs})
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[214.3] ([-178 < 0]: (-30323 / 178) < -\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1},
\theta_{1} = \theta_{1} + \theta_{2} = \theta_{1} + \theta_{2} = \theta_{1} + \theta_{2} = \theta_{2} + \theta_{3} = \theta_{1} + \theta_{2} = \theta_{3} + \theta_{3} = \theta_{3} + \theta_{3} = \theta_{3
< \text{div}(\text{heapIs } \text{\$heap}_{funcstart\_724,1}, \text{\$heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot}, [(-178)]
==0) \wedge !(-178 < 0) \wedge !(0 < -178)]: -30323 < 0)
\rightarrow [simplify]
[214.7] -171 < -\text{div}(\text{heapIs }\text{\$heap}_{funcstart\_724,1}, \text{\$heap}_{funcstart\_724,1}.\text{p3},
[Create new term from terms 214.7, 100.1 using rule: transitivity 5]
[224.0]\ 30322 < ((-170 * (\$heap_{funcstart\_724.1}.p3 \% 178)) + (63 * -(-171 + 1)))
\rightarrow [simplify]
[224.5] 19612 < (-170 * ($heap_{funcstart\_724,1}.p3 % 178))
\rightarrow [literal comparison of product]
[224.6] ([-170 < 0]: (19612 / 170) < –($heap _{funcstart\_724,1}.p3 \% 178), [0 <
-170]: (19612 / -170) < (\text{$heap}_{funcstart\_724,1}.\text{p3} \% 178), [-170 == 0]: 19612 <
0)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[224.7] ([-170 < 0]: (19612 / 170) < -($heap_{funcstart\_724,1}.p3 % 178), [(0 < 10.00)]
-170) \wedge !(-170 < 0)]: (19612 / -170) < ($heap_{funcstart_724,1}.p3 % 178), [(-170)]
==0) \land !(-170 < 0) \land !(0 < -170)]: 19612 < 0)
\rightarrow [simplify]
[224.12] false
Proof of verification condition: Type constraint satisfied in implicit
conversion from 'short int const' to 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (68,27)
Condition defined at:
To prove: minof(int) \le \$heap_{724,1;749,8}.M1
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
```

```
\theta_{init}.a1 == asType<short int>((int)177)
\theta = asType < short int > ((int)2)
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
\theta_{init}.a2 == asType<short int>((int)176)
heap_{init}.b2 == asType<short int>((int)35)
\theta = asType < short int > ((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
invariant
1(heap<br/>Is \rho_{funcstart\_724,1}
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
(asType<integer>(asType<int>($heap_{funcstart\_724,1}.p1)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p1) = =
asType<integer>(div1.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a1) \le
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}),
asType < int > (\$heap_{funcstart\_724,1}.a2))
(asType<integer>(asType<int>($heap_{tuncstart\_724,1}.p2)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
```

```
asType<integer>(div2.quot)
(asType < int > (asType < int > (\$heap_{funcstart\_724,1}.p2)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a2})) = >
(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p2) ==
asType<integer>(div2.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a2}) \leq
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2})) = > !(0 = =
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
\label{eq:div3} \text{div3} == \text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1},
\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}),
asType < int > (\$heap_{funcstart\_724.1}.a3))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) \%
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a3}))) = =
asType<integer>(div3.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a3) \le
asType < integer > (\$heap_{funcstart\_724,1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
\$heap_{724,1;745,8} == \$heap_{funcstart\_724,1}.\_\mathbf{replace}(p1 \rightarrow \mathbf{asType} < \mathbf{short}
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType<int>($heap_{funcstart\_724,1}.b1)))
-asType<integer const>($heap_{724,1:745,8}.M1) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{p1})
!(0 == asType < integer > (\$heap_{724,1;745,8}.p1))
asType<integer>($heap<sub>724.1:745.8</sub>.p1) <
asType<integer>($heap<sub>724.1:745.8</sub>.M1)
```

```
heap_{724,1;747,8} == heap_{724,1;745,8}.replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{724,1;745,8}.\mathrm{r2})) - (\mathbf{asType} < \mathbf{int} > (\mathbf{asType} < \mathbf{short}))
int>(div2.quot)) * asType< int>($heap_{724,1;745.8}.b2))))
-asType<integer const>($heap<sub>724.1:747.8</sub>.M2) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;747,8}.\mathrm{p2})
!(0 == asType < integer > (\$heap_{724,1;747,8}.p2))
asType<integer>($heap<sub>724,1:747,8</sub>.p2) <
asType<integer>($heap<sub>724,1:747,8</sub>.M2)
\$heap_{724,1;749,8} == \$heap_{724,1;747,8}. \textbf{\_replace}(p3 \rightarrow \textbf{asType} {<} \textbf{short}
int>((asType<int>(asType<short int>(div3.rem)) *
asType < int > (\$heap_{724.1:747.8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap<sub>724,1:747,8</sub>.b3))))
-{\bf asType}{<} {\bf integer\ const}{>} (\${\rm heap}_{724,1;749,8}.{\rm M3}) <
asType<integer>($heap<sub>724.1:749.8</sub>.p3)
!(0 == asType < integer > (\$heap_{724,1;749,8}.p3))
asType<integer>($heap<sub>724,1:749,8</sub>.p3) <
asType<integer>($heap<sub>724,1:749,8</sub>.M3)
Proof:
[Take given term]
[11.0] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
\rightarrow [simplify]
[11.1] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType < int > (\$heap_{funcstart\_724.1}.a1))
\rightarrow [const static or extern object]
[11.2] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType < int > (\$heap_{init}.a1))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
[11.3] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType<int>(asType<short int>((int)177)))
\rightarrow [simplify]
[11.6] div1 == div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1, 177)
[Take given term]
[27.0] div2 == div(heapIs $heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
```

```
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
\rightarrow [simplify]
[27.1] \operatorname{div2} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p2,
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
\rightarrow [const static or extern object]
\label{eq:continuous} \mbox{\sc [27.2] div2} == \mbox{\sc div} (\mathbf{heapIs} \ \$\mbox{\sc heap}_{funcstart\_724,1}, \ \$\mbox{\sc heap}_{funcstart\_724,1}.\mbox{\sc p2},
asType < int > (\$heap_{init}.a2))
\rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
[27.3] \operatorname{div2} == \operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p2,
asType<int>(asType<short int>((int)176)))
\rightarrow [simplify]
[27.6] \text{ div2} == \text{div}(\text{heapIs } \text{$heap}_{funcstart\_724,1}, \text{$heap}_{funcstart\_724,1}.p2, 176)
[Take given term]
[43.0] div3 == div(heapIs \theta_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
asType < int > (\$heap_{funcstart\_724,1}.a3))
\rightarrow [simplify]
[43.1] div3 == div(heapIs $heap_{funcstart\_724.1}, $heap_{funcstart\_724.1}.p3,
asType < int > (\$heap_{funcstart\_724,1}.a3))
\rightarrow [const static or extern object]
[43.2] div3 == div(heapIs $heap_{funcstart\_724,1}$, $heap_{funcstart\_724,1}$.p3,
asType < int > (\$heap_{init}.a3))
\rightarrow [expand definition of constant 'a3' at prang.c (26,20)]
[43.3] \ \mathrm{div3} == \ \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3},
asType<int>(asType<short int>((int)178)))
\rightarrow [simplify]
[43.6] \text{ div3} == \text{div}(\mathbf{heapIs} \$ heap_{funcstart\_724,1}, \$ heap_{funcstart\_724,1}.p3, 178)
[Take given term]
[59.0] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1.quot})) \ * \ \mathbf{asType}{<} \mathbf{int}{>} (\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177
[59.1] \theta == 
int>((asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},
```

```
\rho_{tuncstart=724.1.p1, 177).rem} * asType<int>(\rho_{tuncstart=724.1.r1}) -
(asType < int > (asType < short int > (div1.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [simplify]
[59.3] \text{sheap}_{724,1;745,8} == \text{sheap}_{funcstart\_724,1}.\_replace(p1 \rightarrow asType < short)
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType < int > (\$heap_{funcstart\_724.1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
\rightarrow [const static or extern object]
[59.4] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724.1}, \$heap_{funcstart\_724.1}, p1, 177).rem *
asType < int > (\$heap_{init}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType<int>($heap_{tuncstart, 724,1}.b1))))
\rightarrow [expand definition of constant 'r1' at prang.c (15,20)]
[59.5] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
\mathbf{int} > ((\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, \ 177).\operatorname{rem} \ *
asType<int>(asType<short int>((int)171))) -
(asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [simplify]
[59.8] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int > ((div(heapIs \$heap_{funcstart\_724.1}, \$heap_{funcstart\_724.1}, p1, 177).rem * 171)
- (asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart_724,1},
heap_{funcstart_{724,1}}.p1, 177
[59.9] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int > ((171 * div(heapIs \$heap_{funcstart\_724.1}, \$heap_{funcstart\_724.1}, p1, 177).rem)
- (asType<int>(asType<short int>(div(heapIs $heap_{funcstart_724,1},))
heap_{funcstart_{-724,1}.p1, 177}.quot) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [simplify]
[59.11] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((171 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)
- (div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, 177).quot *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [const static or extern object]
[59.12] heap_{724,1;745,8} == heap_{funcstart\_724,1}. replace(p1 \rightarrow asType<short
int>((171 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\textbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
```

```
asType < int > (\$heap_{init}.b1)))
\rightarrow [expand definition of constant 'b1' at prang.c (17,20)]
[59.13] heap_{724,1;745,8} == heap_{funcstart\_724,1}. replace(p1 \rightarrow asType<short
int>((171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType<int>(asType<short int>((int)2))))
\rightarrow [simplify]
[59.19] $\text{heap}_{724.1:745.8} == $\text{heap}_{funcstart_724.1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{rem})))
[Take given term]
[63.0] $\text{heap}_{724,1:747.8} == $\text{heap}_{724,1:745.8}._\text{replace}(p2 \to \text{asType} < \text{short}
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724.1:745.8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType< int>($heap_{724,1;745,8}.b2))))
\rightarrow [from term 59.19, $heap<sub>724,1:745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart_{-724,1},p1,\ 177}.\text{quot}) + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart_{-724,1}})
heap_{funcstart_{-724,1}}.p1, 177).rem)
[63.1] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
(177).rem))._replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724,1:745,8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType< int>($heap_{724,1;745.8}.b2))))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1}}.p2, 176
[63.2] $\text{heap}_{724,1;747,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem))).\_replace(p2 \rightarrow asType < short
\mathbf{int}{>}((\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{short}\ \mathbf{int}{>}(\mathbf{div}(\mathbf{heapIs}\ \$\mathbf{heap}_{funcstart\_724,1},
\text{sheap}_{funcstart\_724,1.p2, 176}.\text{rem}) * asType < int > (\text{sheap}_{724,1:745.8.r2})) -
(asType<int>(asType<short int>(div2.quot)) *
asType < int > (\$heap_{724,1:745,8}.b2))))
\rightarrow [simplify]
[63.4] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
(177).rem))._replace(p2 \rightarrow asType<short int>((div(heapIs)
```

```
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem *
asType < int > (\$heap_{724,1:745,8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724,1:745,8</sub>.b2))))
\rightarrow [from term 59.19, $heap<sub>724,1;745,8</sub> is equal to
heap_{funcstart\_724.1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724.1}),
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1}, 177).quot) + (171 * div(heapIs $heap_{funcstart\_724,1}, 17
heap_{funcstart\_724,1}.p1, 177).rem))
[63.5] heap_{724,1;747,8} == heap_{funcstart\_724,1}.\_replace(p1 \to ((-2 * 
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((\operatorname{div}(\mathbf{heapIs}))))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem *
asType < int > (\$heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * div(heapIs))))))
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
\text{Sheap}_{funcstart_{-724,1}}, \text{Sheap}_{funcstart_{-724,1}}.p1, 177).rem))).r2)) -
(asType<int>(asType<short int>(div2.quot)) *
asType < int > (\$heap_{724,1;745,8}.b2))))
→ [const member of object with modified fields]
[63.6] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem *
asType < int > (\$heap_{tuncstart\_724.1}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [const static or extern object]
[63.7] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
e_{funcstart\_724,1}, e_{funcstart\_724,1.p2, 176}.rem *
asType < int > (\$heap_{init}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType< int>($heap_{724,1;745,8}.b2))))
\rightarrow [expand definition of constant 'r2' at prang.c (20,20)]
[63.8] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
(177).rem))._replace(p2 \rightarrow asType<short int>((div(heapIs)))._replace(p2 \rightarrow asType
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem *
asType<int>(asType<short int>((int)172))) -
(asType<int>(asType<short int>(div2.quot)) *
asType < int > (\$heap_{724,1;745,8}.b2))))
```

```
\rightarrow [simplify]
[63.11] $\text{heap}_{724,1:747,8} == \text{$heap}_{funcstart\_724,1}._\text{$replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, 176).rem * 172) –
(asType<int>(asType<short int>(div2.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{b2}))))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{tuncstart\_724.1},
$heap_{tuncstart_{724,1}}.p2, 176)]
[63.12] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724.1}, \ \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((172 * div(\mathbf{heapIs}))))
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}.p2, 176).rem) –
(asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},))
\text{sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot})) * asType < int > (\text{sheap}_{724,1;745,8}.\text{b2}))))
\rightarrow [simplify]
[63.14] $\text{heap}_{724,1;747,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(\text{p1} \to ((-2 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724.1}, \ \$heap_{funcstart\_724.1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}.p2, 176).quot
asType < int > (\$heap_{724,1:745,8}.b2))))
\rightarrow [from term 59.19, $heap<sub>724,1;745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724,1}),
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177).rem)
[63.15] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\label{eq:div_heap} \text{div}(\textbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).rem))).\_\mathbf{replace}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((172\ ^*\ \mathrm{div}(\mathbf{heapIs}
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs)
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot *
\mathbf{asType}{<}\mathbf{int}{>}(\$\text{heap}_{funcstart\_724,1}.\mathbf{\_replace}(\text{p1} \rightarrow ((\text{-2} * \text{div}(\mathbf{heapIs}
\text{Sheap}_{funcstart_{-724,1}}, \text{Sheap}_{funcstart_{-724,1}}, \text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs}))
\text{Sheap}_{funcstart_{-724,1}}, \text{Sheap}_{funcstart_{-724,1}}.p1, 177).rem))).b2))))
\rightarrow [const member of object with modified fields]
[63.16] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
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177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p2, 176).rem) - (div(\textbf{heapIs}
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 2, 176).quot *
asType < int > (\$heap_{funcstart\_724,1}.b2)))
\rightarrow [const static or extern object]
[63.17] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}. \operatorname{pl},
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem}) - (\text{div}(\text{heapIs})
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1},p2,176}, quot *
asType < int > (\$heap_{init}.b2))))
\rightarrow [expand definition of constant 'b2' at prang.c (22,20)]
[63.18] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
\text{Sheap}_{funcstart_{-724,1}}, \text{Sheap}_{funcstart_{-724,1}}.p2, 176).quot *
asType<int>(asType<short int>((int)35)))))
\rightarrow [simplify]
[63.24] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2}, 176).quot) + (172 * div(heapIs \rho_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p2, 176).rem}
[Take given term]
[67.0] $\text{heap}_{724,1;749,8} == $\text{heap}_{724,1;747,8}._\text{replace}(p3 \to \text{asType} < \text{short}
int>((asType<int>(asType<short int>(div3.rem)) *
asType < int > (\$heap_{724,1:747,8}.r3)) - (asType < int > (asType < short)
\mathbf{int}{>}(\text{div3.quot})) * \mathbf{asType}{<} \mathbf{int}{>} (\$\text{heap}_{724,1;747,8}.\text{b3}))))
\rightarrow [from term 63.24, $heap<sub>724,1;747,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs *heap_{funcstart\_724,1},
\text{Sheap}_{funcstart_{-724,1},p1, 177}.\text{quot}) + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart_{-724,1}})
\rho_{uncstart_{-724,1}.p1, 177).rem})._replace\rho_{uncstart_{-724,1}.p1, 177).rem}._replace\rho_{uncstart_{-724,1}.p1, 177).rem}
heap_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}
\$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p2, 176).rem))]
[67.1] $\text{heap}_{724,1;749,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
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177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2, 176}.rem))._replace(p3 \rightarrow asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType < int > (\$heap_{724,1:747,8}.r3)) - (asType < int > (asType < short)
int > (div3.quot)) * asType < int > ($heap_{724,1:747.8}.b3))))
\rightarrow [from term 43.6, div3 is equal to div(heapIs $heap_{tuncstart_{724.1}},
heap_{funcstart_{-724,1}}.p3, 178
[67.2] $heap<sub>724,1:749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}. p1, \ 177). \operatorname{quot}) + (171 *
\label{eq:div_heap} \text{div}(\textbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{tuncstart_{-724,1},p2, 176,rem})._replace(p3 \rightarrow asType<short
int>((asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},
\text{sheap}_{funcstart-724,1.p3}, 178).rem) * asType<int>(\text{sheap}_{724,1:747,8.r3})) -
(asType<int>(asType<short int>(div3.quot)) *
asType<int>($heap<sub>724.1:747.8</sub>.b3))))
\rightarrow [simplify]
[67.4] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{tuncstart_724.1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2, 176).rem})).\_replace(p3 \rightarrow asType < hort)
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem *
asType < int > (\$heap_{724.1:747.8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap<sub>724.1:747.8</sub>.b3))))
\rightarrow [from term 63.24, $heap<sub>724,1;747,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.p1, 177).quot) + (171 * div(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).rem))._replace(p2 \rightarrow (-35 * div(heapIs)))._
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem))]
[67.5] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs \rho_{tart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2, 176}.rem))._replace(p3 \rightarrow asType<short
int>((\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.p3, 178).\text{rem} *
asType < int > (\$heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * div(heapIs)))))))
\$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).quot) + (171 * div(\textbf{heapIs})
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\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).rem))).\_replace(p2 \rightarrow ((-35))
* div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p2, \ 176).quot) + (172 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p2}, \ 176).\operatorname{rem}))).\operatorname{r3})) \ -
(asType<int>(asType<short int>(div3.quot)) '
asType < int > (\$heap_{724,1;747,8}.b3))))
→ [const member of object with modified fields]
[67.7] $\text{heap}_{724,1;749,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{funcstart\_724,1}.p2, 176).rem))._replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem *
asType < int > (\$heap_{funcstart\_724,1}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType< int>($heap_{724,1:747,8}.b3))))
\rightarrow [const static or extern object]
[67.8] heap_{724,1;749,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart} \ 724.1, \ \$ \operatorname{heap}_{funcstart} \ 724.1, \ p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{uncstart_{724.1},p2,176}.rem)._replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem *
asType < int > (\$heap_{init}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType< int>($heap_{724.1:747.8}.b3))))
\rightarrow [expand definition of constant 'r3' at prang.c (25,20)]
[67.9] \rho_{7.9} = \rho_{7.9,1749,8} = \rho_{1.749,8} = \rho_{1.749
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724.1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724.1},
\rho_{tuncstart\_724.1.p2, 176}.rem))._replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem *
asType<int>(asType<short int>((int)170))) -
(asType<int>(asType<short int>(div3.quot)) *
asType < int > (\$heap_{724.1:747.8}.b3)))
\rightarrow [simplify]
[67.12] $\text{heap}_{724,1;749,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
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\rho_{funcstart=724.1.p2, 176}.rem)._replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem * 170)
- (asType < int > (asType < short int > (div3.quot))*
asType < int > (\$heap_{724,1;747,8}.b3))))
\rightarrow [from term 43.6, div3 is equal to div(heapIs $heap_{funcstart_724.1},
heap_{funcstart_{724,1}}.p3, 178
[67.13] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{tuncstart}, 724.1,
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{funcstart\_724,1.p2, 176}.rem)._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) -
(asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},))
\text{sheap}_{funcstart\_724,1.p3}, 178).\text{quot}) * asType<int>(\text{sheap}_{724,1;747,8.b3}))))
\rightarrow [simplify]
[67.15] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart} \ 724.1, \ \$ \operatorname{heap}_{funcstart} \ 724.1, \ p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{tuncstart_724.1}.p2, 176).rem))._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) –
(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} *
asType<int>($heap<sub>724.1:747.8</sub>.b3))))
\rightarrow [from term 63.24, $heap<sub>724,1;747,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1},
\rho_{uncstart\_724,1}.p1, 177).rem))._replace\rho_{uncstart\_724,1}.p1, 177).rem))._replace
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 2, 176).rem
[67.16] $\text{heap}_{724.1:749.8} == $\text{heap}_{funcstart_724.1}.$\text{-replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart_{-724,1},p2, 176}.quot) + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart_{-724,1}},
\rho_{funcstart\_724,1}.p2, 176).rem))._replace(p3 \rightarrow asType<short int>((170)
* \operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p3, \ 178).rem) -
(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} *
asType < int > (\$heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * div(heapIs)))))))
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1},p1, 177}.quot) + (171 * div(heapIs)
\rho_{tuncstart\_724,1}, \rho_{tuncstart\_724,1}, \rho_{tuncstart\_724,1}, \rho_{tuncstart\_724,1}, \rho_{tuncstart\_724,1}, \rho_{tuncstart\_724,1}
* div(heapIs heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 176).quot) + (172 *
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\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p2}, \ 176).\operatorname{rem}))).\operatorname{b3}))))
→ [const member of object with modified fields]
[67.18] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{tuncstart\_724,1.p2, 176}.rem)._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) –
(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} *
asType < int > (\$heap_{funcstart\_724,1}.b3))))
\rightarrow [const static or extern object]
[67.19] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{uncstart\_724,1.p2, 176).rem}))._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) -
(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{init}.\mathrm{b3}))))
\rightarrow [expand definition of constant 'b3' at prang.c (27,20)]
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\theta_{funcstart\_724,1.p2}, 176).quot) + (172 * div(heapIs \theta_{funcstart\_724,1},
\theta_{funcstart\_724,1}.p2, 176).rem))._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) –
(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).quot *
asType<int>(asType<short int>((int)63)))))
\rightarrow [simplify]
[67.26] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724.1.p2}, 176).rem))._replace(p3 \rightarrow ((-63 * div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs}))
\$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem)))
[Take goal term]
```

```
[1.0] minof(int) \leq $heap<sub>724.1:749.8</sub>.M1
\rightarrow [simplify]
[1.1] -32768 \leq $heap<sub>724.1:749.8</sub>.M1
\rightarrow [from term 67.26, $heap<sub>724.1:749.8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs p_{funcstart\_724,1})
\rho_{uncstart\_724,1}.p1, 177).rem))).\_replace(p2 \rightarrow ((-35 * div(heapIs))).\_replace(p2 \rightarrow ((-35 * div(heapIs)))).\_replace(p2 \rightarrow ((-35 * div(heapIs)))).\_replace(p2 \rightarrow ((-35 * div(heapIs)))))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}.p2, 176).rem))).\_replace(p3 \rightarrow (-63 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).quot) + (170 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).rem))]
[1.2] -32768 \leq $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 * div(heapIs
\$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).quot) + (171 * div(\textbf{heapIs}) + (171 * div(\textbf{heapIs})) + (171
\rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}
* div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, p2, 176).quot) + (172 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p2,
176).rem)))._replace(p3 \rightarrow ((-63 * div(heapIs $heap_{funcstart\_724,1},
\rho_{funcstart\_724,1.p3}, 178).quot) + (170 * div(heapIs \rho_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p3, 178.rem})).M1
\rightarrow [const member of object with modified fields]
[1.5] -32768 \le \text{$heap}_{funcstart\ 724.1}.M1
\rightarrow [const static or extern object]
[1.6] -32768 < \text{$heap}_{init}.M1
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[1.7] - 32768 \le asType \le short int > ((int) 30269)
\rightarrow [simplify]
[1.10] true
Proof of verification condition: Type constraint satisfied in implicit
conversion from 'short int const' to 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (68,27)
Condition defined at:
To prove: heap_{724,1;749,8}.M1 \le maxof(int)
Given:
heap_{init}.LIMIT == (int)80
\theta
\theta_{init}.r1 == asType < short int > ((int)171)
```

```
heap_{init}.a1 == asType < short int > ((int)177)
\theta = asType < short int > ((int)2)
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
\theta_{init}.a2 == asType<short int>((int)176)
heap_{init}.b2 == asType<short int>((int)35)
\theta = asType < short int > ((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta
\theta
\theta = asType < short int > ((int)3)
invariant
1(heap<br/>Is \rho_{funcstart\_724,1}
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
(asType<integer>(asType<int>($heap_{funcstart\_724,1}.p1)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p1) = =
asType<integer>(div1.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a1) \le
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}),
asType < int > (\$heap_{funcstart\_724,1}.a2))
(asType<integer>(asType<int>($heap_{tuncstart\_724,1}.p2)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
```

```
asType<integer>(div2.quot)
(asType < int > (asType < int > (\$heap_{funcstart\_724,1}.p2)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.rem)
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) <
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a2})) = >
(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p2) ==
asType<integer>(div2.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a2}) \leq
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2})) = > !(0 = =
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
\label{eq:div3} \text{div3} == \text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1},
\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}),
asType < int > (\$heap_{funcstart\_724.1}.a3))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) \%
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a3}))) = =
asType<integer>(div3.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a3) \le
asType < integer > (\$heap_{funcstart\_724,1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
\$heap_{724,1;745,8} == \$heap_{funcstart\_724,1}.\_\mathbf{replace}(p1 \rightarrow \mathbf{asType} < \mathbf{short}
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType<int>($heap_{funcstart\_724,1}.b1)))
-asType<integer const>($heap_{724,1:745,8}.M1) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{p1})
!(0 == asType < integer > (\$heap_{724,1;745,8}.p1))
asType<integer>($heap<sub>724.1:745.8</sub>.p1) <
asType<integer>($heap<sub>724.1:745.8</sub>.M1)
```

```
heap_{724,1;747,8} == heap_{724,1;745,8}.replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{724,1;745,8}.\mathbf{r2})) - (\mathbf{asType} < \mathbf{int} > (\mathbf{asType} < \mathbf{short}))
int>(div2.quot)) * asType< int>($heap_{724,1;745.8}.b2))))
-asType<integer const>($heap<sub>724.1:747.8</sub>.M2) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;747,8}.\mathrm{p2})
!(0 == asType < integer > (\$heap_{724,1;747,8}.p2))
asType<integer>($heap<sub>724,1:747,8</sub>.p2) <
asType<integer>($heap<sub>724,1:747,8</sub>.M2)
\$heap_{724,1;749,8} == \$heap_{724,1;747,8}. \textbf{\_replace}(p3 \rightarrow \textbf{asType} {<} \textbf{short}
int>((asType<int>(asType<short int>(div3.rem)) *
asType < int > (\$heap_{724.1:747.8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap<sub>724,1:747,8</sub>.b3))))
-{\bf asType}{<} {\bf integer~const}{>} (\${\rm heap}_{724,1;749,8}.{\rm M3}) <
asType<integer>($heap<sub>724.1:749.8</sub>.p3)
!(0 == asType < integer > (\$heap_{724,1;749,8}.p3))
asType<integer>($heap<sub>724,1:749,8</sub>.p3) <
asType<integer>($heap<sub>724,1:749,8</sub>.M3)
Proof:
[Take given term]
[11.0] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
\rightarrow [simplify]
[11.1] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType < int > (\$heap_{funcstart\_724.1}.a1))
\rightarrow [const static or extern object]
[11.2] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType < int > (\$heap_{init}.a1))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
[11.3] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType<int>(asType<short int>((int)177)))
\rightarrow [simplify]
[11.6] div1 == div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1, 177)
[Take given term]
[27.0] div2 == div(heapIs $heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
```

```
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
\rightarrow [simplify]
[27.1] \operatorname{div2} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p2,
asType < int > (\$heap_{funcstart\_724,1}.a2))
\rightarrow [const static or extern object]
\label{eq:continuous} \mbox{\sc [27.2] div2} == \mbox{\sc div} (\mathbf{heapIs} \ \$\mbox{\sc heap}_{funcstart\_724,1}, \ \$\mbox{\sc heap}_{funcstart\_724,1}.\mbox{\sc p2},
asType < int > (\$heap_{init}.a2))
\rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
[27.3] \operatorname{div2} == \operatorname{div}(\mathbf{heapIs} \ \text{$heap}_{funcstart\_724,1}, \ \text{$heap}_{funcstart\_724,1}.p2,
asType<int>(asType<short int>((int)176)))
\rightarrow [simplify]
[27.6] \text{ div2} == \text{div}(\text{heapIs } \text{$heap}_{funcstart\_724,1}, \text{$heap}_{funcstart\_724,1}.p2, 176)
[Take given term]
[43.0] div3 == div(heapIs \theta_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
asType < int > (\$heap_{funcstart\_724,1}.a3))
\rightarrow [simplify]
[43.1] div3 == div(heapIs $heap_{funcstart\_724.1}, $heap_{funcstart\_724.1}.p3,
asType < int > (\$heap_{funcstart\_724,1}.a3))
\rightarrow [const static or extern object]
[43.2] div3 == div(heapIs $heap_{funcstart\_724,1}$, $heap_{funcstart\_724,1}$.p3,
asType < int > (\$heap_{init}.a3))
\rightarrow [expand definition of constant 'a3' at prang.c (26,20)]
[43.3] \ \mathrm{div3} == \ \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3},
asType<int>(asType<short int>((int)178)))
\rightarrow [simplify]
[43.6] \text{ div3} == \text{div}(\mathbf{heapIs} \$ heap_{funcstart\_724,1}, \$ heap_{funcstart\_724,1}.p3, 178)
[Take given term]
[59.0] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1.quot})) \ * \ \mathbf{asType}{<} \mathbf{int}{>} (\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177
[59.1] \theta == 
int>((asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},
```

```
\rho_{tuncstart=724.1.p1, 177).rem} * asType<int>(\rho_{tuncstart=724.1.r1}) -
(asType < int > (asType < short int > (div1.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [simplify]
[59.3] \text{sheap}_{724,1;745,8} == \text{sheap}_{funcstart\_724,1}.\_replace(p1 \rightarrow asType < short)
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType < int > (\$heap_{funcstart\_724.1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
\rightarrow [const static or extern object]
[59.4] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724.1}, \$heap_{funcstart\_724.1}, p1, 177).rem *
asType < int > (\$heap_{init}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType<int>($heap_{tuncstart, 724,1}.b1))))
\rightarrow [expand definition of constant 'r1' at prang.c (15,20)]
[59.5] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
\mathbf{int} > ((\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, \ 177).\operatorname{rem} \ *
asType<int>(asType<short int>((int)171))) -
(asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [simplify]
[59.8] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int > ((div(heapIs \$heap_{funcstart\_724.1}, \$heap_{funcstart\_724.1}, p1, 177).rem * 171)
- (asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart_724,1},
heap_{funcstart_{724,1}}.p1, 177
[59.9] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int > ((171 * div(heapIs \$heap_{funcstart\_724.1}, \$heap_{funcstart\_724.1}, p1, 177).rem)
- (asType<int>(asType<short int>(div(heapIs $heap_{funcstart_724,1},))
heap_{funcstart_{-724,1}.p1, 177}.quot) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [simplify]
[59.11] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((171 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)
- (div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, 177).quot *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [const static or extern object]
[59.12] heap_{724,1;745,8} == heap_{funcstart\_724,1}. replace(p1 \rightarrow asType<short
int>((171 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\textbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
```

```
asType < int > (\$heap_{init}.b1)))
\rightarrow [expand definition of constant 'b1' at prang.c (17,20)]
[59.13] heap_{724,1;745,8} == heap_{funcstart\_724,1}. replace(p1 \rightarrow asType<short
int>((171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType<int>(asType<short int>((int)2))))
\rightarrow [simplify]
[59.19] $\text{heap}_{724.1:745.8} == $\text{heap}_{funcstart_724.1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{rem})))
[Take given term]
[63.0] $\text{heap}_{724,1:747.8} == $\text{heap}_{724,1:745.8}._\text{replace}(p2 \to \text{asType} < \text{short}
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724.1:745.8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType< int>($heap_{724,1;745,8}.b2))))
\rightarrow [from term 59.19, $heap<sub>724,1:745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart_{-724,1},p1,\ 177}.\text{quot}) + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart_{-724,1}})
heap_{funcstart_{-724,1}}.p1, 177).rem)
[63.1] \theta == 
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
(177).rem))._replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724,1:745,8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType< int>($heap_{724,1;745.8}.b2))))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1}}.p2, 176
[63.2] $\text{heap}_{724,1;747,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem))).\_replace(p2 \rightarrow asType < short
\mathbf{int}{>}((\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{short}\ \mathbf{int}{>}(\mathbf{div}(\mathbf{heapIs}\ \$\mathbf{heap}_{funcstart\_724,1},
\text{sheap}_{funcstart\_724,1.p2, 176}.\text{rem}) * asType < int > (\text{sheap}_{724,1:745.8.r2})) -
(asType<int>(asType<short int>(div2.quot)) *
asType < int > (\$heap_{724,1:745,8}.b2))))
\rightarrow [simplify]
[63.4] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
(177).rem))._replace(p2 \rightarrow asType<short int>((div(heapIs)
```

```
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem *
asType < int > (\$heap_{724,1:745,8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724,1:745,8</sub>.b2))))
\rightarrow [from term 59.19, $heap<sub>724,1;745,8</sub> is equal to
heap_{funcstart\_724.1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724.1}),
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1}, 177).quot) + (171 * div(heapIs $heap_{funcstart\_724,1}, 17
heap_{funcstart\_724,1}.p1, 177).rem))
[63.5] heap_{724,1;747,8} == heap_{funcstart\_724,1}.\_replace(p1 \to ((-2 * 
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((\operatorname{div}(\mathbf{heapIs}))))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem *
asType < int > (\$heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * div(heapIs))))))
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
\text{Sheap}_{funcstart_{-724,1}}, \text{Sheap}_{funcstart_{-724,1}}.p1, 177).rem))).r2)) -
(asType<int>(asType<short int>(div2.quot)) *
asType < int > (\$heap_{724,1;745,8}.b2))))
→ [const member of object with modified fields]
[63.6] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem *
asType < int > (\$heap_{tuncstart\_724.1}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [const static or extern object]
[63.7] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
e_{funcstart\_724,1}, e_{funcstart\_724,1.p2, 176}.rem *
asType < int > (\$heap_{init}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType< int>($heap_{724,1;745,8}.b2))))
\rightarrow [expand definition of constant 'r2' at prang.c (20,20)]
[63.8] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
(177).rem))._replace(p2 \rightarrow asType<short int>((div(heapIs)))._replace(p2 \rightarrow asType
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem *
asType<int>(asType<short int>((int)172))) -
(asType<int>(asType<short int>(div2.quot)) *
asType < int > (\$heap_{724,1;745,8}.b2))))
```

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\rightarrow [simplify]
[63.11] $\text{heap}_{724,1:747,8} == $\text{heap}_{funcstart_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, 176).rem * 172) –
(asType<int>(asType<short int>(div2.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{b2}))))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{tuncstart\_724.1},
$heap_{tuncstart_{724,1}}.p2, 176)]
[63.12] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724.1}, \ \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((172 * div(\mathbf{heapIs}))))
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1},p2, 176}.rem) –
(asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},))
\text{sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot})) * asType < int > (\text{sheap}_{724,1;745,8}.\text{b2}))))
\rightarrow [simplify]
[63.14] $\text{heap}_{724,1;747,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(\text{p1} \to ((-2 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724.1}, \ \$heap_{funcstart\_724.1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}.p2, 176).quot
asType < int > (\$heap_{724,1:745,8}.b2))))
\rightarrow [from term 59.19, $heap<sub>724,1;745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724,1}),
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177).rem)
[63.15] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\label{eq:div_heap} \text{div}(\textbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).rem))).\_\mathbf{replace}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((172\ ^*\ \mathrm{div}(\mathbf{heapIs}
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs)
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot *
\mathbf{asType}{<}\mathbf{int}{>}(\$\text{heap}_{funcstart\_724,1}.\mathbf{\_replace}(\text{p1} \rightarrow ((\text{-2} * \text{div}(\mathbf{heapIs}
\text{Sheap}_{funcstart_{-724,1}}, \text{Sheap}_{funcstart_{-724,1}}, \text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs}))
\text{Sheap}_{funcstart_{-724,1}}, \text{Sheap}_{funcstart_{-724,1}}.p1, 177).rem))).b2))))
\rightarrow [const member of object with modified fields]
[63.16] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
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177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p2, 176).rem) - (div(\textbf{heapIs}
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 2, 176).quot *
asType < int > (\$heap_{funcstart\_724,1}.b2)))
\rightarrow [const static or extern object]
[63.17] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}. \operatorname{pl},
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem}) - (\text{div}(\text{heapIs})
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1},p2,176}, quot *
asType < int > (\$heap_{init}.b2))))
\rightarrow [expand definition of constant 'b2' at prang.c (22,20)]
[63.18] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
\text{Sheap}_{funcstart_{-724,1}}, \text{Sheap}_{funcstart_{-724,1}}.p2, 176).quot *
asType<int>(asType<short int>((int)35)))))
\rightarrow [simplify]
[63.24] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2}, 176).quot) + (172 * div(heapIs \rho_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p2, 176).rem}
[Take given term]
[67.0] $\text{heap}_{724,1;749,8} == $\text{heap}_{724,1;747,8}._\text{replace}(p3 \to \text{asType} < \text{short}
int>((asType<int>(asType<short int>(div3.rem)) *
asType < int > (\$heap_{724,1:747,8}.r3)) - (asType < int > (asType < short)
\mathbf{int}{>}(\text{div3.quot})) * \mathbf{asType}{<} \mathbf{int}{>} (\$\text{heap}_{724,1;747,8}.\text{b3}))))
\rightarrow [from term 63.24, $heap<sub>724,1;747,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs *heap_{funcstart\_724,1},
\text{Sheap}_{funcstart_{-724,1},p1, 177}.\text{quot}) + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart_{-724,1}})
\rho_{uncstart_{-724,1}.p1, 177).rem})._replace\rho_{uncstart_{-724,1}.p1, 177).rem}._replace\rho_{uncstart_{-724,1}.p1, 177).rem}
heap_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}
\$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p2, 176).rem))]
[67.1] $\text{heap}_{724,1;749,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
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177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2, 176}.rem))._replace(p3 \rightarrow asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType < int > (\$heap_{724,1:747,8}.r3)) - (asType < int > (asType < short)
int > (div3.quot)) * asType < int > ($heap_{724,1:747.8}.b3))))
\rightarrow [from term 43.6, div3 is equal to div(heapIs $heap_{tuncstart_{724.1}},
heap_{funcstart_{-724,1}}.p3, 178
[67.2] $heap<sub>724,1:749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}. p1, \ 177). \operatorname{quot}) + (171 *
\label{eq:div_heap} \text{div}(\textbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{tuncstart_{-724,1},p2, 176,rem})._replace(p3 \rightarrow asType<short
int>((asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},
\text{sheap}_{funcstart-724,1.p3}, 178).rem) * asType<int>(\text{sheap}_{724,1:747,8.r3})) -
(asType<int>(asType<short int>(div3.quot)) *
asType<int>($heap<sub>724.1:747.8</sub>.b3))))
\rightarrow [simplify]
[67.4] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{tuncstart_724.1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2, 176).rem})).\_replace(p3 \rightarrow asType < hort)
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem *
asType < int > (\$heap_{724.1:747.8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap<sub>724.1:747.8</sub>.b3))))
\rightarrow [from term 63.24, $heap<sub>724,1;747,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.p1, 177).quot) + (171 * div(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).rem))._replace(p2 \rightarrow (-35 * div(heapIs)))._
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem))]
[67.5] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heap
Is \rho_{tart\_724,1}
\rho_{funcstart\_724,1.p2}, 176).quot) + (172 * div(heapIs \rho_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2, 176}.rem))._replace(p3 \rightarrow asType<short
int>((\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.p3, 178).\text{rem} *
asType < int > (\$heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * div(heapIs)))))))
\$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).quot) + (171 * div(\textbf{heapIs})
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\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).rem))).\_replace(p2 \rightarrow ((-35))
* div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p2, \ 176).quot) + (172 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p2}, \ 176).\operatorname{rem}))).\operatorname{r3})) \ -
(asType<int>(asType<short int>(div3.quot)) '
asType < int > (\$heap_{724,1;747,8}.b3))))
→ [const member of object with modified fields]
[67.7] $\text{heap}_{724,1;749,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{funcstart\_724,1}.p2, 176).rem))._replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem *
asType < int > (\$heap_{funcstart\_724,1}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType< int>($heap_{724,1:747,8}.b3))))
\rightarrow [const static or extern object]
[67.8] heap_{724,1;749,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart} \ 724.1, \ \$ \operatorname{heap}_{funcstart} \ 724.1, \ p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{uncstart_{724.1},p2,176}.rem)._replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem *
asType < int > (\$heap_{init}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType< int>($heap_{724.1:747.8}.b3))))
\rightarrow [expand definition of constant 'r3' at prang.c (25,20)]
[67.9] \rho_{7.9} = \rho_{7.9}
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724.1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724.1},
\rho_{tuncstart\_724.1.p2, 176}.rem))._replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem *
asType<int>(asType<short int>((int)170))) -
(asType<int>(asType<short int>(div3.quot)) *
asType < int > (\$heap_{724.1:747.8}.b3)))
\rightarrow [simplify]
[67.12] $\text{heap}_{724,1;749,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
```

```
\rho_{funcstart=724.1.p2, 176}.rem)._replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem * 170)
- (asType < int > (asType < short int > (div3.quot))*
asType < int > (\$heap_{724,1;747,8}.b3))))
\rightarrow [from term 43.6, div3 is equal to div(heapIs $heap_{funcstart_724.1},
heap_{funcstart_{724,1}}.p3, 178
[67.13] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{tuncstart}, 724.1,
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{funcstart\_724,1.p2, 176}.rem)._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) -
(asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},))
\text{sheap}_{funcstart\_724,1.p3}, 178).\text{quot}) * asType<int>(\text{sheap}_{724,1;747,8.b3}))))
\rightarrow [simplify]
[67.15] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart} \ 724.1, \ \$ \operatorname{heap}_{funcstart} \ 724.1, \ p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{tuncstart_724.1}.p2, 176).rem))._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) –
(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} *
asType<int>($heap<sub>724.1:747.8</sub>.b3))))
\rightarrow [from term 63.24, $heap<sub>724,1;747,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1},
\rho_{uncstart\_724,1}.p1, 177).rem))._replace\rho_{uncstart\_724,1}.p1, 177).rem))._replace
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 2, 176).rem
[67.16] $\text{heap}_{724.1:749.8} == $\text{heap}_{funcstart_724.1}.$\text{-replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart_{-724,1},p2, 176}.quot) + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart_{-724,1}},
\rho_{funcstart\_724,1}.p2, 176).rem))._replace(p3 \rightarrow asType<short int>((170)
* \operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p3, \ 178).rem) -
(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} *
asType < int > (\$heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * div(heapIs)))))))
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1},p1, 177}.quot) + (171 * div(heapIs)
\rho_{tuncstart\_724,1}, \rho_{tuncstart\_724,1}, \rho_{tuncstart\_724,1}, \rho_{tuncstart\_724,1}, \rho_{tuncstart\_724,1}, \rho_{tuncstart\_724,1}
* div(heapIs heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 176).quot) + (172 *
```

```
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p2}, \ 176).\operatorname{rem}))).\operatorname{b3}))))
\rightarrow [const member of object with modified fields]
[67.18] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{tuncstart\_724,1.p2, 176}.rem)._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) –
(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} *
asType < int > (\$heap_{funcstart\_724,1}.b3))))
\rightarrow [const static or extern object]
[67.19] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{uncstart\_724,1.p2, 176).rem}))._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) -
(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{init}.\mathrm{b3}))))
\rightarrow [expand definition of constant 'b3' at prang.c (27,20)]
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\theta_{funcstart\_724,1.p2}, 176).quot) + (172 * div(heapIs \theta_{funcstart\_724,1},
\theta_{funcstart\_724,1.p2, 176}.rem)._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) –
(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).quot *
asType<int>(asType<short int>((int)63)))))
\rightarrow [simplify]
[67.26] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724.1.p2}, 176).rem))._replace(p3 \rightarrow ((-63 * div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs}))
\$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem)))
[Take goal term]
```

```
[1.0] $heap<sub>724,1:749.8</sub>.M1 \leq maxof(int)
\rightarrow [from term 67.26, $heap<sub>724,1:749,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1}, 177).quot) + (171 * div(heapIs $heap_{funcstart\_724,1}, 17
\rho_{funcstart\_724.1.p1, 177).rem}))._replace\rho_{funcstart\_724.1.p1, 177).rem})
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem)))._replace(p3 \rightarrow (-63 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).quot) + (170 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).rem))]
[1.1] heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p1, 177).quot) + (171 * div(heapIs
* div(\mathbf{heapIs} \ \$ heap_{funcstart\_724,1}, \ \$ heap_{funcstart\_724,1}.p2, \ 176).quot) + (172 \ *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p2,
176).rem)))._replace(p3 \rightarrow ((-63 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} + (170 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{rem})).\text{M1} \leq \text{maxof(int)}
\rightarrow [const member of object with modified fields]
[1.4] $\text{heap}_{funcstart_724.1}.\text{M1} \leq \text{maxof(int)}
\rightarrow [const static or extern object]
[1.5] $heap<sub>init</sub>.M1 \leq maxof(int)
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[1.6] asType<short int>((int)30269) < maxof(int)
\rightarrow [simplify]
[1.10] true
Proof of verification condition: Type constraint satisfied in implicit
conversion from 'short int' to 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (68,17)
Condition defined at:
To prove: minof(int) \le \$heap_{724,1:749,8}.p1
Given:
heap_{init}.LIMIT == (int)80
\theta
\theta_{init}.r1 == asType < short int > ((int)171)
\theta
\theta = asType < short int > ((int)2)
```

```
heap_{init}.M2 == asType < short int > ((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
\theta
heap_{init}.b2 == asType<short int>((int)35)
\theta sheap<sub>init</sub>.M3 == asType<short int>((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\rho = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart_{-724,1}})
div1 == div(\mathbf{heapIs} \$ heap_{funcstart\_724.1},
asType < int > (\$heap_{funcstart\_724.1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) /
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}))) = =
asType<integer>(div1.quot)
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \%
asType < integer > (asType < int > (\$heap_{funcstart_{-724.1}}.a1))) = =
asType<integer>(div1.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1})) =>
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) ==
asType<integer>(div1.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a1) \le
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart_{-724.1}},
asType < int > (\$heap_{funcstart\_724,1}.p2),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p2})) \ / \\
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) \%
```

```
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(asType < integer > (\$heap_{funcstart\_724.1}.p2) = =
asType<integer>(div2.rem))
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
(asType<integer>(asType<int>($heap_{tuncstart\_724.1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724.1}.a3))) = =
asType<integer>(div3.quot)
(asType < integer > (asType < int > (\$heap_{tuncstart\_724,1}.p3)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) ==
asType<integer>(div3.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a3}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
\$heap_{724,1;745,8} == \$heap_{funcstart\_724,1}.\_\mathbf{replace}(p1 \rightarrow \mathbf{asType} < \mathbf{short}
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
-\mathbf{asType} {<} \mathbf{integer\ const} {>} (\$ \mathbf{heap}_{724,1;745,8}.\mathbf{M1}) <
asType<integer>($heap<sub>724,1;745,8</sub>.p1)
!(0 == asType < integer > (\$heap_{724,1;745,8}.p1))
asType<integer>($heap<sub>724,1;745,8</sub>.p1) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{M1})
heap_{724,1:747,8} == heap_{724,1:745,8}._replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div2.rem))
```

```
asType < int > (\$heap_{724.1:745.8}.r2)) - (asType < int > (asType < short)
int > (div2.quot)) * asType < int > ($heap_{724,1;745,8}.b2))))
-\mathbf{asType}{<}\mathbf{integer\ const}{>}(\$\mathrm{heap}_{724,1;747,8}.\mathrm{M2}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;747,8}.\mathrm{p2})
!(0 == asType < integer > (\$heap_{724,1;747,8}.p2))
asType<integer>($heap<sub>724,1:747,8</sub>.p2) <
asType<integer>($heap<sub>724,1:747,8</sub>.M2)
\text{heap}_{724.1:749.8} == \text{heap}_{724.1:747.8}._replace(p3 \rightarrow asType<short)
int>((asType<int>(asType<short int>(div3.rem)) *
\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{724,1;747,8}.\mathrm{r3})) - (\mathbf{asType} < \mathbf{int} > (\mathbf{asType} < \mathbf{short}))
int>(div3.quot)) * asType<int>($heap<sub>724.1:747.8</sub>.b3))))
-asType<integer const>($heap<sub>724,1:749,8</sub>.M3) <
asType<integer>($heap<sub>724,1:749,8</sub>.p3)
!(0 == asType < integer > (\$heap_{724,1;749,8}.p3))
asType<integer>($heap<sub>724,1:749,8</sub>.p3) <
asType<integer>($heap<sub>724,1:749,8</sub>.M3)
Proof:
[Take given term]
[11.0] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
\rightarrow [simplify]
[11.1] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
asType < int > (\$heap_{funcstart\_724,1}.a1))
\rightarrow [const static or extern object]
[11.2]~{\rm div1} == {\rm div}(\mathbf{heapIs}~\$ \mathrm{heap}_{funcstart\_724,1},\,\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType < int > (\$heap_{init}.a1))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
[11.3] div1 == div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
asType<int>(asType<short int>((int)177)))
\rightarrow [simplify]
[11.6] div1 == div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177)
[Take given term]
[27.0] div2 == div(heapIs heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
\rightarrow [simplify]
```

```
\label{eq:continuous} \textit{[27.1]} \ \text{div2} == \ \text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p2},
asType < int > (\$heap_{funcstart\_724,1}.a2))
\rightarrow [const static or extern object]
[27.2]~{\rm div2} == {\rm div}(\mathbf{heapIs}~\$ \mathrm{heap}_{funcstart\_724,1},\,\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2},
asType < int > (\$heap_{init}.a2))
\rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
[27.3] \operatorname{div2} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p2,
asType<int>(asType<short int>((int)176)))
\rightarrow [simplify]
[27.6] div2 == div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176)
[Take given term]
[43.0] \operatorname{div3} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a3}))
\rightarrow [simplify]
[43.1] div3 == div(heapIs $heap_{funcstart\_724.1}, $heap_{funcstart\_724.1}.p3,
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
\rightarrow [const static or extern object]
[43.2] \ \mathrm{div3} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3},
asType < int > (\$heap_{init}.a3))
\rightarrow [expand definition of constant 'a3' at prang.c (26,20)]
[43.3] \ \mathrm{div3} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3},
asType<int>(asType<short int>((int)178)))
\rightarrow [simplify]
[43.6] \text{ div3} == \text{div}(\mathbf{heapIs} \$ heap_{funcstart\_724,1}, \$ heap_{funcstart\_724,1}.p3, 178)
[Take given term]
[59.0] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1.quot})) \ * \ \mathbf{asType}{<} \mathbf{int}{>} (\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177
[59.1] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},))
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}) * asType<int>(\text{Sheap}_{funcstart\_724,1}.\text{r1})) -
(asType < int > (asType < short int > (div1.quot)) *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
```

```
\rightarrow [simplify]
[59.3] \rho_{1745,8} == \rho_{1745
int>((\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} *
\mathbf{asType} {<} \mathbf{int} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{r1})) - (\mathbf{asType} {<} \mathbf{int} {>} (\mathbf{asType} {<} \mathbf{short}
int>(div1.quot)) * asType<int>($heap_{funcstart\_724,1}.b1)))
\rightarrow [const static or extern object]
[59.4] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
\mathbf{int}{>}((\mathrm{div}(\mathbf{heapIs}\ \$\mathrm{heap}_{funcstart\_724,1},\ \$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},\ 177).\mathrm{rem}\ *
asType < int > (\$heap_{init}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType<int>($heap_{funcstart\_724,1}.b1)))
\rightarrow [expand definition of constant 'r1' at prang.c (15,20)]
[59.5] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType<int>(asType<short int>((int)171))) -
(asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724.1}.b1))))
\rightarrow [simplify]
[59.8] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem * 171)
- (asType<int>(asType<short int>(div1.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1},p1,177}
[59.9] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
\mathbf{int} > ((171 * \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, 177).\operatorname{rem})
- (asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},)
heap_{funcstart_{724,1}}.p1, 177).quot) *
asType < int > (\$heap_{funcstart\_724.1}.b1))))
\rightarrow [simplify]
[59.11] \theta_{13} = \theta_
int>((171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [const static or extern object]
[59.12] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType < int > (\$heap_{init}.b1)))
\rightarrow [expand definition of constant 'b1' at prang.c (17,20)]
```

```
[59.13] \text{sheap}_{724,1;745,8} == \text{sheap}_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType < int > (asType < short int > ((int)2))))
\rightarrow [simplify]
[59.19] $\text{heap}_{724,1;745,8} == \text{$heap}_{funcstart\_724,1}._\text{$replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).rem)))
[Take given term]
[60.0] -asType<integer const>($heap_{724.1:745.8}.M1) <
asType<integer>($heap<sub>724,1:745,8</sub>.p1)
\rightarrow [from term 59.19, $heap<sub>724,1:745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs p_{funcstart\_724,1}),
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs p_{funcstart\_724,1})
heap_{funcstart_{-724,1}}.p1, 177).rem)
[60.1] -asType<integer const>(p1 \rightarrow (-2 * p1))
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).rem))).M1) <
asType<integer>($heap<sub>724,1;745,8</sub>.p1)
\rightarrow [const member of object with modified fields]
[60.2] -asType<integer const>($heap_tuncstart_724.1.M1) <
asType<integer>($heap<sub>724,1:745,8</sub>.p1)
\rightarrow [const static or extern object]
[60.3] -asType<integer const>($heap_{init}.M1) <
asType<integer>($heap<sub>724,1:745,8</sub>.p1)
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[60.4] -asType<integer const>(asType<short int>((int)30269)) <
asType<integer>($heap<sub>724,1:745,8</sub>.p1)
\rightarrow [simplify]
[60.8] - 30269 < asType < integer > ($heap_{724,1;745,8}.p1)
\rightarrow [from term 59.19, $heap<sub>724.1:745.8</sub> is equal to
heap_{funcstart\_724.1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724.1}),
\text{Sheap}_{funcstart\_724,1}.p1, 177).quot) + (171 * div(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{724,1}.p1, 177).rem}
[60.9] -30269 < asType<integer>($heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724.1}, \ \text{\$heap}_{funcstart\_724.1}.p1, \ 177).rem))).p1)
\rightarrow [simplify]
```

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[60.11] -30269 < ((-2 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1,
177).quot) + (171 * div(heapIs heapI_{funcstart_{724,1}}, heap_{funcstart_{724,1}}.p1,
177).rem))
[Take given term]
[63.0] $\text{heap}_{724,1:747,8} == $\text{heap}_{724,1:745,8}._\text{replace}(p2 \to \text{asType} < \text{short}
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724,1:745,8}.r2)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathrm{div2.quot})) * \mathbf{asType}{<} \mathbf{int}{>} (\$\mathrm{heap}_{724.1:745.8}.\mathrm{b2}))))
\rightarrow [from term 59.19, $heap<sub>724,1;745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177).rem)
[63.1] heap_{724,1;747,8} == heap_{funcstart\_724,1}.\_replace(p1 \to ((-2 * 
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
(177).rem))._replace(p2 \rightarrow asType < short)
int>((asType<int>(asType<short\ int>(div2.rem))*
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{r2})) - (\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{short}
int>(div2.quot)) * asType< int>($heap_{724.1:745.8}.b2))))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p2, 176
[63.2] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
(177).rem))._replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724.1},
\text{sheap}_{funcstart\_724,1.p2, 176}.\text{rem}) * asType < int > (\text{sheap}_{724,1;745,8.r2})) -
(asType<int>(asType<short int>(div2.quot)) *
asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [simplify]
[63.4] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 176).rem *
\mathbf{asType} \small{<} \mathbf{int} \small{>} (\$ \mathrm{heap}_{724,1;745,8}.\mathrm{r2})) \\ - (\mathbf{asType} \small{<} \mathbf{int} \small{>} (\mathbf{asType} \small{<} \mathbf{short}
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [from term 59.19, $heap<sub>724,1:745,8</sub> is equal to
heap_{funcstart\ 724.1}._replace(p1 \rightarrow (-2 * div(heapIs \$heap_{funcstart\ 724.1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1}, 177).quot) + (171 * div(heapIs $heap_{funcstart\_724,1}, 17
heap_{funcstart_{-724,1}}.p1, 177).rem)
```

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[63.5] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\label{eq:div_heap} \text{div}(\textbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
(177).rem))._replace(p2 \rightarrow asType<short int>((div(heapIs)))._replace(p2)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem} *
asType < int > (\$heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * div(heapIs))))))
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1},p1, 177}.rem)).r2)) -
(asType<int>(asType<short int>(div2.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\${\rm heap}_{724,1;745,8}.{\rm b2}))))
→ [const member of object with modified fields]
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((\operatorname{div}(\mathbf{heapIs}))))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem *
asType < int > (\$heap_{funcstart\_724,1}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [const static or extern object]
[63.7] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem *
asType < int > (\$heap_{init}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [expand definition of constant 'r2' at prang.c (20,20)]
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((\operatorname{div}(\mathbf{heapIs}))))
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p_{176}.rem *
asType<int>(asType<short int>((int)172))) -
(asType<int>(asType<short int>(div2.quot)) *
asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [simplify]
[63.11] $\text{heap}_{724,1;747,8} == \text{$heap}_{funcstart\_724,1}._\text{$replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((\operatorname{div}(\mathbf{heapIs}))))
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}.p2, 176).rem * 172) -
(asType<int>(asType<short int>(div2.quot)) *
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asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p2, 176
[63.12] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem) -
(asType < int > (asType < short int > (div(heapIs $heap_{funcstart\_724,1}, 
\text{Sheap}_{funcstart\ 724,1}.p2,\ 176).quot) * asType<int>(\text{Sheap}_{724,1:745,8}.b2))))
\rightarrow [simplify]
[63.14] $\text{heap}_{724,1;747,8} == \text{$heap}_{funcstart\_724,1}._\text{$replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).quot *
asType < int > (\$heap_{724,1;745,8}.b2))))
\rightarrow [from term 59.19, $heap<sub>724.1:745.8</sub> is equal to
heap_{funcstart\_724.1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724.1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177).rem)
[63.15] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs)
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1},p2, 176}.quot *
asType < int > (\$heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * div(heapIs)))))))
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.pl, 177).quot) + (171 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).rem))).b2))))
\rightarrow [const member of object with modified fields]
[63.16] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b2}))))
\rightarrow [const static or extern object]
[63.17] $\text{heap}_{724,1;747,8} == \text{$heap}_{funcstart\_724,1}._\text{$replace}(p1 \to ((-2 *
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\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
p_{funcstart_{-724,1}}, p_{funcstart_{-724,1},p_{2,176}}.quot *
asType < int > (\$heap_{init}.b2))))
\rightarrow [expand definition of constant 'b2' at prang.c (22,20)]
[63.18] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 2, 176).quot *
asType<int>(asType<short int>((int)35)))))
\rightarrow [simplify]
[63.24] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{tuncstart_724.1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p2, 176).rem))
[Take given term]
[67.0] $\text{heap}_{724,1:749,8} == $\text{heap}_{724,1:747.8}._\text{replace}(p3 \to \text{asType} < \text{short}
int>((asType<int>(asType<short int>(div3.rem)) *
asType < int > (\$heap_{724.1:747.8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap<sub>724,1:747,8</sub>.b3))))
\rightarrow [from term 63.24, $heap<sub>724,1;747,8</sub> is equal to
\text{Sheap}_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1}), the sheap funcstart\_724,1).
\text{Sheap}_{funcstart_{-724,1},p1, 177}.\text{quot}) + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart_{-724,1}})
\rho_{funcstart\_724,1}.p1, 177).rem))._replace(p2 \rightarrow (-35 * div(heapIs))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).quot) + (172 * div(\textbf{heapIs})
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, p2, 176).rem)
[67.1] heap_{724,1;749,8} == heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * 
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\theta_{funcstart\_724,1}.p2, 176.quot) + (172 * div(heapIs \theta_{funcstart\_724,1},
\theta_{tuncstart\_724,1}, p2, 176).rem)))._replace(p3 \rightarrow asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType < int > (\$heap_{724,1;747,8}.r3)) - (asType < int > (asType < short)
int > (div3.quot)) * asType < int > (\$heap_{724,1;747,8}.b3))))
\rightarrow [from term 43.6, div3 is equal to div(heapIs $heap_{funcstart_{724,1}},
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heap_{funcstart_{-724,1}}.p3, 178
[67.2] heap_{724,1;749,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{tuncstart_724.1},
\text{Sheap}_{funcstart\_724.1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724.1},
\theta_{funcstart\_724,1}.p2, 176).rem))._replace(p3 \rightarrow asType<short
int>((asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p3}, 178).\text{rem}) * \mathbf{asType} < \mathbf{int} > (\text{Sheap}_{724,1:747,8.r3})) -
(asType<int>(asType<short int>(div3.quot)) *
asType < int > (\$heap_{724,1;747,8}.b3))))
\rightarrow [simplify]
[67.4] heap_{724,1;749,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724.1}, \ \$heap_{funcstart\_724.1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart_{724,1},p2, 176}.quot) + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart_{724,1}},
\theta_{uncstart_724.1.p2, 176}.rem)._replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem *
asType < int > (\$heap_{724,1:747,8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap<sub>724,1:747,8</sub>.b3))))
\rightarrow [from term 63.24, $heap<sub>724,1;747,8</sub> is equal to
\text{Sheap}_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1}), the sheap funcstart\_724,1).
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1}.p1, 177).rem))._replace\rho_{funcstart\_724,1}.p1, 177).rem))._replace
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem)
[67.5] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{funcstart\_724,1}.p2, 176).rem))._replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem *
\mathbf{asType}{<}\mathbf{int}{>}(\$\text{heap}_{funcstart\_724,1}.\_\mathbf{replace}(\text{p1} \rightarrow ((\text{-2} * \text{div}(\mathbf{heapIs}
\text{Sheap}_{funcstart\_724.1}, \text{Sheap}_{funcstart\_724.1}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs})
\$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem))).\_\mathbf{replace}(p2 \rightarrow ((-35), -20)))
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724.1}, \ \text{\$heap}_{funcstart\_724.1}.p2, 176).rem))).r3)) -
(asType<int>(asType<short int>(div3.quot))
asType<int>($heap<sub>724,1;747,8</sub>.b3))))
→ [const member of object with modified fields]
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\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2, 176}.rem))._replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem *
asType < int > (\$heap_{funcstart\_724,1}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap<sub>724.1:747.8</sub>.b3))))
\rightarrow [const static or extern object]
[67.8] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\label{eq:div_heap} \text{div}(\textbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{uncstart\_724,1.p2, 176).rem}))._replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem *
\mathbf{asType} {<} \mathbf{int} {>} (\$ \mathbf{heap}_{init}.\mathbf{r3})) - (\mathbf{asType} {<} \mathbf{int} {>} (\mathbf{asType} {<} \mathbf{short}
int>(div3.quot)) * asType<int>($heap<sub>724.1:747.8</sub>.b3))))
\rightarrow [expand definition of constant 'r3' at prang.c (25,20)]
[67.9] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{tuncstart_724.1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{1} = \theta_{1} - \theta_{2} - \theta_{3} - \theta_{4} - \theta_{5} - \theta_{6} - \theta_{6
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem *
asType<int>(asType<short int>((int)170))) -
(asType<int>(asType<short int>(div3.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{724,1;747,8}.\mathrm{b3}))))
\rightarrow [simplify]
[67.12] $\text{heap}_{724,1;749,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs \rho_{tart\_724,1},
\text{Sheap}_{funcstart\_724.1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724.1},
\theta_{uncstart_{724.1},p2,176,rem})._replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem * 170)
- (asType < int > (asType < short int > (div3.quot))
asType < int > (\$heap_{724,1;747,8}.b3))))
\rightarrow [from term 43.6, div3 is equal to div(heapIs $heap_{funcstart\_724.1},
heap_{funcstart_{-724,1}}.p3, 178
[67.13] heap_{724,1;749,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
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\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{tuncstart\_724,1.p2, 176, rem})._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) –
(asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724.1},
\text{Sheap}_{funcstart_{724,1},p3, 178}, \text{quot}) * \mathbf{asType} < \mathbf{int} > (\text{Sheap}_{724,1;747,8}, \text{b3}))))
\rightarrow [simplify]
[67.15] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{uncstart_{-724,1},p2, 176, rem)}._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) –
(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} *
asType<int>($heap<sub>724.1:747.8</sub>.b3))))
\rightarrow [from term 63.24, $heap<sub>724,1:747,8</sub> is equal to
\text{Sheap}_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(\textbf{heapIs } \$heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1}, 177).quot) + (171 * div(heapIs $heap_{funcstart\_724,1}, 17
heap_{funcstart\_724,1}.p1, 177).rem)._replace(p2 \rightarrow (-35 * div(heapIs)))._
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p2, 176).rem)
[67.16] $\text{heap}_{724,1;749,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(\text{p1} \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{tuncstart=724.1}.p2, 176).rem))._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}, n_{funcstart\_724,1}, n_{funcstart\_724,1}, n_{funcstart\_724,1}
(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).quot *
asType < int > (\$heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * div(heapIs)))))))
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1},p1, 177}.quot) + (171 * div(heapIs)
\rho_{funcstart\_724,1}, \rho_{func
* div(\mathbf{heapIs} \ \$ heap_{funcstart\_724,1}, \ \$ heap_{funcstart\_724,1}.p2, \ 176).quot) + (172 \ *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p2, \ 176).rem))).b3))))
→ [const member of object with modified fields]
[67.18] $\text{heap}_{724,1;749,8} == \text{$heap}_{funcstart\_724,1}._\text{$-replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
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\rho_{tuncstart=724.1.p2, 176}.rem)._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) –
(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} *
asType < int > (\$heap_{funcstart\_724,1}.b3))))
\rightarrow [const static or extern object]
[67.19] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\ 724.1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs} \text{Sheap}_{funcstart\ 724.1},
\rho_{tuncstart\_724,1.p2, 176, rem})._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) –
(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} *
asType < int > (\$heap_{init}.b3))))
\rightarrow [expand definition of constant 'b3' at prang.c (27,20)]
[67.20] heap_{724,1;749,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{tuncstart_724.1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{tuncstart\_724,1.p2, 176}.rem)._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) –
(\text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724.1}, \ \$ \text{heap}_{funcstart\_724.1}. \text{p3}, \ 178). \text{quot} \ *
asType<int>(asType<short int>((int)63))))
\rightarrow [simplify]
[67.26] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{$heap}_{funcstart\_724,1}, \ \text{$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724.1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1}.p2, 176).rem))._replace(p3 \rightarrow ((-63 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 178).rem)
[Take goal term]
[1.0] minof(int) \leq $heap<sub>724.1:749.8</sub>.p1
\rightarrow [simplify]
[1.1] -32768 \leq $heap<sub>724,1;749,8</sub>.p1
\rightarrow [from term 67.26, $heap_{724,1;749,8}$ is equal to
heap_{funcstart\_724.1}._replace(p1 \rightarrow ((-2 * div(heapIs heap_{funcstart\_724.1}),
\text{Sheap}_{funcstart_{-724,1},p1, 177}.\text{quot}) + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart_{-724,1}})
\rho_{funcstart\_724,1}.p1, 177).rem))).\_replace(p2 \rightarrow ((-35 * div(heapIs))).\_replace(p2 \rightarrow ((-35 * div(heapIs)))))
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heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
\rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).quot) + (170 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p3, \ 178).\operatorname{rem}))]
[1.2] -32768 \leq $heap<sub>funcstart_724.1</sub>._replace(p1 \rightarrow ((-2 * div(heapIs
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1, 177).quot) + (171 * div(heapIs)
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
* div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, p2, 176).quot) + (172 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p2,
176).rem)))._replace(p3 \rightarrow ((-63 * div(heapIs $heap_{funcstart\_724,1},
\text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} + (170 * \text{div}(\text{heapIs } \text{heap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p3, 178).rem)).p1
\rightarrow [simplify]
 \label{eq:continuous} \mbox{$[1.7]$ -32769} < ((-2 * \mbox{div}(\mathbf{heapIs} \ \$ \mbox{$heap}_{funcstart\_724,1}, \$ \mbox{$heap}_{funcstart\_724,1}.\mbox{$p$}_1,
177).quot) + (171 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart\_724,1}, \text{\$heap}_{funcstart\_724,1}.\text{p1},
177).rem))
\rightarrow [from term 60.11, literala < ((-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1})
heap_{funcstart\_724,1}.p1, 177).rem is true whenever (-1 + literala) < -30269
       Proof of rule precondition:
       [1.7.0](-32769 + -1) < -30269
       \rightarrow [simplify]
       [1.7.2] true
[1.8] true
Proof of verification condition: Type constraint satisfied in implicit
conversion from 'short int' to 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (68,17)
Condition defined at:
To prove: heap_{724,1;749,8}.p1 \le maxof(int)
Given:
heap_{init}.LIMIT == (int)80
\theta
\theta_{init}.r1 == asType < short int > ((int)171)
\theta
\theta
\theta
```

```
\rho_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta
heap_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart\_724,1})
div1 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) /
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}))) = =
asType<integer>(div1.quot)
(asType<int>(asType<int>($heap_{funcstart\_724,1}.p1)) %
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) ==
asType<integer>(div1.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a1) \le
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1})) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}))\ /
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))) ==
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heap_{tuncstart\_724.1}.p2)) %
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.rem)
```

```
(asType < integer > (\$heap_{funcstart\_724,1}.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) ==
asType<integer>(div2.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a2) \le
asType < integer > (\$heap_{funcstart\_724,1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
asType < int > (\$heap_{funcstart\_724.1}.a3))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p3})) \ / \\
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(asType<int>(asType<int>($heap_{funcstart\_724,1}.p3)) %
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(asType < integer > (\$heap_{funcstart\ 724,1}.p3) = =
asType<integer>(div3.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a3) \le
asType < integer > (\$heap_{funcstart\_724,1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
\mathbf{asType} \small{<} \mathbf{int} \small{>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{r1})) \\ - (\mathbf{asType} \small{<} \mathbf{int} \small{>} (\mathbf{asType} \small{<} \mathbf{short}
int>(div1.quot)) * asType< int>($heap_{tuncstart\_724.1}.b1))))
-asType<integer const>($heap<sub>724,1:745,8</sub>.M1) <
asType<integer>($heap<sub>724.1:745.8</sub>.p1)
!(0 == asType < integer > (\$heap_{724.1:745.8}.p1))
asType<integer>($heap<sub>724.1:745.8</sub>.p1) <
asType<integer>($heap<sub>724,1:745,8</sub>.M1)
heap_{724,1;747,8} == heap_{724,1;745,8}._replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724.1:745.8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
```

```
-asType < integer const > (\$heap_{724,1:747.8}.M2) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;747,8}.\mathrm{p2})
!(0 == \mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathrm{heap}_{724,1;747,8}.\mathrm{p2}))
asType<integer>($heap<sub>724,1;747,8</sub>.p2) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;747,8}.\mathrm{M2})
heap_{724,1:749,8} == heap_{724,1:747,8}.replace(p3 \rightarrow asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType < int > (\$heap_{724,1:747,8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap<sub>724,1:747,8</sub>.b3))))
-asType<integer const>($heap<sub>724.1:749.8</sub>.M3) <
asType<integer>($heap<sub>724.1:749.8</sub>.p3)
!(0 == asType < integer > (\$heap_{724,1;749,8}.p3))
asType<integer>($heap<sub>724.1:749.8</sub>.p3) <
asType<integer>($heap<sub>724.1:749.8</sub>.M3)
Proof:
[Take given term]
[11.0] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
\rightarrow [simplify]
[11.1] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType < int > (\$heap_{funcstart\_724,1}.a1))
\rightarrow [const static or extern object]
[11.2] div1 == div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1},
asType < int > (\$heap_{init}.a1))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
[11.3] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType<int>(asType<short int>((int)177)))
\rightarrow [simplify]
[11.6] div1 == div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p1, 177)
[Take given term]
[27.0] div2 == div(heapIs $heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
\rightarrow [simplify]
[27.1] \ \mathrm{div2} == \ \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2},
asType < int > (\$heap_{funcstart\_724,1}.a2))
```

```
\rightarrow [const static or extern object]
[27.2] div2 == div(heapIs $heap_{funcstart\_724.1}, $heap_{funcstart\_724.1}.p2,
asType < int > (\$heap_{init}.a2))
\rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
[27.3]~{\rm div2} == {\rm div}(\mathbf{heapIs}~\$ \mathrm{heap}_{funcstart\_724,1},\,\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2},
asType<int>(asType<short int>((int)176)))
\rightarrow [simplify]
[27.6] div2 == div(heapIs $heap<sub>funcstart_724,1</sub>, $heap<sub>funcstart_724,1</sub>.p2, 176)
[Take given term]
[43.0] div3 == div(heapIs $heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
asType < int > (\$heap_{funcstart\_724,1}.a3))
\rightarrow [simplify]
[43.1] \ \mathrm{div3} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3},
asType < int > (\$heap_{funcstart\_724,1}.a3))
\rightarrow [const static or extern object]
[43.2] \text{ div3} == \text{div}(\mathbf{heapIs} \$ heap_{funcstart\_724,1}, \$ heap_{funcstart\_724,1}.p3,
asType < int > (\$heap_{init}.a3))
\rightarrow [expand definition of constant 'a3' at prang.c (26,20)]
[43.3] div3 == div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p3,
asType<int>(asType<short int>((int)178)))
\rightarrow [simplify]
[43.6] \ \mathrm{div3} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}, \ 178)
[Take given term]
[59.0] \text{sheap}_{724,1;745,8} == \text{sheap}_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177
[59.1] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>)(asType<short int>(div(heapIs $heap_tuncstart_724.1,
\theta_{tuncstart_{724,1},p1,177,rem} * asType<int>(\theta_{tuncstart_{724,1},r1}) -
(asType<int>(asType<short int>(div1.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [simplify]
[59.3] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
```

```
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
\rightarrow [const static or extern object]
[59.4] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType < int > (\$heap_{init}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1.quot})) * \mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
\rightarrow [expand definition of constant 'r1' at prang.c (15,20)]
[59.5] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType<int>(asType<short int>((int)171))) -
(asType<int>(asType<short int>(div1.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [simplify]
[59.8] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem * 171)
- (asType<int>(asType<short int>(div1.quot))
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724.1},
heap_{funcstart_{724,1}}.p1, 177
[59.9] heap_{724,1:745,8} == heap_{funcstart\_724,1}-replace(p1 \rightarrow asType<short
int>((171 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)
- (asType<int>(asType<short int>(div(heapIs $heap_{funcstart 724.1},
heap_{funcstart_{724,1}}.p1, 177).quot) *
asType < int > (\$heap_{funcstart\_724,1}.b1)))
\rightarrow [simplify]
[59.11] \text{heap}_{724,1;745,8} == \text{heap}_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [const static or extern object]
[59.12] $\text{heap}_{724.1:745.8} == $\text{heap}_{funcstart\_724.1}._\text{replace}(p1 \rightarrow \text{asType} < \text{short}
int>((171 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{init}.\mathrm{b1}))))
\rightarrow [expand definition of constant 'b1' at prang.c (17,20)]
[59.13] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((171 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\textbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
```

```
asType<int>(asType<short int>((int)2))))
\rightarrow [simplify]
[59.19] $\text{heap}_{724,1;745,8} == \text{$heap}_{funcstart\_724,1}._\text{$replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, \ 177).\operatorname{rem})))
[Take given term]
[62.0] asType<integer>($heap_{724,1;745,8}.p1) <
asType<integer>($heap<sub>724.1:745.8</sub>.M1)
\rightarrow [from term 59.19, $heap<sub>724,1:745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724,1}),
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1}, 177).quot) + (171 * div(heapIs $heap_{funcstart\_724,1}, 17
heap_{funcstart_{-724,1}}.p1, 177).rem)
[62.1] asType<integer>(p1 \rightarrow ((-2 * p1)^2))
div(\mathbf{heapIs} \ \$heap_{funcstart\_724.1}, \ \$heap_{funcstart\_724.1}.p1, \ 177).quot) + (171 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p1, \ 177).rem))).p1) <
asType<integer>($heap<sub>724,1;745,8</sub>.M1)
\rightarrow [simplify]
[62.3] ((-2 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).quot) + (171 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
(177).rem) < asType < integer > (\$heap_{724,1;745,8}.M1)
\rightarrow [from term 59.19, $heap<sub>724,1;745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724,1}),
heap_{funcstart_{724,1},p1, 177}, quot) + (171 * div(heapIs p_{funcstart_{724,1},p1, 177}).
heap_{funcstart_{-724,1}}.p1, 177).rem)
[62.4] ((-2 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).quot) + (171 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart\_724,1}, \text{\$heap}_{funcstart\_724,1}.\text{p1},
177).rem)) < asType<integer>($heap_{funcstart\_724,1}.replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, \ 177).\operatorname{rem}))).\operatorname{M1})
\rightarrow [const member of object with modified fields]
\textit{[62.5]} \ ((\text{-2 * div}(\textbf{heapIs }\$ \text{heap}_{funcstart\_724,1},\,\$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).quot) + (171 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
(177).rem) < asType < integer > (\$heap_{funcstart\_724,1}.M1)
\rightarrow [const static or extern object]
[62.6] ((-2 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).quot) + (171 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
(177).rem) < asType < integer > (\$heap_{init}.M1)
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
\textit{[62.7]} \ (\text{(-2 * div}(\textbf{heapIs }\$\text{heap}_{funcstart\_724,1},\,\$\text{heap}_{funcstart\_724,1}.\text{p1},\,
```

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177).quot) + (171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1,
(177).rem) < asType < integer > (asType < short int > ((int) 30269))
\rightarrow [simplify]
[62.17] -30269 < ((-171 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177).quot)
[Take given term]
[63.0] \; \$ heap_{724,1;747,8} == \; \$ heap_{724,1;745,8}.\_\mathbf{replace} (p2 \to \mathbf{asType} < \mathbf{short})
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724.1:745.8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [from term 59.19, $heap<sub>724,1:745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724,1}),
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs p_{funcstart\_724,1})
heap_{funcstart_{-724,1}}.p1, 177).rem)
[63.1] $\text{heap}_{724,1;747,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem))).\_replace(p2 \rightarrow asType < short
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724,1:745,8}.r2)) - (asType < int > (asType < short)
\mathbf{int}{>}(\text{div2.quot})) \ * \ \mathbf{asType}{<} \mathbf{int}{>} (\$\text{heap}_{724,1;745,8}.\text{b2}))))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1}}.p2, 176
[63.2] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
(177).rem))._replace(p2 \rightarrow asType < short)
int>((asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},))
\text{sheap}_{funcstart\_724,1.p2, 176}.\text{rem}) * asType < int > (\text{sheap}_{724,1:745,8.r2})) -
(asType<int>(asType<short int>(div2.quot)) *
asType < int > (\$heap_{724,1;745,8}.b2))))
\rightarrow [simplify]
[63.4] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem))).\_\mathbf{replace}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((div(\mathbf{heapIs}))))
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}.p2, 176).rem *
\mathbf{asType}{<}\mathbf{int}{>}(\$\text{heap}_{724,1;745,8}.\mathbf{r2})) - (\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{short}
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [from term 59.19, $heap<sub>724,1;745,8</sub> is equal to
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heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs \text{Sheap}_{funcstart\_724,1}),
heap_{funcstart_{-724,1}}.p1, 177).rem)
[63.5] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem))).\_\mathbf{replace}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((div(\mathbf{heapIs}
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathbf{\_replace}(\mathrm{p1} \rightarrow ((\text{-}2\ *\ \mathrm{div}(\mathbf{heapIs}
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, 177).rem)).r2)) -
(asType<int>(asType<short int>(div2.quot)) *
asType < int > (\$heap_{724,1:745.8}.b2))))
\rightarrow [const member of object with modified fields]
[63.6] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((\operatorname{div}(\mathbf{heapIs}))))
\text{Sheap}_{funcstart_{-724,1}}, \text{Sheap}_{funcstart_{-724,1},p2, 176}.rem *
asType < int > (\$heap_{funcstart\_724,1}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724,1:745,8</sub>.b2))))
\rightarrow [const static or extern object]
[63.7] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
\text{Sheap}_{funcstart_{-724,1}}, \text{Sheap}_{funcstart_{-724,1}}.p2, 176).rem *
asType < int > (\$heap_{init}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType< int>($heap_{724.1:745.8}.b2))))
\rightarrow [expand definition of constant 'r2' at prang.c (20,20)]
[63.8] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ ^*
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
(177).rem)._replace(p2 \rightarrow asType<short int>((div(heapIs))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem} *
asType<int>(asType<short int>((int)172))) -
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{short}\ \mathbf{int}{>}(\mathbf{div2.quot}))\ ^*
asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [simplify]
[63.11] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
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177).rem)))._{replace(p2 \rightarrow asType < short int > ((div(heapIs))))}
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p_2, 176).rem * 172) -
(asType<int>(asType<short int>(div2.quot)) *
asType < int > (\$heap_{724,1;745,8}.b2))))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{funcstart_724.1},
heap_{funcstart_{724,1}}.p2, 176)
[63.12] $\text{heap}_{724,1:747,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem) -
(asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724.1},
\text{sheap}_{funcstart\_724,1.p2}, 176).\text{quot}) * asType < int > (\text{sheap}_{724,1:745,8}.b2))))
\rightarrow [simplify]
[63.14] $\text{heap}_{724,1;747,8} == \text{$heap}_{funcstart\_724,1}._\text{$-replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((172 * div(\mathbf{heapIs}))))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem}) - (\text{div}(\text{heapIs})
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}
asType < int > (\$heap_{724,1;745,8}.b2))))
\rightarrow [from term 59.19, $heap<sub>724,1;745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724,1}),
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p1, 177).rem}
[63.15] $\text{heap}_{724,1;747,8} == \text{$heap}_{funcstart\_724,1}._\text{$-replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}.p2, 176).quot *
asType < int > (\$heap_{funcstart\_724.1}.\_replace(p1 \rightarrow ((-2 * div(heapIs))))))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs}))
\text{Sheap}_{funcstart_{724,1}}, \text{Sheap}_{funcstart_{724,1}}.p1, 177).rem))).b2))))
\rightarrow [const member of object with modified fields]
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}.p2, 176).quot *
asType < int > (\$heap_{funcstart\_724,1}.b2)))
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\rightarrow [const static or extern object]
[63.17] $\text{heap}_{724,1:747,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1},p2}, 176).quot *
asType < int > (\$heap_{init}.b2))))
\rightarrow [expand definition of constant 'b2' at prang.c (22,20)]
[63.18] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724.1}, \theta_{funcstart\_724.1}, \theta_{funcstart\_724.1}, \theta_{funcstart\_724.1}, \theta_{funcstart\_724.1}
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1},p2,176}.quot *
\mathbf{asType} {<} \mathbf{int} {>} (\mathbf{asType} {<} \mathbf{short} \ \mathbf{int} {>} ((\mathbf{int})35)))))
\rightarrow [simplify]
[63.24] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p2, 176).rem)
[Take given term]
[67.0] $\text{heap}_{724,1:749,8} == $\text{heap}_{724,1:747,8}._\text{replace}(p3 \to \text{asType} < \text{short}
int>((asType<int>(asType<short int>(div3.rem)) *
asType < int > (\$heap_{724.1:747.8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap<sub>724.1:747.8</sub>.b3))))
\rightarrow [from term 63.24, $heap<sub>724,1;747,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1}, 177).quot) + (171 * div(heapIs $heap_{funcstart\_724,1}, 17
\rho_{uncstart_{-724,1}.p1, 177).rem})).\_replace(p2 \rightarrow (-35 * div(heapIs))).
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}. p2, p2, p3, p3, p4, 
heap_{funcstart_{724.1}}, heap_{funcstart_{724.1}}, 2, 176).rem
[67.1] heap_{724,1;749,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{uncstart\_724,1.p2, 176).rem}))._replace(p3 \rightarrow asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{724,1;747,8}.\mathrm{r3})) - (\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{short}
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int>(div3.quot)) * asType< int>($heap_{724.1:747.8}.b3))))
\rightarrow [from term 43.6, div3 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p3, 178
[67.2] $\text{heap}_{724,1;749,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2, 176}.rem))._replace(p3 \rightarrow asType<short
int>((asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{rem}) * asType < int > (\text{Sheap}_{724,1:747.8}.\text{r3})) -
(asType<int>(asType<short int>(div3.quot)) *
asType < int > (\$heap_{724,1;747,8}.b3))))
\rightarrow [simplify]
[67.4] $\text{heap}_{724,1;749,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{tuncstart_{-724.1},p2, 176,rem})._replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem *
asType < int > (\$heap_{724.1:747.8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap<sub>724.1:747.8</sub>.b3))))
\rightarrow [from term 63.24, $heap<sub>724,1;747,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1},p1, 177}, quot) + (171 * div(heapIs heap_{funcstart_{724,1},p1, 177})
\theta_{funcstart\_724,1}.p1, 177).rem))._replace(p2 \rightarrow (-35 * div(\mathbf{heapIs})))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
\$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p2, 176).rem))]
[67.5] $heap<sub>724,1:749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724.1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{funcstart\_724,1}.p2, 176).rem))).\_replace(p3 \rightarrow asType < short)
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem *
asType < int > (\$heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * div(heapIs))))))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs})
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}))._replace(p2 \rightarrow ((-35)
* div(\mathbf{heapIs} \ \$ heap_{funcstart\_724,1}, \ \$ heap_{funcstart\_724,1}.p2, \ 176).quot) + (172 \ *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p2, 176).rem))).r3)) -
(asType<int>(asType<short int>(div3.quot)) *
asType < int > (\$heap_{724,1;747,8}.b3))))
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\rightarrow [const member of object with modified fields]
[67.7] $heap<sub>724,1:749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{tuncstart_724.1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{funcstart\_724,1}.p2, 176).rem))._replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem *
asType < int > (\$heap_{funcstart\_724.1}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap<sub>724.1:747.8</sub>.b3))))
\rightarrow [const static or extern object]
[67.8] heap_{724,1;749,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724.1}, \ \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{tuncstart_{724,1},p2,176,rem})._replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem *
asType < int > (\$heap_{init}.r3)) - (asType < int > (asType < short)
int > (div3.quot)) * asType < int > ($heap_{724,1;747,8}.b3))))
\rightarrow [expand definition of constant 'r3' at prang.c (25,20)]
[67.9] heap_{724,1;749,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{funcstart\_724,1.p2, 176).rem}))._replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem *
asType<int>(asType<short int>((int)170))) -
(asType<int>(asType<short int>(div3.quot)) *
asType < int > (\$heap_{724,1;747,8}.b3))))
\rightarrow [simplify]
[67.12] $\text{heap}_{724,1;749,8} == \text{$heap}_{funcstart\_724,1}._\text{$-replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724.1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724.1},
\theta_{tuncstart} $\text{p2}, 176\).rem)))._replace(p3 \rightarrow asType < short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem * 170)
- (asType<int>(asType<short int>(div3.quot)) *
asType < int > (\$heap_{724,1;747,8}.b3))))
\rightarrow [from term 43.6, div3 is equal to div(heapIs $heap_{funcstart\_724,1},
```

```
heap_{funcstart_{-724,1}}.p3, 178
[67.13] heap_{724,1;749,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{tuncstart_724.1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{uncstart\_724,1.p2, 176}.rem)._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) –
(asType<int>(asType<short int>(div(heapIs $heap_{tuncstart\_724.1}),
\text{sheap}_{funcstart\_724,1.p3}, 178).\text{quot}) * asType < int > (\text{sheap}_{724,1:747,8}.b3))))
\rightarrow [simplify]
[67.15] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
div(heapIs \$heap_{funcstart\_724.1}, \$heap_{funcstart\_724.1}.p1, 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{tuncstart\_724.1.p2, 176).rem})._replace(p3 \rightarrow asType<short int>((170
* \operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p3, \ 178).rem) -
(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} *
asType < int > (\$heap_{724,1:747,8}.b3))))
\rightarrow [from term 63.24, $heap<sub>724,1;747,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1},p1, 177}, quot) + (171 * div(heapIs heap_{funcstart_{-724,1},p1, 177})
\rho_{funcstart\_724.1}.p1, 177).rem)._replace\rho_{funcstart\_724.1}.p1, 177).rem)._replace
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem)
[67.16] $\text{heap}_{724,1:749,8} == $\text{heap}_{funcstart_724,1}. \text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}. p1, \ 177). \operatorname{quot}) + (171 *
\label{eq:div_heap} \text{div}(\textbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs} \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart_{-724,1},p2,176,rem})._replace(p3 \rightarrow asType<short int>((170
* \operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p3, \ 178).rem) -
(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} *
asType < int > (\$heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * div(heapIs)))))))
\text{Sheap}_{funcstart\_724.1}, \text{Sheap}_{funcstart\_724.1}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs})
\$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem))).\_\mathbf{replace}(p2 \rightarrow ((-35), -20)))
* div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}.p2, 176).quot) + (172 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724.1}, \ \$ \operatorname{heap}_{funcstart\_724.1}. \operatorname{p2}, \ 176).\operatorname{rem}))).\operatorname{b3}))))
\rightarrow [const member of object with modified fields]
[67.18] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\mathrm{div}(\mathbf{heapIs}\ \$\mathrm{heap}_{funcstart\_724,1},\ \$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},\ 177).\mathrm{quot}) + (171\ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}. \operatorname{pl},
```

```
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724.1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs} \text{Sheap}_{funcstart\_724,1}),
\rho_{tuncstart\_724,1.p2, 176}.rem)._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}, 178).rem) –
(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} *
asType < int > (\$heap_{funcstart\_724,1}.b3))))
\rightarrow [const static or extern object]
[67.19] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart} \ 724.1, \ \$ \operatorname{heap}_{funcstart} \ 724.1.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{funcstart\_724,1.p2, 176}.rem)._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) -
(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} *
asType < int > (\$heap_{init}.b3))))
\rightarrow [expand definition of constant 'b3' at prang.c (27,20)]
[67.20] heap_{724,1;749,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724,1},
\text{Sheap}_{funcstart\_724.1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724.1},
\rho_{tuncstart_724.1}.p2, 176).rem))._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart\_724.1}, heap_{funcstart\_724.1}, n_{funcstart\_724.1}, n_{funcstart\_724.1}
(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} *
asType<int>(asType<short int>((int)63)))))
\rightarrow [simplify]
[67.26] $\text{heap}_{724,1;749,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724.1},
\text{Sheap}_{funcstart\_724.1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724.1},
\rho_{tuncstart\_724.1.p2, 176}.rem)._replace(p3 \rightarrow ((-63 * div(heapIs
\theta_{funcstart_{-724,1}}, \theta_{funcstart_{-724,1}}, \theta_{funcstart_{-724,1}}, \theta_{funcstart_{-724,1}}, \theta_{funcstart_{-724,1}}
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 178).rem)
[Take goal term]
[1.0] $\text{heap}_{724,1;749,8}.p1 \leq \text{maxof(int)}
\rightarrow [from term 67.26, $heap<sub>724,1;749,8</sub> is equal to
heap_{funcstart\ 724.1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\ 724.1}), heap_{funcstart\ 724.1})
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1}, 177).quot) + (171 * div(heapIs $heap_{funcstart\_724,1}, 17
\rho_{uncstart\_724,1.p1, 177).rem}))._replace\rho_{uncstart\_724,1.p1, 177).rem}))._replace
heap_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}
```

```
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem)))._replace(p3 \rightarrow (-63 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).quot) + (170 \ *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).rem))]
[1.1] heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs
\text{Sheap}_{funcstart\_724.1}, \text{Sheap}_{funcstart\_724.1}, \text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs}))
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
* div(heapIs heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 176).quot) + (172 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p2,
176).rem)))._replace(p3 \rightarrow ((-63 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} + (170 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{funcstart\_724,1.p3}, 178).rem))).p1 \leq \max(\text{int})
\rightarrow [simplify]
[1.18] -32768 < ((-171 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724.1.pl}, 177).\text{rem} + (2 * \text{div}(\text{heapIs} \text{Sheap}_{funcstart\_724.1},
heap_{funcstart_{-724,1}.p1, 177}, quot))
\rightarrow [from term 62.17, literala < ((-171 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.p1, 177).rem) + (2 * div(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot) is true whenever (-1 + literala) < -30269
   Proof of rule precondition:
   [1.18.0](-32768 + -1) < -30269
   \rightarrow [simplify]
   [1.18.2] true
[1.19] true
Proof of verification condition: Type constraint satisfied in explicit
conversion from 'integer' to 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (68,11)
Condition defined at:
To prove: minof(int) \le
static\_cast < integer > (asType < int > (\$heap_{724.1:749.8}.p1) < (int)0)
Given:
heap_{init}.LIMIT == (int)80
\theta
\theta
\theta
\theta = asType < short int > ((int)2)
\theta
```

```
\rho_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta
heap_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart\_724,1})
div1 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) /
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}))) = =
asType<integer>(div1.quot)
(asType<int>(asType<int>($heap_{funcstart\_724,1}.p1)) %
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) ==
asType<integer>(div1.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a1) \le
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1})) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}))\ /
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))) ==
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heap_{tuncstart\_724.1}.p2)) %
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.rem)
```

```
(asType < integer > (\$heap_{funcstart\_724,1}.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) ==
asType<integer>(div2.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a2) \le
asType < integer > (\$heap_{funcstart\_724,1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
asType < int > (\$heap_{funcstart\_724.1}.a3))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p3})) \ / \\
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(asType<int>(asType<int>($heap_{funcstart\_724,1}.p3)) %
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(asType < integer > (\$heap_{funcstart\ 724,1}.p3) = =
asType<integer>(div3.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a3) \le
asType < integer > (\$heap_{funcstart\_724,1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
\mathbf{asType} \small{<} \mathbf{int} \small{>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{r1})) \\ - (\mathbf{asType} \small{<} \mathbf{int} \small{>} (\mathbf{asType} \small{<} \mathbf{short}
int>(div1.quot)) * asType< int>($heap_{tuncstart\_724.1}.b1))))
-asType<integer const>($heap<sub>724,1:745,8</sub>.M1) <
asType<integer>($heap<sub>724.1:745.8</sub>.p1)
!(0 == asType < integer > (\$heap_{724.1:745.8}.p1))
asType<integer>($heap<sub>724.1:745.8</sub>.p1) <
asType<integer>($heap<sub>724,1:745,8</sub>.M1)
heap_{724,1;747,8} == heap_{724,1;745,8}._replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724.1:745.8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
```

```
-asType < integer const > (\$heap_{724,1:747.8}.M2) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;747,8}.\mathrm{p2})
!(0 == \mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathrm{heap}_{724,1;747,8}.\mathrm{p2}))
asType<integer>($heap<sub>724,1;747,8</sub>.p2) <
asType<integer>($heap<sub>724,1;747,8</sub>.M2)
heap_{724,1:749,8} == heap_{724,1:747,8}.replace(p3 \rightarrow asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType < int > (\$heap_{724,1:747,8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap<sub>724,1:747,8</sub>.b3))))
-asType<integer const>($heap<sub>724.1:749.8</sub>.M3) <
asType<integer>($heap<sub>724.1:749.8</sub>.p3)
!(0 == asType < integer > (\$heap_{724,1;749,8}.p3))
asType<integer>($heap<sub>724.1:749.8</sub>.p3) <
asType<integer>($heap<sub>724.1:749.8</sub>.M3)
Proof:
[Take given term]
[11.0] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
\rightarrow [simplify]
[11.1]~{\rm div1} == {\rm div}(\mathbf{heapIs}~\$ \mathrm{heap}_{funcstart\_724,1},\,\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType < int > (\$heap_{funcstart\_724,1}.a1))
\rightarrow [const static or extern object]
[11.2] div1 == div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1},
asType < int > (\$heap_{init}.a1))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
[11.3] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType<int>(asType<short int>((int)177)))
\rightarrow [simplify]
[11.6] div1 == div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p1, 177)
[Take given term]
[27.0] div2 == div(heapIs $heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
\rightarrow [simplify]
[27.1] \ \mathrm{div2} == \ \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2},
asType < int > (\$heap_{funcstart\_724,1}.a2))
```

```
\rightarrow [const static or extern object]
[27.2] div2 == div(heapIs $heap_{funcstart\_724.1}, $heap_{funcstart\_724.1}.p2,
asType < int > (\$heap_{init}.a2))
\rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
[27.3]~{\rm div2} == {\rm div}(\mathbf{heapIs}~\$ \mathrm{heap}_{funcstart\_724,1},\,\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2},
asType<int>(asType<short int>((int)176)))
\rightarrow [simplify]
[27.6] div2 == div(heapIs $heap<sub>funcstart_724,1</sub>, $heap<sub>funcstart_724,1</sub>.p2, 176)
[Take given term]
[43.0] div3 == div(heapIs $heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
asType < int > (\$heap_{funcstart\_724,1}.a3))
\rightarrow [simplify]
[43.1] \ \mathrm{div3} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3},
asType < int > (\$heap_{funcstart\_724,1}.a3))
\rightarrow [const static or extern object]
[43.2] \text{ div3} == \text{div}(\mathbf{heapIs} \$ heap_{funcstart\_724,1}, \$ heap_{funcstart\_724,1}.p3,
asType < int > (\$heap_{init}.a3))
\rightarrow [expand definition of constant 'a3' at prang.c (26,20)]
[43.3] div3 == div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p3,
asType<int>(asType<short int>((int)178)))
\rightarrow [simplify]
[43.6] \ \mathrm{div3} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}, \ 178)
[Take given term]
[59.0] \text{sheap}_{724,1;745,8} == \text{sheap}_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177
[59.1] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>)(asType<short int>(div(heapIs $heap_tuncstart_724.1,
\theta_{tuncstart_{724,1},p1,177,rem} * asType<int>(\theta_{tuncstart_{724,1},r1}) -
(asType<int>(asType<short int>(div1.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [simplify]
[59.3] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
```

```
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
\rightarrow [const static or extern object]
[59.4] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType < int > (\$heap_{init}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
\rightarrow [expand definition of constant 'r1' at prang.c (15,20)]
[59.5] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType<int>(asType<short int>((int)171))) -
(asType<int>(asType<short int>(div1.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [simplify]
[59.8] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem * 171)
- (asType<int>(asType<short int>(div1.quot))
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724.1},
heap_{funcstart_{724,1}}.p1, 177
[59.9] heap_{724,1:745,8} == heap_{funcstart\_724,1}-replace(p1 \rightarrow asType<short
int>((171 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)
- (asType<int>(asType<short int>(div(heapIs $heap_{funcstart 724.1},
heap_{funcstart_{724,1}}.p1, 177).quot) *
asType < int > (\$heap_{funcstart\_724,1}.b1)))
\rightarrow [simplify]
[59.11] \text{heap}_{724,1;745,8} == \text{heap}_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [const static or extern object]
[59.12] $\text{heap}_{724.1:745.8} == $\text{heap}_{funcstart\_724.1}._\text{replace}(p1 \rightarrow \text{asType} < \text{short}
int>((171 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\textbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{init}.\mathrm{b1}))))
\rightarrow [expand definition of constant 'b1' at prang.c (17,20)]
[59.13] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((171 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\textbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
```

```
asType<int>(asType<short int>((int)2))))
\rightarrow [simplify]
[59.19] $\text{heap}_{724,1;745,8} == \text{$heap}_{funcstart\_724,1}._\text{$replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, \ 177).\operatorname{rem})))
[Take given term]
[61.0]!(0 == asType < integer > (\$heap_{724.1:745.8}.p1))
\rightarrow [from term 59.19, $heap<sub>724,1:745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724,1}),
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1}, 177).quot) + (171 * div(heapIs $heap_{funcstart\_724,1}, 177).quot)
heap_{funcstart_{-724,1}}.p1, 177).rem)
div(heapIs \$heap_{funcstart\_724.1}, \$heap_{funcstart\_724.1}.p1, 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{$heap}_{funcstart\_724.1}, \ \text{$heap}_{funcstart\_724.1}.p1, \ 177).rem))).p1))
\rightarrow [simplify]
\label{eq:final_loss} \mbox{$[61.3]$ !$(0 == ((-2 * div(\mathbf{heapIs} \$ heap_{funcstart\_724,1}, \$ heap_{funcstart\_724,1}.p1, $]) $(0 == ((-2 * div(\mathbf{heapIs} \$ heap_{funcstart\_724,1}, \$ heap_{funcstart\_724,1}.p1, \$ heap_{f
177).quot) + (171 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).rem)))
[Take given term]
[63.0] $\text{heap}_{724,1;747,8} == $\text{heap}_{724,1;745,8}._\text{replace}(p2 \rightarrow \text{asType} < \text{short}
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724.1:745.8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [from term 59.19, $heap<sub>724,1:745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724,1}),
\text{Sheap}_{funcstart\_724,1}.p1, 177).quot + (171 * div(\textbf{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177).rem)
[63.1] \theta == 
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
\mathbf{asType} < \mathbf{int} > (\$ heap_{724,1;745,8}.r2)) - (\mathbf{asType} < \mathbf{int} > (\mathbf{asType} < \mathbf{short})
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{funcstart_{724,1}},
heap_{funcstart_{-724,1}}.p2, 176)
[63.2] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
(177).rem))._replace(p2 \rightarrow asType<short
```

```
int>((asType<int>(asType<short int>(div(heapIs $heap_{tuncstart\_724.1},
\text{Sheap}_{funcstart\_724,1.p2, 176}.\text{rem}) * asType < int > (\text{Sheap}_{724,1:745,8}.\text{r2})) -
(asType<int>(asType<short int>(div2.quot)) *
asType < int > ($heap_{724,1;745,8}.b2))))
\rightarrow [simplify]
[63.4] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
\text{Sheap}_{funcstart_{-724,1}}, \text{Sheap}_{funcstart_{-724,1}}.p2, 176).rem *
asType < int > (\$heap_{724,1:745,8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724,1:745,8</sub>.b2))))
\rightarrow [from term 59.19, $heap<sub>724,1;745,8</sub> is equal to
heap_{funcstart\_724.1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724.1}),
heap_{funcstart_{724,1},p1, 177}, quot) + (171 * div(heapIs p_{funcstart_{724,1},p1, 177}), quot)
heap_{funcstart_{724,1}}.p1, 177).rem)
[63.5] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem))).replace(p2 \rightarrow asType < short int > ((div(heapIs)))
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, p_{7,176}.rem *
\mathbf{asType}{<}\mathbf{int}{>}(\$\text{heap}_{funcstart\_724,1}.\_\mathbf{replace}(\text{p1} \rightarrow ((\text{-2} * \text{div}(\mathbf{heapIs}
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1, 177).quot) + (171 * div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).rem))).r2)) -
(asType<int>(asType<short int>(div2.quot)) *
asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [const member of object with modified fields]
[63.6] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((\operatorname{div}(\mathbf{heapIs}))))
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1},p2,176}.rem *
\mathbf{asType} \small{<} \mathbf{int} \small{>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{r2})) \\ - (\mathbf{asType} \small{<} \mathbf{int} \small{>} (\mathbf{asType} \small{<} \mathbf{short}
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [const static or extern object]
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((\operatorname{div}(\mathbf{heapIs}))))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem *
\mathbf{asType} \hspace{-0.1em}<\hspace{-0.1em} \mathbf{int} \hspace{-0.1em}>\hspace{-0.1em} (\$ \mathbf{heap}_{init}.\mathbf{r2})) - (\mathbf{asType} \hspace{-0.1em}<\hspace{-0.1em} \mathbf{int} \hspace{-0.1em}>\hspace{-0.1em} (\mathbf{asType} \hspace{-0.1em}<\hspace{-0.1em} \mathbf{short})
int>(div2.quot)) * asType<int>($heap<sub>724,1:745,8</sub>.b2))))
```

```
\rightarrow [expand definition of constant 'r2' at prang.c (20,20)]
[63.8] $heap<sub>724,1:747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem} *
asType<int>(asType<short int>((int)172))) -
(asType<int>(asType<short int>(div2.quot)) *
asType < int > (\$heap_{724.1:745.8}.b2))))
\rightarrow [simplify]
[63.11] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._{replace(p2 \rightarrow asType < short int > ((div(heapIs))))}
\text{Sheap}_{funcstart_{724.1}}, \text{Sheap}_{funcstart_{724.1}}, \text{p2}, 176).\text{rem} * 172) -
(asType<int>(asType<short int>(div2.quot)) *
asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}, p2, 176
[63.12] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem) -
(asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},))
\text{sheap}_{funcstart\_724,1.p2}, 176).\text{quot}) * asType<int>(\text{sheap}_{724,1:745,8}.\text{b2}))))
\rightarrow [simplify]
[63.14] $\text{heap}_{724,1;747,8} == \text{$heap}_{funcstart\_724,1}._\text{$replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs)
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 2, 176).quot *
asType < int > (\$heap_{724,1:745,8}.b2))))
\rightarrow [from term 59.19, $heap<sub>724.1:745.8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1},p1,177,rem})
[63.15] $\text{heap}_{724,1:747,8} == \text{$heap}_{funcstart\_724,1}.$\text{$_-$replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
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\theta_{funcstart_{-724,1}}, \theta_{funcstart_{-724,1},p2, 176}.rem) - (div(heapIs)
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}.p2, 176).quot *
\mathbf{asType}{<}\mathbf{int}{>}(\$\text{heap}_{funcstart\_724,1}.\_\mathbf{replace}(\text{p1} \rightarrow ((\text{-2} * \text{div}(\mathbf{heapIs}
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1},p1, 177}.quot) + (171 * div(heapIs)
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}.p1, 177).rem)).b2))))
→ [const member of object with modified fields]
[63.16] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot *
asType < int > (\$heap_{funcstart\_724,1}.b2))))
\rightarrow [const static or extern object]
[63.17] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem}) - (\text{div}(\text{heapIs})
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1},p2,176}, quot *
asType < int > (\$heap_{init}.b2))))
\rightarrow [expand definition of constant 'b2' at prang.c (22,20)]
[63.18] \rho_{724,1;747,8} == \rho_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * p1.24,1) + p1.24,1)))
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1},p2,176}.quot *
asType<int>(asType<short int>((int)35)))))
\rightarrow [simplify]
[63.24] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{tuncstart_724.1},
\theta_{funcstart\_724,1}.p2, 176.quot) + (172 * div(heapIs \theta_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p2, 176).rem)
[Take given term]
[67.0] $\text{heap}_{724,1;749,8} == $\text{heap}_{724,1;747,8}._\text{replace}(p3 \to \text{asType} < \text{short}
int>((asType<int>(asType<short int>(div3.rem)) *
asType < int > (\$heap_{724.1:747.8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap<sub>724.1:747.8</sub>.b3))))
```

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\rightarrow [from term 63.24, $heap<sub>724.1:747.8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1},p1, 177}, quot) + (171 * div(heapIs heap_{funcstart_{724,1},p1, 177})
\rho_{funcstart\_724,1}.p1, 177).rem))._replace(p2 \rightarrow (-35 * div(heapIs))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p2, 176).rem)
[67.1] \theta == 
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{uncstart_724.1.p2, 176}.rem)._replace(p3 \rightarrow asType<short
int>((asType<int>(asType<short int>(div3.rem))
asType < int > (\$heap_{724,1:747,8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType< int>($heap_{724,1;747,8}.b3))))
\rightarrow [from term 43.6, div3 is equal to div(heapIs $heap_{funcstart_724,1},
heap_{funcstart_{724,1}}.p3, 178
[67.2] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2, 176}.rem))._replace(p3 \rightarrow asType<short
int>((asType < int > (asType < short int > (div(heapIs $heap_{funcstart\_724,1}, 
\text{sheap}_{funcstart\_724,1.p3}, 178).rem) * asType<int>(\text{sheap}_{724,1:747.8.r3})) -
(asType<int>(asType<short int>(div3.quot)) *
asType < int > (\$heap_{724,1;747,8}.b3))))
\rightarrow [simplify]
[67.4] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2, 176}.rem))._replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem *
asType < int > (\$heap_{724,1.747,8.}r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType< int>($heap_{724,1;747,8}.b3))))
\rightarrow [from term 63.24, $heap<sub>724,1;747,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.p1, 177).quot) + (171 * div(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{uncstart\_724,1}.p1, 177).rem))._replace\rho_{uncstart\_724,1}.p1, 177).rem))._replace
heap_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, 2, 176).rem
```

```
[67.5] heap_{724,1;749,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1}.p2, 176).rem))).\_replace(p3 \rightarrow asType < hort)
int>((div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p3, 178).rem *
asType < int > (\$heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * div(heapIs)))))))
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
\theta_{funcstart\_724.1}, \theta_{funcstart\_724.1}, \theta_{funcstart\_724.1}, \theta_{funcstart\_724.1}, \theta_{funcstart\_724.1}, \theta_{funcstart\_724.1}
* div(heapIs heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p2, 176).quot) + (172 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724.1}, \ \text{\$heap}_{funcstart\_724.1}.p2, 176).rem))).r3)) -
(asType<int>(asType<short int>(div3.quot))
asType < int > (\$heap_{724,1;747,8}.b3))))
\rightarrow [const member of object with modified fields]
[67.7] $\text{heap}_{724,1;749,8} == $\text{heap}_{funcstart_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724.1}, \ \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724.1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724.1},
\theta_{uncstart_724.1.p2, 176}.rem)._replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem *
\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{r3})) - (\mathbf{asType} < \mathbf{int} > (\mathbf{asType} < \mathbf{short}))
int>(div3.quot)) * asType<int>($heap<sub>724.1:747.8</sub>.b3))))
\rightarrow [const static or extern object]
[67.8] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724.1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724.1},
\theta_{uncstart\ 724,1}, p2, 176).rem)._replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem *
asType < int > (\$heap_{init}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType< int>($heap_{724,1;747,8}.b3))))
\rightarrow [expand definition of constant 'r3' at prang.c (25,20)]
[67.9] heap_{724,1;749,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{funcstart\_724,1}.p2, 176).rem))._replace(p3 \rightarrow asType<short
int>((div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p3, 178).rem *
asType<int>(asType<short int>((int)170))) -
```

```
(asType<int>(asType<short int>(div3.quot)) *
asType < int > (\$heap_{724,1;747,8}.b3))))
\rightarrow [simplify]
[67.12] $\text{heap}_{724,1;749,8} == $\text{heap}_{funcstart_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{1} = \theta_{1} - \theta_{2} - \theta_{3} - \theta_{4} - \theta_{5} - \theta_{5
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem * 170)
- (asType<int>(asType<short int>(div3.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\${\rm heap}_{724,1;747,8}.{\rm b3}))))
\rightarrow [from term 43.6, div3 is equal to div(heapIs $heap_{tuncstart_{724.1}},
heap_{funcstart_{-724,1}}.p3, 178
[67.13] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart_{724,1},p2, 176}.quot) + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart_{724,1}},
\rho_{tuncstart,724,1},p2,176).rem)._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) –
(asType<int>(asType<short int>(div(heapIs $heap_{tuncstart_724.1},
\text{Sheap}_{funcstart_724,1.p3}, 178).\text{quot}) * asType < int > (\text{Sheap}_{724,1:747.8.b3})))
\rightarrow [simplify]
[67.15] $\text{heap}_{724,1;749,8} == \text{$heap}_{funcstart\_724,1}._\text{$-replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{uncstart\_724,1.p2, 176).rem})).\_replace(p3 \rightarrow asType < short int > ((170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 -
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) –
(\text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724.1}, \ \$ \text{heap}_{funcstart\_724.1}. \text{p3}, \ 178).\text{quot} \ *
asType<int>($heap<sub>724.1:747.8</sub>.b3))))
\rightarrow [from term 63.24, $heap<sub>724,1:747,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1}, 177).quot) + (171 * div(heapIs $heap_{funcstart\_724,1}, 17
heap_{funcstart\_724,1}.p1, 177).rem))._replace(p2 \rightarrow (-35 * div(heapIs)))._
heap_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, 2, 176).rem
[67.16] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
```

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177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724.1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{tuncstart\_724,1.p2, 176}.rem)._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}, 178).rem) –
(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} *
asType<int>($heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 * div(heapIs
heap_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}
\rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}
* div(heapIs heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 176).quot) + (172 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p2, \ 176).rem))).b3))))
\rightarrow [const member of object with modified fields]
[67.18] \rho_{7.24,1;749,8} == \rho_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{funcstart\_724,1}.p2, 176).rem))._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart\_724.1}, heap_{funcstart\_724.1}, n_{funcstart\_724.1}, n_{funcstart\_724.1}
(div(heapIs $heap<sub>funcstart_724.1</sub>, $heap<sub>funcstart_724.1</sub>.p3, 178).quot *
asType < int > (\$heap_{funcstart\_724.1}.b3))))
\rightarrow [const static or extern object]
[67.19] heap_{724,1;749,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724.1}, \ \text{\$heap}_{funcstart\_724.1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{tuncstart_724.1}.p2, 176).rem))._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) –
(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} *
asType < int > (\$heap_{init}.b3))))
\rightarrow [expand definition of constant 'b3' at prang.c (27,20)]
[67.20] $\text{heap}_{724.1:749.8} == $\text{heap}_{funcstart_724.1}.$\text{-replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs} \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1}.p2, 176).rem))._replace(p3 \rightarrow asType<short int>((170)
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) –
(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} *
asType<int>(asType<short int>((int)63)))))
\rightarrow [simplify]
[67.26] $heap<sub>724,1:749.8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
```

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\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{funcstart\_724,1}.p2, 176).rem))).\_replace(p3 \rightarrow ((-63 * div(heapIs)))._replace(p3 \rightarrow ((-63 * div(heapIs))))._replace(p3 \rightarrow ((-63 * div(heapIs))))._replace(p3 \rightarrow ((-63 * div(heapIs)))))._replace(p3 \rightarrow ((-63 * div(heapIs)))))._replace(p3 \rightarrow ((-63 * div(heapIs)))))._replace(p3 \rightarrow ((-63 * div(heapIs)))))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p3, 178).quot) + (170 * div(heapIs)
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, 178).rem)
[Take goal term]
[1.0] minof(int) \leq static_cast<integer>(asType<int>($heap<sub>724.1:749.8</sub>.p1)
< (int)0)
\rightarrow [simplify]
[1.1] -32768 < static_cast<integer>(asType<int>($heap<sub>724,1.749,8.</sub>p1) <
(int)0)
\rightarrow [from term 67.26, $heap<sub>724,1;749,8</sub> is equal to
heap_{funcstart\_724.1}._replace(p1 \rightarrow ((-2 * div(heapIs heap_{funcstart\_724.1}),
heap_{funcstart_{-724,1},p1, 177}, quot) + (171 * div(heapIs heap_{funcstart_{-724,1},p1, 177})
\rho_{tuncstart\_724.1.p1, 177).rem}))._replace\rho_{tuncstart\_724.1.p1, 177).rem})
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
\$heap_{funcstart\_724,1},\,\$heap_{funcstart\_724,1}.p2,\,176).rem))).\_\mathbf{replace}(p3\rightarrow(-63\ *Coloredge))
div(\mathbf{heapIs} \ \$heap_{funcstart\_724.1}, \ \$heap_{funcstart\_724.1}.p3, \ 178).quot) + (170 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).rem))]
[1.2] - 32768 <
static\_cast < integer > (asType < int > (\$heap_{funcstart\_724,1}.\_replace(p1 \rightarrow funcstart\_724,1}))
((-2 * \text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}) +
(171 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart\_724,1}, \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2, 176}.rem)._replace(p3 \rightarrow ((-63 * div(heapIs
\text{Sheap}_{funcstart\_724.1}, \text{Sheap}_{funcstart\_724.1}.\text{p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs}))
\theta_{uncstart_{-724,1}}, \theta_{uncstart_{-724,1},p3, 178,rem})).p1) < (int)0)
\rightarrow [simplify]
[1.14] -32768 \leq ([0 < ((-171 * div(heapIs $heap<sub>funcstart_724,1</sub>,
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{funcstart_{724,1},p1, 177,quot)} : 1, [: 0]
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[1.15] -32768 \le ([0 < ((-171 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{funcstart_{724,1},p1,177,quot}): 1, [!(0 < ((-171 * div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}) + (2 * \text{div}(\text{heapIs}))
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 177).quot)))]: 0
\rightarrow [simplify]
```

```
[1.20] -32768 < ([0 < ((-171 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p1, 177}.quot): 1, [-1 < ((171 * div(heapIs))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1, 177).rem) + (-2 * div(heapIs)
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1, 177).quot): 0)
\rightarrow [from term 61.3, -1 < ((-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1}, 177).quot) + (171 * div(heapIs $heap_{funcstart\_724,1}, 17
heap_{funcstart\_724,1}.p1, 177).rem is true if and only if 0 < ((-2 * div(\mathbf{heapIs})))
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p_1, 177).quot + (171 * div(heapIs))
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, p1, 177).rem)
[1.21] -32768 \leq ([0 < ((-171 * div(heapIs $heap<sub>funcstart_724,1</sub>,
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\{\text{heap}_{funcstart\_724,1}.\text{p1}, 177\}.\text{quot}\}: 1, [0 < ((-2 * \text{div}(\text{heapIs})))]: 1, [0 < ((-2 * \text{div}(\text{heapIs})))]:
\theta_{funcstart_{-724,1}}, \theta_{funcstart_{-724,1}}, \theta_{funcstart_{-724,1}}, \theta_{funcstart_{-724,1}}, \theta_{funcstart_{-724,1}}
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1},p1, 177}.rem): 0)
\rightarrow [simplify]
[1.23] -32769 < ([0 < ((-171 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\text{heap}_{funcstart_{-724,1},p1, 177}.\text{quot}): 1, [0 < ((-2 * \text{div}(\text{heapIs})))]: 1, [0 < ((-2 * \text{div}(\text{heapIs})))]:
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs})
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1},p1, 177}.rem): 0)
\rightarrow [move guard outside expression]
\label{eq:local_local} \textit{[1.24] ([0 < ((-171 * div(\textbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1,
177).rem) + (2 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart\_724,1}, \text{\$heap}_{funcstart\_724,1}.p1,
177).quot))]: -32769 < 1, [0 < ((-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, 
\label{eq:heap_funcstart_724,1.p1} \$ \operatorname{heap_{funcstart\_724,1.p1}}, \ 177). \\ \operatorname{quot}) + (171 * \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap_{funcstart\_724,1}},
\frac{\text{heap}_{funcstart_724,1.p1, 177}.rem)}{\text{rem}} = -32769 < 0
\rightarrow [simplify]
[1.26] ([0 < ((-171 * div(heapIs heapIs funcstart_{-724,1}, heap_{funcstart_{-724,1}}.p1,
177).rem) + (2 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart\_724,1}, \text{\$heap}_{funcstart\_724,1}.p1,
177).quot))]: true, [0 < ((-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, 
\text{Sheap}_{funcstart\_724,1.p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{funcstart\_724,1}.p1, 177).rem): true
\rightarrow [all guards have equal guarded terms]
[1.27] true
```

Proof of verification condition: Type constraint satisfied in explicit conversion from 'integer' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (68,11) Condition defined at:

```
To prove: static_cast<integer>(asType<int>($heap_{724.1:749.8}.p1) <
(int)0) \leq maxof(int)
Given:
heap_{init}.LIMIT == (int)80
\theta
\theta_{init}.r1 == asType < short int > ((int)171)
\theta
\theta = asType < short int > ((int)2)
heap_{init}.M2 == asType < short int > ((int)30307)
\theta
heap_{init}.a2 == asType < short int > ((int)176)
\theta
heap_{init}.M3 == asType < short int > ((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart_{-724,1}})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \ \operatorname{\$heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}))~\%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p1) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) = =
asType<integer>(div1.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a1}) \leq
asType < integer > (\$heap_{funcstart-724.1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
```

```
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
\label{eq:div2} \text{div2} == \text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}),
asType < int > (\$heap_{funcstart\_724.1}.a2))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.rem)
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) ==
asType<integer>(div2.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a2) \le
asType < integer > (\$heap_{funcstart\_724.1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType < integer > (div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p3})) \ / \\
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3})) =>
(asType < integer > (\$heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a3) \le
asType < integer > (\$heap_{funcstart\_724,1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
```

```
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1}.\mathbf{quot})) * \mathbf{asType}{<} \mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
-{\bf asType}{<}{\bf integer~const}{>}(\${\rm heap}_{724,1;745,8}.{\rm M1})<
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{p1})
!(0 == asType < integer > (\$heap_{724,1;745,8}.p1))
asType<integer>($heap<sub>724,1:745,8</sub>.p1) <
asType<integer>($heap<sub>724.1:745.8</sub>.M1)
\text{heap}_{724.1:747.8} == \text{heap}_{724.1:745.8}._replace(p2 \rightarrow asType<short)
int>((asType<int>(asType<short int>(div2.rem)) *
\mathbf{asType} < \mathbf{int} > (\$ heap_{724,1;745,8}.r2)) - (\mathbf{asType} < \mathbf{int} > (\mathbf{asType} < \mathbf{short})
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
-asType<integer const>($heap<sub>724,1:747,8</sub>.M2) <
asType<integer>($heap<sub>724,1:747,8</sub>.p2)
!(0 == asType < integer > (\$heap_{724,1;747,8}.p2))
asType<integer>($heap<sub>724,1:747,8</sub>.p2) <
asType<integer>($heap<sub>724,1;747,8</sub>.M2)
heap_{724,1;749,8} == heap_{724,1;747,8}.replace(p3 \rightarrow asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType < int > (\$heap_{724.1:747.8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType< int>($heap_{724,1;747,8}.b3))))
-asType<integer const>($heap<sub>724,1:749,8</sub>.M3) <
asType<integer>($heap<sub>724,1:749,8</sub>.p3)
!(0 == asType < integer > (\$heap_{724,1:749.8}.p3))
asType<integer>($heap<sub>724,1:749,8</sub>.p3) <
asType<integer>($heap<sub>724,1;749,8</sub>.M3)
Proof:
[Take given term]
[11.0] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
\rightarrow [simplify]
[11.1] div1 == div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p1,
asType < int > (\$heap_{funcstart\_724,1}.a1))
\rightarrow [const static or extern object]
[11.2] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType < int > (\$heap_{init}.a1))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
```

```
\textit{[11.3]} \ \text{div1} == \text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
asType<int>(asType<short int>((int)177)))
\rightarrow [simplify]
[11.6]~{\rm div1} == {\rm div}(\mathbf{heapIs}~\$ \mathrm{heap}_{funcstart\_724,1},~\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},~177)
[Take given term]
[27.0] \operatorname{div2} == \operatorname{div}(\mathbf{heapIs} \ \operatorname{\$heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
\rightarrow [simplify]
[27.1] \operatorname{div2} == \operatorname{div}(\mathbf{heapIs} \operatorname{\$heap}_{funcstart\_724,1}, \operatorname{\$heap}_{funcstart\_724,1}.p2,
asType < int > (\$heap_{funcstart\_724,1}.a2))
\rightarrow [const static or extern object]
\label{eq:continuous} \mbox{[27.2]} \mbox{ div2} == \mbox{div}(\mbox{\bf heapIs} \mbox{ \$heap}_{funcstart\_724,1}, \mbox{ \$heap}_{funcstart\_724,1}.\mbox{p2},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{init}.\mathrm{a2}))
\rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
[27.3] div2 == div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p2,
asType<int>(asType<short int>((int)176)))
\rightarrow [simplify]
[27.6] \text{ div2} == \text{div}(\mathbf{heapIs} \$ heap_{funcstart\_724,1}, \$ heap_{funcstart\_724,1}.p2, 176)
[Take given term]
[43.0] \operatorname{div3} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > ($heap_{funcstart\_724,1}.p3),
asType < int > (\$heap_{funcstart\_724,1}.a3))
\rightarrow [simplify]
[43.1] div3 == div(heapIs $heap_{tuncstart\_724.1}, $heap_{tuncstart\_724.1}.p3,
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
\rightarrow [const static or extern object]
[43.2]~{\rm div3} == {\rm div}(\mathbf{heapIs}~\$ \mathrm{heap}_{funcstart\_724,1},\,\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3},
asType < int > (\$heap_{init}.a3))
\rightarrow [expand definition of constant 'a3' at prang.c (26,20)]
[43.3] \ \mathrm{div3} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3},
asType<int>(asType<short int>((int)178)))
\rightarrow [simplify]
[43.6] div3 == div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178)
[Take given term]
[59.0] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
```

```
int>((asType<int>(asType<short int>(div1.rem)) *
\mathbf{asType} \hspace{-0.1em}<\hspace{-0.1em} \mathbf{int} \hspace{-0.1em}> \hspace{-0.1em} (\$ heap_{funcstart\_724,1}.r1)) - (\mathbf{asType} \hspace{-0.1em}<\hspace{-0.1em} \mathbf{int} \hspace{-0.1em}> \hspace{-0.1em} (\mathbf{asType} \hspace{-0.1em}<\hspace{-0.1em} \mathbf{short})
\mathbf{int}{>}(\mathbf{div1.quot})) * \mathbf{asType}{<} \mathbf{int}{>} (\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{tuncstart_724.1},
heap_{funcstart_{-724,1},p1,177}
[59.1] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},))
\theta_{funcstart\_724,1}.p1, 177).rem ** asType<int>($\text{heap}_{funcstart\_724,1}.r1)) -
(asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart, 724,1}.b1)))
\rightarrow [simplify]
[59.3] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
\rightarrow [const static or extern object]
[59.4] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType < int > (\$heap_{init}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1.quot})) * \mathbf{asType}{<} \mathbf{int}{>} (\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
\rightarrow [expand definition of constant 'r1' at prang.c (15,20)]
[59.5] heap_{724,1:745,8} == heap_{funcstart\_724,1}-replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType<int>(asType<short int>((int)171))) -
(asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [simplify]
[59.8] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int > ((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem * 171)
- (asType < int > (asType < short int > (div1.quot))
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724.1},
heap_{funcstart_{-724,1}}.p1, 177
[59.9] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).rem)
- (asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},))
heap_{funcstart_{724,1},p1,177}, quot)) *
asType < int > (\$heap_{funcstart\_724,1}.b1)))
\rightarrow [simplify]
[59.11] \text{heap}_{724,1:745,8} == \text{heap}_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
```

```
int>((171 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [const static or extern object]
[59.12] \rho_{12} = \rho_{124,1;745,8} = \rho_{124,1;74
int>((171 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType < int > (\$heap_{init}.b1)))
\rightarrow [expand definition of constant 'b1' at prang.c (17,20)]
\text{[59.13] $\$heap_{724,1;745,8} == \$heap_{funcstart\_724,1}.\_\textbf{replace}(p1 \rightarrow \textbf{asType} < \textbf{short})$}
int>((171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{short}\ \mathbf{int}{>}((\mathbf{int})2))))
\rightarrow [simplify]
[59.19] $\text{heap}_{724,1;745,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}. p1, 177).rem)))
[Take given term]
[61.0]!(0 == asType < integer > (\$heap_{724.1:745.8}.p1))
\rightarrow [from term 59.19, $heap<sub>724,1:745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs p_{funcstart\_724,1}),
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1}, 177).quot) + (171 * div(heapIs $heap_{funcstart\_724,1}, 17
heap_{funcstart_{-724,1}.p1, 177}.rem)
[61.1]!(0 == asType < integer > (\$heap_{funcstart\_724.1}.\_replace(p1 \rightarrow ((-2 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, \ 177).\operatorname{rem}))).\operatorname{p1}))
\rightarrow [simplify]
[61.3] !(0 == ((-2 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1,
177).quot) + (171 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).rem)))
[Take given term]
[63.0] $heap<sub>724.1:747.8</sub> == $heap<sub>724.1:745.8</sub>._replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
\mathbf{asType} < \mathbf{int} > (\$ heap_{724,1;745,8}.r2)) - (\mathbf{asType} < \mathbf{int} > (\mathbf{asType} < \mathbf{short})
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [from term 59.19, $heap<sub>724,1:745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177).rem)
```

```
[63.1] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\label{eq:div_heap} \text{div}(\textbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
(177).rem))).\_replace(p2 \rightarrow asType < short)
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724,1:745,8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{tuncstart_{724.1}},
heap_{funcstart_{-724,1}}.p2, 176
[63.2] $heap<sub>724,1:747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\label{eq:div_heap} \text{div}(\textbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).rem))).\_replace(p2 \rightarrow asType < short
int>((asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},
\label{eq:funcstart_724,1.p2} $$ \text{heap}_{funcstart_724,1.p2},\ 176).rem)) * asType < int > ($$ \text{heap}_{724,1;745,8.r2})) - $$
(asType<int>(asType<short int>(div2.quot)) *
asType < int > (\$heap_{724,1;745,8}.b2))))
\rightarrow [simplify]
[63.4] $heap<sub>724,1:747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem *
asType < int > (\$heap_{724.1:745.8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [from term 59.19, $heap<sub>724,1:745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724,1}),
\text{Sheap}_{funcstart\ 724,1}, p1,\ 177).quot) + (171 * div(\textbf{heapIs}\ \text{Sheap}_{funcstart\ 724,1},
heap_{funcstart_{-724,1}}.p1, 177).rem)
[63.5] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((\operatorname{div}(\mathbf{heapIs}))))
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}.p2, 176).rem *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathbf{\_replace}(\mathrm{p1} \rightarrow ((-2 * \mathrm{div}(\mathbf{heapIs}
\text{Sheap}_{funcstart_{-724,1}}, \text{Sheap}_{funcstart_{-724,1}}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs}))
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 177).rem)).r2)) -
(asType<int>(asType<short int>(div2.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\${\rm heap}_{724,1;745,8}.{\rm b2}))))
→ [const member of object with modified fields]
[63.6] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
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\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
(177).rem))._replace(p2 \rightarrow asType<short int>((div(heapIs)))._replace(p2)
\rho_{funcstart_{724,1}}, \rho_{funcstart_{724,1},p2, 176}.rem *
asType < int > (\$heap_{funcstart\_724,1}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724,1:745,8</sub>.b2))))
\rightarrow [const static or extern object]
[63.7] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem *
asType < int > (\$heap_{init}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724,1:745.8</sub>.b2))))
\rightarrow [expand definition of constant 'r2' at prang.c (20,20)]
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem))). replace(p2 \rightarrow asType < short int > ((div(heapIs))) = (div(heapIs))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem} *
asType<int>(asType<short int>((int)172))) -
(asType<int>(asType<short int>(div2.quot)) *
asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [simplify]
[63.11] $\text{heap}_{724,1:747,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}. p1, \ 177). \operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((\operatorname{div}(\mathbf{heapIs}))))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem} * 172) -
(asType<int>(asType<short int>(div2.quot)) *
asType < int > (\$heap_{724,1;745,8}.b2))))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{funcstart_{724,1}},
heap_{funcstart_{-724,1}}.p2, 176
[63.12] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem) -
(asType<int>(asType<short int>(div(heapIs $heap_{funcstart_724.1},
\text{sheap}_{funcstart\_724,1.p2, 176}.\text{quot}) * asType < int > (\text{sheap}_{724,1:745,8}.\text{b2}))))
\rightarrow [simplify]
[63.14] $\text{heap}_{724,1;747,8} == \text{$heap}_{funcstart\_724,1}._\text{$replace}(p1 \to ((-2 *
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\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 176).quot *
asType < int > (\$heap_{724,1;745,8}.b2))))
\rightarrow [from term 59.19, $heap<sub>724,1;745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs *heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724.1}.p1, 177).quot) + (171 * div(\text{heapIs } \text{Sheap}_{funcstart\_724.1},
heap_{funcstart_{-724,1}}.p1, 177).rem)
[63.15] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem}) - (\text{div}(\textbf{heapIs})
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, 2, 176).quot *
asType < int > (\$heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * div(heapIs)))))))
\text{Sheap}_{funcstart_{-724,1}}, \text{Sheap}_{funcstart_{-724,1}}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs})
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).rem))).b2))))
\rightarrow [const member of object with modified fields]
[63.16] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}.p2, 176).quot *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b2}))))
\rightarrow [const static or extern object]
[63.17] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((172 * div(\mathbf{heapIs}))))
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}.p2, 176).quot
asType < int > (\$heap_{init}.b2)))
\rightarrow [expand definition of constant 'b2' at prang.c (22,20)]
[63.18] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 2, 176).quot *
```

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asType<int>(asType<short int>((int)35)))))
\rightarrow [simplify]
[63.24] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p2, 176).rem}
[Take given term]
[67.0] $heap<sub>724.1:749.8</sub> == $heap<sub>724.1:747.8</sub>._replace(p3 \rightarrow asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType < int > (\$heap_{724,1.747,8.}r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap<sub>724,1:747,8</sub>.b3))))
\rightarrow [from term 63.24, $heap<sub>724,1:747,8</sub> is equal to
heap_{funcstart\_724.1}._replace(p1 \rightarrow ((-2 * div(heapIs heap_{funcstart\_724.1}),
heap_{funcstart_{724,1},p1, 177}, quot) + (171 * div(heapIs p_{funcstart_{724,1},p1, 177}), quot)
\rho_{funcstart\_724.1}.p1, 177).rem)._replace\rho_{funcstart\_724.1}.p1, 177).rem)._replace
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem))]
[67.1] $\text{heap}_{724,1:749,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{tuncstart_{-724,1},p2, 176,rem})._replace(p3 \rightarrow asType<short
int>((asType<int>(asType<short int>(div3.rem))
asType < int > (\$heap_{724,1;747,8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType< int>($heap_{724,1;747,8}.b3))))
\rightarrow [from term 43.6, div3 is equal to div(heapIs $heap_{tuncstart_724.1},
heap_{funcstart_{-724,1}}.p3, 178
[67.2] \rho_{7.24,1;749,8} == \rho_{1.749,1}.\_replace(p1 \rightarrow ((-2 * p1.54)))
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{tuncstart_724.1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{funcstart\_724,1}.p2, 176).rem))._replace(p3 \rightarrow asType<short
int>((asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart_724,1.p3}, 178).\text{rem}) * asType < int > (\text{Sheap}_{724,1:747,8.r3})) -
(asType<int>(asType<short int>(div3.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{724,1;747,8}.\mathrm{b3}))))
\rightarrow [simplify]
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[67.4] $\text{heap}_{724,1;749,8} == $\text{heap}_{funcstart\_724,1}._\text{-replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1}.p2, 176).rem))).\_replace(p3 \rightarrow asType < hort)
int>((div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p3, 178).rem *
asType < int > (\$heap_{724,1:747,8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap<sub>724.1:747.8</sub>.b3))))
\rightarrow [from term 63.24, $heap<sub>724,1;747,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1},p1, 177}, quot) + (171 * div(heapIs heap_{funcstart_{-724,1},p1, 177})
heap_{funcstart\_724.1}.p1, 177).rem))._replace(p2 \rightarrow (-35 * div(heapIs)))._
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p2, 176).rem)
[67.5] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724.1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724.1},
\theta_{uncstart_724.1.p2, 176}.rem)._replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem *
asType < int > (\$heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * div(heapIs)))))))
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p1, 177).quot) + (171 * div(heapIs
\theta_{funcstart=724,1}, \theta_{funcstart=724,1}
* div(heapIs heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 176).quot + (172 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p2, \ 176).rem))).r3)) -
(asType<int>(asType<short int>(div3.quot)) *
asType < int > (\$heap_{724,1;747,8}.b3))))
→ [const member of object with modified fields]
[67.7] $heap<sub>724,1:749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}. \operatorname{pl},
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart_{724,1},p2,176}.rem)._replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem *
asType < int > (\$heap_{funcstart\_724,1}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap<sub>724,1:747,8</sub>.b3))))
\rightarrow [const static or extern object]
[67.8] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
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177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs} \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2, 176}.rem))._replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem *
asType < int > (\$heap_{init}.r3)) - (asType < int > (asType < short)
int > (div3.quot)) * asType < int > ($heap_{724,1:747,8}.b3))))
\rightarrow [expand definition of constant 'r3' at prang.c (25,20)]
[67.9] \rho_{7.9,1;749,8} == \rho_{1.749,1}.\_replace(p1 \rightarrow ((-2 * p1.5) + p1.5))
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{funcstart\_724,1}.p2, 176).rem))).replace(p3 \rightarrow asType < short)
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem *
asType<int>(asType<short int>((int)170))) -
(asType<int>(asType<short int>(div3.quot)) *
asType < int > (\$heap_{724,1;747,8}.b3))))
\rightarrow [simplify]
[67.12] $\text{heap}_{724,1:749.8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724.1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724.1},
\theta_{tunestart, 724, 1.p2, 176}.rem)._replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem * 170)
- (asType<int>(asType<short int>(div3.quot)) *
asType < int > (\$heap_{724.1:747.8}.b3)))
\rightarrow [from term 43.6, div3 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1}}.p3, 178
[67.13] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724.1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{uncstart\_724,1.p2, 176}.rem)._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart_{-724.1}}, heap_{funcstart_{-724.1}}, 178).rem) -
(asType<int>(asType<short int>(div(heapIs $heap_{funcstart_724,1},))
\text{sheap}_{funcstart\_724,1.p3}, 178).\text{quot}) * asType < int > (\text{sheap}_{724,1:747.8.b3})))
\rightarrow [simplify]
[67.15] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
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177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs} \text{Sheap}_{funcstart\_724,1}),
\rho_{funcstart\_724,1}.p2, 176).rem))._replace(p3 \rightarrow asType<short int>((170)
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}, 178).rem) –
(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} *
asType < int > (\$heap_{724,1;747,8}.b3))))
\rightarrow [from term 63.24, $heap<sub>724,1;747,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs *heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724.1}.p1, 177).quot) + (171 * div(\text{heapIs } \text{Sheap}_{funcstart\_724.1},
\rho_{months, replace}(p2 \rightarrow (-35 * div(\mathbf{heapIs}))).
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, p2, 176).rem)
[67.16] $\text{heap}_{724,1:749.8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{tuncstart_724.1}.p2, 176).rem))._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) –
(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).quot *
asType < int > (\$heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * div(heapIs)))))))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs})
* div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, p2, 176).quot) + (172 *
\operatorname{div}(\mathbf{heapIs} \ \text{Sheap}_{funcstart\_724.1}, \ \text{Sheap}_{funcstart\_724.1}, \operatorname{p2}, 176).\operatorname{rem}))).\operatorname{b3}))))
→ [const member of object with modified fields]
[67.18] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{tuncstart_724.1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{tuncstart\_724,1.p2, 176}.rem)._replace(p3 \rightarrow asType<short int>((170
* \operatorname{div}(\mathbf{heapIs} \ \text{$heap}_{funcstart\_724,1}, \ \text{$heap}_{funcstart\_724,1}.p3, \ 178).rem) -
(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.p3, 178).\text{quot} *
asType < int > (\$heap_{funcstart\_724,1}.b3))))
\rightarrow [const static or extern object]
[67.19] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{tuncstart\_724,1.p2, 176}.rem)._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) –
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(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} *
asType < int > (\$heap_{init}.b3)))
\rightarrow [expand definition of constant 'b3' at prang.c (27,20)]
[67.20] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{tuncstart\_724,1.p2, 176}.rem)._replace(p3 \rightarrow asType<short int>((170
* div(heapIs $heap_{uncstart_{724,1}}, $heap_{uncstart_{724,1}}.p3, 178).rem) -
(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} *
asType<int>(asType<short int>((int)63)))))
\rightarrow [simplify]
[67.26] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\text{heap}_{tuncstart\_724.1.p2}, 176).rem))._replace(p3 \rightarrow ((-63 * div(heapIs)
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}.p3, 178).quot) + (170 * div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 178).rem)
[Take goal term]
[1.0] static_cast<integer>(asType<int>($heap<sub>724.1:749.8</sub>.p1) < (int)0) \leq
maxof(int)
\rightarrow [from term 67.26, $heap<sub>724,1;749,8</sub> is equal to
\text{Sheap}_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1}), the sheap funcstart\_724,1).
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724.1}.p1, 177).rem))).\_replace(p2 \rightarrow ((-35 * div(heapIs))).\_replace(p2 \rightarrow ((-35 * div(heapIs))))._replace(p2 \rightarrow ((-35 * div(heapIs))))._replace(p2 \rightarrow ((-35 * div(heapIs)))))._replace(p2 \rightarrow ((-35 * div(heapIs))))._replace(p2 \rightarrow ((-35 * div(heapIs)))))._replace(p2 \rightarrow ((-35 * div(heapIs)))))._replace(p2 \rightarrow ((-35 * div(heapIs))))._replace(p2 \rightarrow ((-35 * div(heapIs)))))._replace(p2 \rightarrow ((-35 * div(heapIs)))))._replace(p2 \rightarrow ((-35 * div(heapIs)))))._replace(p2 \rightarrow ((-35 * div(heapIs))))))._replace(p2 \rightarrow ((-35 * div(heapIs)))))._replace(p2 \rightarrow ((-35 * div(heapIs))))))
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}, p2, p3, p3, p4, 
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).quot) + (170 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).rem))]
[1.1] static_cast<integer>(asType<int>($heap_{tuncstart\_724.1}._replace(p1
\rightarrow ((-2 * div(heapIs $heap_{tuncstart\_724.1}, $heap_{tuncstart\_724.1}.p1, 177).quot) +
(171 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724.1.p2}, 176).rem))._replace(p3 \rightarrow ((-63 * div(heapIs)
\text{Sheap}_{funcstart_{-724,1}}, \text{Sheap}_{funcstart_{-724,1}}.p3, 178).quot) + (170 * div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{rem})).\text{p1}) < (\text{int})0) \le
maxof(int)
\rightarrow [simplify]
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 [1.13] ([0 < ((-171*div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1,
177).rem) + (2 * \text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1},
(177).quot): 1, []: 0) \leq maxof(int)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
 \label{eq:continuous} \textit{[1.14]} \; ( \mbox{[0 < ((-171 * div(\mathbf{heapIs} \; \$heap_{funcstart\_724,1}, \, \$heap_{funcstart\_724,1}.p1, \, } \mbox{$ \mbox{[1.14]} \; (\mbox{[0 < ((-171 * div(\mathbf{heapIs} \; \$heap_{funcstart\_724,1}, \, \$heap_{funcstart\_724,1}.p1, \, $ \mbox{$ \mbox{[1.14]} \; (\mbox{[0 < ((-171 * div(\mathbf{heapIs} \; \$heap_{funcstart\_724,1}, \, \$heap_{funcstart\_724,1}.p1, \, $ \mbox{$ \mbox{[1.14]} \; (\mbox{[0 < ((-171 * div(\mathbf{heapIs} \; \$heap_{funcstart\_724,1}, \, \$heap_{funcstart\_724,1}.p1, \, $ \mbox{$ \mbox{[1.14]} \; (\mbox{[0 < ((-171 * div(\mathbf{heapIs} \; \$heap_{funcstart\_724,1}, \, \$heap_{funcstart\_724,1}.p1, \, $ \mbox{$ \mbox{[1.14]} \; (\mbox{[0 < ((-171 * div(\mathbf{heapIs} \; \$heap_{funcstart\_724,1}, \, \$heap_{funcstart\_724,1}.p1, \, $ \mbox{$ \mbox{[0 < ((-171 * div(\mathbf{heapIs} \; \$heap_{funcstart\_724,1}.p1, \, \$heap_{funcstart\_724,1}.p1, \, $ \mbox{$ \mbox{[0 < ((-171 * div(\mathbf{heapIs} \; \$heap_{funcstart\_724,1}, \, \$heap_{funcstart\_724,1}.p1, \, $ \mbox{$ \mbox{[0 < ((-171 * div(\mathbf{heapIs} \; \$heap_{funcstart\_724,1}, \, \$heap_{funcstart\_724,1}.p1, \, $ \mbox{$ \mbox{[0 < ((-171 * div(\mathbf{heapIs} \; \$heap_{funcstart\_724,1}.p1, \, \$heap_{funcstart\_724,1}.p1, \, $ \mbox{$ \mbox{[0 < ((-171 * div(\mathbf{heapIs} \; \$heap_{funcstart\_724,1}.p1, \, \$heap_{funcstart\_724,1}.p1, \, $ \mbox{$ \mbox{[0 < ((-171 * div(\mathbf{heapIs} \; \$heap_{funcstart\_724,1}.p1, \, \$heap_{funcstart\_724,1}.p1, \, $ \mbox{$ \mbox{[0 < ((-171 * div(\mathbf{heapIs} \; \$heap_{funcstart\_724,1}.p1, \, \$heap_{funcstart\_724,1}.p1, \, $ \mbox{$ \mbox{[0 < ((-171 * div(\mathbf{heapIs} \; \$heap_{funcstart\_724,1}.p1, \, \$heap_{funcstart\_724,1}.p1, \, $ \mbox{$ \mbox{[0 < ((-171 * div(\mathbf{heapIs} \; \$heap_{funcstart\_724,1}.p1, \, \$heap_{funcstart\_724,1}.p1, \, $ \mbox{$ \mbox{[0 < ((-171 * div(\mathbf{heapIs} \; \$heap_{funcstart\_724,1}.p1, \, \$heap_{funcstart\_724,1}.p1, \, $ \mbox{$ \mbox{[0 < ((-171 * div(\mathbf{heapIs} \; \$heap_funcstart\_724,1].p1, \, $ \mbox{$ \mbox{[0 < ((-171 * div(\mathbf{heapIs} \; \$heap_funcstart\_724,1].p1, \, $ \mbox{$ \mbox{[0 < ((-171 * div(\mathbf{heapIs} \; \$heap_funcstart\_724,1].p1, \, $ \mbox{$ \mbox{$ \mbox{[0 < ((-171
177).rem) + (2 * \text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724.1}, \$ \text{heap}_{funcstart\_724.1}.\text{p1},
177).quot))]: 1, [!(0 < ((-171 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot))): 0) \leq maxof(int)
\rightarrow [simplify]
\label{eq:continuous} \textit{[1.19]} \; ([0 < ((-171 \; * \; \mathrm{div}(\mathbf{heapIs} \; \$ \mathrm{heap}_{funcstart\_724,1}, \; \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}, \;
177).rem) + (2 * \text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724.1}, \$ \text{heap}_{funcstart\_724.1}.\text{p1},
177).quot))]: 1, [-1 < ((171 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + (-2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\{\text{heap}_{funcstart\_724,1}.\text{p1}, 177\}.\text{quot}\}: 0 \le \max(\text{int})
\rightarrow [from term 61.3, -1 < ((-2 * div(heapIs $heap_{funcstart_724.1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).rem is true if and only if 0 < ((-2 * div(\mathbf{heapIs})))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1, 177).quot) + (171 * div(heapIs)
heap_{funcstart_{724.1}}, heap_{funcstart_{724.1}}, 177).rem)
 \label{eq:continuous} \mbox{ $[1.20] ([0 < ((-171 * div(\mathbf{heapIs} \$ heap_{funcstart\_724,1}, \$ heap_{funcstart\_724,1}.p1,
177).rem) + (2 * \text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.p1,
177).quot))]: 1, [0 < ((-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724.1}, 
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\frac{\text{sheap}_{funcstart\_724,1.p1, 177}.rem)}{0} \le maxof(int)
\rightarrow [simplify]
[1.22] (-1 + ([0 < ((-171 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}): 1, [0 < ((-2 * \text{div}(\textbf{heapIs})))]: 1, [0 < ((-2 * \text{div}(\textbf{heapIs})))]:
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).quot) + (171 * div(heapIs)
\{\text{heap}_{funcstart\_724,1}, \{\text{heap}_{funcstart\_724,1}.p1, 177\}.rem\}\}: 0)) < 32767
\rightarrow [move guard outside expression]
 \label{eq:continuous} \mbox{$[1.23]$ ([0 < ((-171 * div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p1, \ }) ) ) ) ) ) } } \mbox{$[-1.23]$ ([0 < ((-171 * div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p1, \ })] ) ] ) ] ) } \mbox{$[-1.23]$ ([0 < ((-171 * div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p1, \ }) ] ) ] ) ] ) ] ) | ([0 < ((-171 * div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap
177).rem) + (2 * \text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).quot))]: -1 + 1, [0 < ((-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, 
\rho_{tuncstart_{-724.1},p1, 177} = 177 + (171 * div(heapIs $heap_{tuncstart_{-724.1},p1})
\rightarrow [simplify]
[1.26]\ 0 < (32767 + -([0 < ((-171 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p1}, 177).\text{quot}): 0, [0 < ((-2 * \text{div}(\textbf{heapIs})))]: 0, [0 < ((-2 * \text{div}(\textbf{heapIs})))]:
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\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs}))
\{\text{heap}_{funcstart\_724,1}, \{\text{heap}_{funcstart\_724,1}.p1, 177\}.rem\}\}: -1))
\rightarrow [move guard outside expression]
[1.27] \ 0 < (32767 + ([0 < ((-171 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).quot) + (171 * div(heapIs)
\frac{\text{sheap}_{funcstart_{724,1}}, \text{sheap}_{funcstart_{724,1}.p1, 177).rem}}{\text{cm}} = -1)}
\rightarrow [simplify]
[1.29] 0 < (32767 + ([0 < ((-171 * div(heapIs $heap_{funcstart\_724.1}), 
\text{Sheap}_{funcstart_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart_724,1},
\text{Sheap}_{funcstart_{-724,1},p1, 177}.\text{quot}): 0, [0 < ((-2 * \text{div}(\textbf{heapIs})))]: 0, [0 < ((-2 * \text{div}(\textbf{heapIs})))]:
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
\label{eq:heap_funcstart_724,1} \$ heap_{funcstart\_724,1}.p1,\ 177).rem))]:\ 1))
\rightarrow [move guard outside expression]
[1.30] \ 0 < ([0 < ((-171 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\{\text{heap}_{funcstart\_724,1}.\text{p1}, 177\}.\text{quot}\}: 0 + 32767, [0 < ((-2 * \text{div}(\text{heapIs})))]: 0 + 32767, [0 < ((-2 * \text{div}(\text{heapIs})))]
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1},p1, 177}.quot + (171 * div(heapIs))
\frac{\text{sheap}_{funcstart\_724,1}, \text{sheap}_{funcstart\_724,1}.p1, 177).rem)}{1 + 32767}
\rightarrow [simplify]
[1.32] \ 0 < ([0 < ((-171 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724.1.p1, 177}.\text{rem} + (2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724.1,})
\text{Sheap}_{funcstart\_724,1.p1, 177}.\text{quot}): 32767, [0 < ((-2 * \text{div}(\textbf{heapIs})))]: 32767, [0 < ((-2 * \text{div}(\textbf{heapIs})))]:
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1},p1, 177}.quot + (171 * div(heapIs))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1, 177).rem): 32768)
\rightarrow [move guard outside expression]
[1.33] ([0 < ((-171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1,
177).rem) + (2 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart\_724,1}, \text{\$heap}_{funcstart\_724,1}.p1,
177).quot))]: 0 < 32767, [0 < ((-2 * div(heapIs $heap_{funcstart\_724,1}, 
\theta_{funcstart\_724,1.p1}, 177).quot) + (171 * div(heapIs \theta_{funcstart\_724,1},
\frac{\text{sheap}_{funcstart\_724,1.p1, 177}.rem)}{0}: 0 < 32768}
\rightarrow [simplify]
[1.35] ([0 < ((-171 * div(heapIs heapIs funcstart_{724,1}, heap_{funcstart_{724,1}}, p1,
177).rem) + (2 * \text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.p1,
177).quot))]: true, [0 < ((-2 * div(\textbf{heapIs } \$heap_{funcstart\_724,1}, 
\text{Sheap}_{funcstart\_724,1.p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\frac{\text{sheap}_{funcstart_{724,1}.p1, 177}.rem)}{\text{true}}
\rightarrow [all guards have equal guarded terms]
[1.36] true
```

```
limit of type 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (68,25)
Condition defined at:
To prove: minof(int) \le (asType < int > (\$heap_{724,1;749,8}.M1) *
\mathbf{asType} < \mathbf{int} > (\mathbf{static\_cast} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{724,1:749.8}.\mathrm{p1}) < \mathsf{nt}) < \mathsf{nt} > \mathsf{nt} >
(\mathbf{int})(0)
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
\theta_{init}.a1 == asType<short int>((int)177)
heap_{init}.M2 == asType < short int > ((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
\theta_{init}.a2 == asType<short int>((int)176)
\theta == asType<short int>((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs $heap_{tuncstart_724.1})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ / \\
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(\mathbf{asType} {<} \mathbf{int} {>} (\mathbf{asType} {<} \mathbf{int} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
```

Proof of verification condition: Arithmetic result of operator '*' is within

 $(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart_724,1}.\mathsf{p1}) <$

```
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a1})) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) ==
asType < integer > (div1.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a1}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart_{-724,1}}.a2))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.quot)
(asType<int>(asType<int>($heap_{tuncstart\_724.1}.p2)) %
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p2) = =
asType<integer>(div2.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.a2) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724.1}.p3),
asType < int > (\$heap_{funcstart\_724,1}.a3))
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}))\ /
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathtt{a3}))) ==
asType<integer>(div3.quot)
(asType<integer>(asType<int>($heap_{tuncstart\_724.1}.p3)) %
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a3}))) = =
asType<integer>(div3.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a3})) =>
(asType < integer > ($heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a3}) \leq
```

```
asType < integer > (\$heap_{funcstart-724.1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
\$heap_{724,1;745,8} == \$heap_{funcstart\_724,1}.\_\mathbf{replace}(p1 \to \mathbf{asType} < \mathbf{short}
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724.1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
-asType<integer const>($heap<sub>724,1:745,8</sub>.M1) <
asType<integer>($heap<sub>724.1:745.8</sub>.p1)
!(0 == asType < integer > (\$heap_{724,1;745,8}.p1))
asType < integer > (\$heap_{724,1;745,8}.p1) <
asType<integer>($heap<sub>724,1:745,8</sub>.M1)
\text{heap}_{724.1:747.8} == \text{heap}_{724.1:745.8}._replace(p2 \rightarrow asType<short)
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724,1;745,8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType< int>($heap_{724,1;745,8}.b2))))
-asType<integer const>($heap<sub>724,1:747,8</sub>.M2) <
asType<integer>($heap<sub>724.1:747.8</sub>.p2)
!(0 == asType < integer > (\$heap_{724,1;747,8}.p2))
{\bf asType}{<} {\bf integer}{>} (\$ {\rm heap}_{724,1;747,8}.{\rm p2}) <
asType<integer>($heap<sub>724,1;747,8</sub>.M2)
heap_{724,1:749.8} == heap_{724,1:747.8}._replace(p3 \rightarrow asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType < int > (\$heap_{724.1:747.8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType< int>($heap_{724,1;747,8}.b3))))
-asType < integer const > (\$heap_{724,1:749,8}.M3) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;749,8}.\mathrm{p3})
!(0 == asType < integer > (\$heap_{724,1;749,8}.p3))
asType<integer>($heap<sub>724,1:749,8</sub>.p3) <
asType<integer>($heap<sub>724.1:749.8</sub>.M3)
Proof:
[Take given term]
[11.0] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a1}))
\rightarrow [simplify]
[11.1] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
```

```
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
\rightarrow [const static or extern object]
[11.2] div1 == div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1},
asType < int > (\$heap_{init}.a1))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
[11.3] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType < int > (asType < short int > ((int)177)))
\rightarrow [simplify]
[11.6] div1 == div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1, 177)
[Take given term]
[27.0] div2 == div(heapIs $heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
\rightarrow [simplify]
\label{eq:continuous} \textit{[27.1]} \ \text{div2} == \ \text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p2},
asType < int > (\$heap_{funcstart\_724,1}.a2))
\rightarrow [const static or extern object]
[27.2] div2 == div(heapIs $heap_{funcstart\_724.1}, $heap_{funcstart\_724.1}.p2,
asType < int > (\$heap_{init}.a2))
\rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
[27.3] \ \mathrm{div2} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2},
asType<int>(asType<short int>((int)176)))
\rightarrow [simplify]
[27.6]~{\rm div2} == {\rm div}(\mathbf{heapIs}~\$ \mathrm{heap}_{funcstart\_724,1},~\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2},~176)
[Take given term]
[43.0] div3 == div(heapIs $heap_{tuncstart\_724.1},
asType < int > (\$heap_{funcstart\_724.1}.p3),
asType < int > (\$heap_{funcstart\_724,1}.a3))
\rightarrow [simplify]
[43.1] div3 == div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p3,
asType < int > (\$heap_{funcstart\_724,1}.a3))
\rightarrow [const static or extern object]
[43.2] \ \mathrm{div3} == \ \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3},
asType < int > (\$heap_{init}.a3))
\rightarrow [expand definition of constant 'a3' at prang.c (26,20)]
[43.3] \operatorname{div3} == \operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p3,
```

```
asType<int>(asType<short int>((int)178)))
\rightarrow [simplify]
[43.6] div3 == div(heapIs $heap_{funcstart\_724,1}$, $heap_{funcstart\_724,1}.p3, 178)
[Take given term]
[59.0] \rho_{1745,8} == \rho_{1745,8} == \rho_{1745,8} == \rho_{1745,8} - \rho_{1745,8} == \rho_{1745,8}
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{tuncstart\_724.1}.b1))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart_{724,1}},
heap_{funcstart_{-724,1}}.p1, 177)
[59.1] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div(heapIs $heap_{tuncstart\_724.1},
\text{sheap}_{funcstart\_724.1}.\text{p1}, 177).\text{rem}) * asType < int > (\text{sheap}_{funcstart\_724.1}.\text{r1})) -
(asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [simplify]
[59.3] \rho_{724,1;745,8} == \rho_{funcstart\_724,1}.\_replace(p1 \rightarrow asType < short)
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1.quot})) \ * \ \mathbf{asType}{<} \mathbf{int}{>} (\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
\rightarrow [const static or extern object]
[59.4] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType < int > (\$heap_{init}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{tuncstart\_724.1}.b1))))
\rightarrow [expand definition of constant 'r1' at prang.c (15,20)]
[59.5] \rho_{724,1;745,8} == \rho_{funcstart\_724,1}.\_replace(p1 \rightarrow asType < short)
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType<int>(asType<short int>((int)171))) -
(asType<int>(asType<short int>(div1.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [simplify]
[59.8] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem * 171)
- (asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart_724,1},
heap_{funcstart_{-724,1}}.p1, 177
[59.9] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
```

```
int>((171 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)
- (asType<int>(asType<short int>(div(heapIs $heap_{funcstart_724,1},))
heap_{funcstart_{724,1}}.p1, 177).quot) *
asType < int > (\$heap_{funcstart\_724,1}.b1)))
\rightarrow [simplify]
[59.11] \theta == 
int>((171 * div(heapIs $heap_{funcstart_724,1}, $heap_{funcstart_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [const static or extern object]
[59.12] $\text{heap}_{724.1:745.8} == $\text{heap}_{funcstart\_724.1}._\text{replace}(p1 \rightarrow \text{asType} < \text{short}
int>((171 * div(heapIs \$heap_{tuncstart\_724.1}, \$heap_{tuncstart\_724.1}, p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{init}.\mathrm{b1}))))
\rightarrow [expand definition of constant 'b1' at prang.c (17,20)]
[59.13] heap_{724,1;745,8} == heap_{funcstart\_724,1}. replace(p1 \rightarrow asType<short
int>((171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\textbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType < int > (asType < short int > ((int)2))))
\rightarrow [simplify]
[59.19] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).rem)))
[Take given term]
[61.0]!(0 == asType < integer > (\$heap_{724.1:745.8}.p1))
\rightarrow [from term 59.19, $heap<sub>724,1:745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs p_{funcstart\_724,1})
heap_{funcstart_{-724,1}.p1, 177).rem}
[61.1] !(0 == asType<integer>(heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).rem))).p1))
\rightarrow [simplify]
\textit{[61.3] !} (0 == ((-2 * \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1},
177).quot) + (171 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).rem)))
[Take given term]
[63.0] $heap<sub>724.1:747.8</sub> == $heap<sub>724.1:745.8</sub>._replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
```

```
asType < int > (\$heap_{724.1:745.8}.r2)) - (asType < int > (asType < short)
int > (div2.quot)) * asType < int > (\$heap_{724,1:745,8}.b2))))
\rightarrow [from term 59.19, $heap<sub>724,1:745,8</sub> is equal to
heap_{funcstart\_724.1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724.1}),
heap_{funcstart_{724,1},p1, 177}, quot) + (171 * div(heapIs p_{funcstart_{724,1},p1, 177}), quot)
\$heap_{funcstart\_724,1}.p1,\ 177).rem))]
[63.1] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
div(\mathbf{heapIs} \ \text{$heap}_{funcstart\_724,1}, \ \text{$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
(177).rem))._replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724,1:745,8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724,1:745,8</sub>.b2))))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{tuncstart_{724.1}},
heap_{funcstart_{-724,1},p2,176}
[63.2] \rho_{13,1747,8} == \rho_{13,1747,8} 
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
(177).rem))._replace(p2 \rightarrow asType<short
\mathbf{int}{>}((\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{short}\ \mathbf{int}{>}(\mathbf{div}(\mathbf{heapIs}\ \$\mathbf{heap}_{funcstart\_724,1},
\text{sheap}_{funcstart\_724,1.p2, 176}.\text{rem}) * asType < int > (\text{sheap}_{724,1:745,8}.\text{r2})) -
(asType<int>(asType<short int>(div2.quot)) *
asType < int > (\$heap_{724,1;745,8}.b2))))
\rightarrow [simplify]
[63.4] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem *
\mathbf{asType} < \mathbf{int} > (\$ heap_{724,1;745,8}.r2)) - (\mathbf{asType} < \mathbf{int} > (\mathbf{asType} < \mathbf{short})
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [from term 59.19, $heap<sub>724,1;745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs \$heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.p1, 177).quot + (171 * div(\textbf{heapIs} \$heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p1, 177).rem}
\mathrm{div}(\mathbf{heapIs}\ \$\mathrm{heap}_{funcstart\_724,1},\ \$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},\ 177).\mathrm{quot}) + (171\ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}.p2, 176).rem *
\mathbf{asType}{<}\mathbf{int}{>}(\$\text{heap}_{funcstart\_724,1}.\mathbf{\_replace}(\text{p1} \rightarrow ((\text{-}2 * \text{div}(\mathbf{heapIs}
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1, 177).quot) + (171 * div(heapIs
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\$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem))).r2)) - \\
(asType<int>(asType<short int>(div2.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\${\rm heap}_{724,1;745,8}.{\rm b2}))))
→ [const member of object with modified fields]
[63.6] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
\rho_{funcstart_{724,1}}, \rho_{funcstart_{724,1}}, \rho_{funcstart_{724,1}}, \rho_{funcstart_{724,1}}, \rho_{funcstart_{724,1}}
asType<int>($heap_tuncstart_724.1.r2)) - (asType<int>(asType<short
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [const static or extern object]
[63.7] heap_{724,1;747,8} == heap_{funcstart\_724,1}.\_replace(p1 \to ((-2 * 
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
(177).rem))._replace(p2 \rightarrow asType<short int>((div(heapIs)
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem *
\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{init}.\mathbf{r2})) - (\mathbf{asType} < \mathbf{int} > (\mathbf{asType} < \mathbf{short}
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [expand definition of constant 'r2' at prang.c (20,20)]
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
\text{Sheap}_{funcstart_{-724,1}}, \text{Sheap}_{funcstart_{-724,1}}.p2, 176).rem *
asType<int>(asType<short int>((int)172))) -
(asType<int>(asType<short int>(div2.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{b2}))))
\rightarrow [simplify]
[63.11] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}.p2, 176).rem * 172) -
(asType<int>(asType<short int>(div2.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{b2}))))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1},p2,176}
[63.12] $\text{heap}_{724,1;747,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(\text{p1} \to ((-2 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
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177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem) -
(asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},))
\text{sheap}_{funcstart\_724,1.p2, 176}.\text{quot}) * asType < int > (\text{sheap}_{724,1;745,8.b2}))))
\rightarrow [simplify]
[63.14] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}. \operatorname{pl},
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem}) - (\text{div}(\text{heapIs})
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 2, 176).quot *
asType < int > (\$heap_{724,1;745,8}.b2))))
\rightarrow [from term 59.19, $heap_{724,1;745,8}$ is equal to
heap_{funcstart\_724.1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724.1}),
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs p_{funcstart\_724,1}),
heap_{funcstart_{-724,1}}.p1, 177).rem)
[63.15] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
e_{funcstart\_724,1}, e_{funcstart\_724,1}.p2, 176).quot *
asType < int > (\$heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * div(heapIs))))))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1, 177).quot) + (171 * div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).rem))).b2))))
\rightarrow [const member of object with modified fields]
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((172 * div(\mathbf{heapIs}))))
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
\text{Sheap}_{funcstart_{724,1}}, \text{Sheap}_{funcstart_{724,1}}, p2, 176).quot *
asType < int > (\$heap_{funcstart\_724.1}.b2))))
\rightarrow [const static or extern object]
[63.17] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2, 176).rem - (div(heapIs))
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}.p2, 176).quot *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{init}.\mathrm{b2}))))
\rightarrow [expand definition of constant 'b2' at prang.c (22,20)]
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[63.18] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\label{eq:div_heap} \text{div}(\textbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
p_{funcstart_{-724,1}}, p_{funcstart_{-724,1},p_{2,176}}
asType<int>(asType<short int>((int)35)))))
\rightarrow [simplify]
[63.24] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p2, 176).rem)
[Take given term]
[67.0] $\text{heap}_{724,1;749,8} == \text{$heap}_{724,1;747,8}.$\text{$replace}(p3 \to asType < short)$
int>((asType<int>(asType<short\ int>(div3.rem))*
\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{724,1;747,8}.\mathbf{r3})) - (\mathbf{asType} < \mathbf{int} > (\mathbf{asType} < \mathbf{short}))
int>(div3.quot)) * asType< int>($heap_{724,1:747.8}.b3))))
\rightarrow [from term 63.24, $heap<sub>724.1:747.8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs *heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1}, 177).quot) + (171 * div(heapIs $heap_{funcstart\_724,1}, 17
heap_{funcstart\_724,1}.p1, 177).rem))._replace(p2 \rightarrow (-35 * div(heapIs)))._
heap_{funcstart-724,1}, heap_{funcstart-724,1}, p_{funcstart-724,1}, p_{funcstart-724,1}, p_{funcstart-724,1}
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p2, 176).rem)
[67.1] $\text{heap}_{724,1;749,8} == $\text{heap}_{funcstart_724,1}._\text{replace}(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{$heap}_{funcstart\_724,1}, \ \text{$heap}_{funcstart\_724,1.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724.1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{tuncstart\_724.1.p2, 176}.rem))._replace(p3 \rightarrow asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType < int > (\$heap_{724 \cdot 1.747 \cdot 8.173})) - (asType < int > (asType < short)
int>(div3.quot)) * asType< int>($heap_{724.1:747.8}.b3))))
\rightarrow [from term 43.6, div3 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p3, 178
[67.2] $\text{heap}_{724,1;749,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{funcstart_{724,1},p2,176,rem})._replace(p3 \rightarrow asType<short
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int>((asType<int>(asType<short int>(div(heapIs $heap_{tuncstart\_724.1},
\text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{rem}) * asType < int > (\text{Sheap}_{724,1;747,8}.\text{r3})) -
(asType<int>(asType<short int>(div3.quot)) *
asType < int > (\$heap_{724,1;747,8}.b3))))
\rightarrow [simplify]
[67.4] $\text{heap}_{724,1;749,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\rho_{tuncstart_{-724.1},p2, 176} + (172 * div(heapIs $heap_{tuncstart_{-724.1},p2})
\rho_{uncstart\_724,1.p2, 176).rem}))._replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem *
asType < int > (\$heap_{724,1:747,8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap<sub>724,1:747,8</sub>.b3))))
\rightarrow [from term 63.24, $heap<sub>724.1:747.8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724.1}.p1, 177).rem)._replace(p2 \rightarrow (-35 * div(heapIs)))._
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p2, 176).rem)
[67.5] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{uncstart\_724,1.p2, 176).rem}).replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem *
asType < int > (\$heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * div(heapIs)))))))
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p1, 177).quot) + (171 * div(heapIs
\rho_{tuncstart=724.1}, \rho_{tuncstart=724.1}, \rho_{tuncstart=724.1}, \rho_{tuncstart=724.1}, \rho_{tuncstart=724.1}, \rho_{tuncstart=724.1}
* div(heapIs heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p2, 176).quot) + (172 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p2, \ 176).rem))).r3)) -
(asType<int>(asType<short int>(div3.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\${\rm heap}_{724,1;747,8}.{\rm b3}))))
→ [const member of object with modified fields]
[67.7] $\text{heap}_{724,1;749,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs} \text{Sheap}_{funcstart\_724,1},
\theta_{funcstart\_724,1}.p2, 176).rem))._replace(p3 \rightarrow asType<short
int>((div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p3, 178).rem *
asType < int > (\$heap_{funcstart\_724,1}.r3)) - (asType < int > (asType < short)
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int>(div3.quot)) * asType< int>($heap_{724.1:747.8}.b3))))
\rightarrow [const static or extern object]
[67.8] heap_{724,1;749,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{1} = \theta_{1} - \theta_{2} = \theta_{1} - \theta_{2} = \theta_{2} - \theta_{3} - \theta_{4} = \theta_{1} - \theta_{2} - \theta_{4} = \theta_{1} - \theta_{2} - \theta_{4} = \theta_{4} - \theta_{4} - \theta_{4} - \theta_{4} - \theta_{4} = \theta_{4} - \theta_{4
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem *
asType < int > (\$heap_{init}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap<sub>724.1:747.8</sub>.b3))))
\rightarrow [expand definition of constant 'r3' at prang.c (25,20)]
[67.9] \rho_{7.9,1749,8} == \rho_{1.749,1...} = \rho_{1.749,1...
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2, 176}.rem))._replace(p3 \rightarrow asType<short
int>((div(heapIs $heap_tuncstart_724.1, $heap_tuncstart_724.1.p3, 178).rem *
asType<int>(asType<short int>((int)170))) -
(asType<int>(asType<short int>(div3.quot)) *
asType<int>($heap<sub>724.1:747.8</sub>.b3))))
\rightarrow [simplify]
[67.12] $\text{heap}_{724,1:749.8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}. p1, \ 177). \operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{uncstart_724.1.p2, 176}.rem)._replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem * 170)
- (asType < int > (asType < short int > (div3.quot)) *
asType < int > (\$heap_{724,1;747,8}.b3))))
\rightarrow [from term 43.6, div3 is equal to div(heapIs $heap_{funcstart_724,1},
heap_{funcstart_{724,1}}.p3, 178
[67.13] \rho_{7.24,1;749,8} == \rho_{1.724,1}.\_replace(p1 \rightarrow ((-2 * p1.24,1)))
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\frac{\text{sheap}_{funcstart\_724,1.p2, 176}.rem)}{\text{.replace}(p3 \rightarrow asType < short int > ((170)))}
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) –
(asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},
```

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\text{sheap}_{funcstart_{-724,1},p3, 178,quot}) * asType < int > (\text{sheap}_{724,1:747,8},b3))))
\rightarrow [simplify]
[67.15] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{tuncstart\_724,1.p2, 176}.rem)._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) –
(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} *
asType < int > (\$heap_{724,1:747,8}.b3))))
\rightarrow [from term 63.24, $heap<sub>724,1;747,8</sub> is equal to
heap_{funcstart\_724.1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724.1},
heap_{funcstart\_724.1.p1}, 177).quot + (171 * div(heapIs $heap_{funcstart\_724.1}, 177).quot) + (171 * div(heapIs $heap_{funcstart\_724.1}, 17
\rho_{funcstart\_724.1}.p1, 177).rem)._replace\rho_{funcstart\_724.1}.p1, 177).rem)._replace
\$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(\textbf{heapIs}))
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p2, 176).rem
[67.16] $\text{heap}_{724,1;749,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}. p1, \ 177). \operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{tuncstart_724.1}.p2, 176).rem))._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) –
(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} *
asType < int > (\$heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * div(heapIs))))))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs})
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p1, 177).rem))).\_replace(p2 \rightarrow ((-35))
* div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}.p2, 176).quot) + (172 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724.1}, \ \$ \operatorname{heap}_{funcstart\_724.1}, \operatorname{p2}, 176).\operatorname{rem}))).\operatorname{b3}))))
\rightarrow [const member of object with modified fields]
[67.18] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724.1.p2, 176}.rem)._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) –
(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} *
asType < int > (\$heap_{funcstart\_724,1}.b3)))
\rightarrow [const static or extern object]
[67.19] $\text{heap}_{724,1:749.8} == \text{$heap}_{funcstart\_724,1}.$\text{$_{-}$replace}(p1 \to ((-2 *
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\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{tuncstart\_724,1.p2, 176}.rem)._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) –
(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} *
asType < int > (\$heap_{init}.b3))))
\rightarrow [expand definition of constant 'b3' at prang.c (27,20)]
[67.20] heap_{724,1;749,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\label{eq:div_heap} \text{div}(\textbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart_{-724,1},p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart_{-724,1}},
\rho_{uncstart\_724,1.p2, 176).rem}))._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) –
(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} *
asType<int>(asType<short int>((int)63))))
\rightarrow [simplify]
[67.26] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{tuncstart_724.1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2, 176}.rem)._replace(p3 \rightarrow ((-63 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs}))
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, 178).rem)
[Take goal term]
[1.0]  minof(int) \leq (asType < int > (\$heap_{724.1:749.8}.M1) *
asType<int>(static_cast<integer>(asType<int>($heap_{724.1:749.8}.p1) <
(int)0)))
\rightarrow [simplify]
[1.1] -32768 \leq (asType<int>($heap<sub>724.1:749.8</sub>.M1) *
\mathbf{asType} < \mathbf{int} > (\mathbf{static\_cast} < \mathbf{integer}) < (\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{724,1;749,8}.\mathrm{p1}) < (\$ \mathrm{heap}_{724,1;749,8}.\mathrm{p2}) < (\$ \mathrm{heap}_{724,1;749,8}.\mathrm{p1}) < (\$ \mathrm{heap}_{724,1;749,8}.\mathrm{p1}) < (\$ \mathrm{heap}_{724,1;749,8}.\mathrm{p2}) < (\$ \mathrm{heap}_{724,1;749,8}.\mathrm{p2})
(int)0)))
\rightarrow [from term 67.26, $heap<sub>724,1;749,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1},p1, 177}, quot) + (171 * div(heapIs heap_{funcstart_{724,1},p1, 177})
\rho_{1.5}(p2) = \rho_{1.5}(p2) - \rho_{1.5}(p2) $\text{heapIs} \div(\text{heapIs})._\text{replace}
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem)))._replace(p3 \rightarrow (-63 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).quot) + (170 *
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div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).rem))]
[1.2] -32768 \leq (asType<int>($heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724.1},
\text{Sheap}_{funcstart\_724.1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724.1},
\rho_{funcstart\_724,1.p2, 176).rem}))._replace(p3 \rightarrow ((-63 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p3, 178).quot) + (170 * div(heapIs)
\text{Sheap}_{funcstart_{724,1}}, \text{Sheap}_{funcstart_{724,1}}, p_3, 178).rem))).M1) *
asType<int>(static_cast<integer>(asType<int>($heap<sub>724.1:749.8</sub>.p1) <
(\mathbf{int})(0)
\rightarrow [const member of object with modified fields]
[1.5] -32768 \le (asType < int > (\$heap_{tuncstart\_724.1}.M1) *
\mathbf{asType} < \mathbf{int} > (\mathbf{static\_cast} < \mathbf{integer}) < (\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{724,1;749,8}.\mathrm{p1}) < (\$ \mathrm{heap}_{724,1;749,8}.\mathrm{p2}) < (\$ \mathrm{heap}_{724,1;749,8}.\mathrm{p2})
(int)0)))
\rightarrow [const static or extern object]
[1.6] -32768 < (asType < int > (\$heap_{init}.M1) *
asType<int>(static_cast<integer>(asType<int>($heap<sub>724.1:749.8</sub>.p1) <
(int)0)))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[1.7] -32768 \leq (asType\leqint>(asType\leqshort int>((int)30269)) *
asType<int>(static_cast<integer>(asType<int>($heap<sub>724.1:749.8</sub>.p1) <
(\mathbf{int})(0)
\rightarrow [simplify]
[1.10] -32768 < (30269 *
asType<int>(static_cast<integer>(asType<int>($heap_{724.1:749.8}.p1) <
(\mathbf{int})(0)
\rightarrow [from term 67.26, $heap<sub>724,1:749.8</sub> is equal to
$heap_{funcstart\_724,1}.$_{replace}(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
\operatorname{Sheap}_{funcstart\_724,1}.p1, 177).\operatorname{quot} + (171 * \operatorname{div}(\mathbf{heapIs} \operatorname{Sheap}_{funcstart\_724,1},
\rho_{1.5}(p2) = \rho_{1.5}(p2) - \rho_{1.5}(p2) $\text{heapIs} \div(\text{heapIs})._\text{replace}
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).quot) + (170 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p3, \ 178).\operatorname{rem}))]
[1.11] -32768 \le (30269 *
\mathbf{asType} < \mathbf{int} > (\mathbf{static\_cast} < \mathbf{integer}) < (\mathbf{asType} < \mathbf{int}) < (\mathbf{static\_rat}_{-724,1}...\mathbf{replace}) 
\rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).quot) +
(171 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{tuncstart_724.1},
\rho_{tuncstart_{724.1},p2, 176} = 176 \cdot 172 * div(heapIs \part_{1724.1}, p2, 176) \cdot 176 \cdot 172 * div(heapIs \part_{1724.1}, p2, 176) \cdot 176 \cdot 176
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\$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).quot) + (170 * div(\textbf{heapIs}))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{rem}))).\text{p1}) < (\text{int})0)))
\rightarrow [simplify]
[1.23] -32768 \leq (30269 * asType<int>(([0 < ((-171 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).quot): 1, []: 0)))
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[1.24] -32768 < (30269 * asType < int > (([0 < ((-171 * div(heapIs))])))))
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p1, 177).rem) + (2 * div(heapIs
\frac{1}{1} \left[ \frac{1}{1} \left( -\frac{1}{1} \right) \right] = \frac{1}{1} \left[ \frac{1}{1} \left( -\frac{1}{1} \right) \left( -\frac{1}{1} \right) \right] = \frac{1}{1} \left[ \frac{1}{1} \left( -\frac{1}{1} \right) \left( -\frac{1}{1} \right) \right] = \frac{1}{1} \left[ \frac{1}{1} \left( -\frac{1}{1} \right) \left( -\frac{1}{1} \right) \right] = \frac{1}{1} \left[ \frac{1}{1} \left( -\frac{1}{1} \right) \left( -\frac{1}{1} \right) \right] = \frac{1}{1} \left[ \frac{1}{1} \left( -\frac{1}{1} \right) \left( -\frac{1}{1} \right) \left( -\frac{1}{1} \right) \right] = \frac{1}{1} \left[ \frac{1}{1} \left( -\frac{1}{1} \right) \left( -\frac{1}{1} \right) \left( -\frac{1}{1} \right) \right] = \frac{1}{1} \left[ \frac{1}{1} \left( -\frac{1}{1} \right) \left( -\frac{1}{1} \right) \left( -\frac{1}{1} \right) \left( -\frac{1}{1} \right) \right] = \frac{1}{1} \left[ \frac{1}{1} \left( -\frac{1}{1} \right) \right] = \frac{1}{1} \left[ \frac{1}{1} \left( -\frac{1}{1} \right) \left( -\frac{1}{
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724.1}, \ \$ \operatorname{heap}_{funcstart\_724.1}. \operatorname{p1}, \ 177).\operatorname{rem}) + (2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot})))]: 0)))
\rightarrow [simplify]
[1.29] -32768 \le (30269 * asType < int > (([0 < ((-171 * div(heapIs)))))))
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p1, 177).rem) + (2 * div(heapIs
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).rem) + (-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}))]: 0)))
\rightarrow [from term 61.3, -1 < ((-2 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1},p1, 177}.rem) is true if and only if 0 < ((-2 * div(heapIs)))
heap_{funcstart\_724.1}, heap_{funcstart\_724.1}.p1, 177).quot) + (171 * div(heapIs)
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1, 177).rem))]
[1.30] -32768 \leq (30269 * asType<int>(([0 < ((-171 * div(heapIs
\theta_{funcstart\_724.1}, \theta_{funcstart\_724.1}, \theta_{funcstart\_724.1}, \theta_{funcstart\_724.1}, \theta_{funcstart\_724.1}
\rho_{funcstart_{-724,1}}, \rho_{funcstart_{-724,1}}, 177).quot): 1, [0 < ((-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{$heap}_{funcstart\_724,1}, \ \text{$heap}_{funcstart\_724,1}.p1, \ 177).rem))]: 0)))
\rightarrow [simplify]
[1.31] -32768 \leq (30269 * ([0 < ((-171 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177).quot): 1, [0 < ((-2 * div(heapIs))]:
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).quot) + (171 * div(heapIs)
\frac{\text{sheap}_{funcstart\_724,1}, \text{sheap}_{funcstart\_724,1.p1, 177}.rem)}{1}: 0)}
\rightarrow [move guard outside expression]
[1.32] -32768 \leq ([0 < ((-171 * div(heapIs $heap<sub>funcstart_724,1</sub>,
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{uncstart_{-724,1},p1,177,quot}): 1 * 30269, \rho_{uncstart_{-724,1},p1,177,quot}: 1 * 30269, \rho_{uncstart_{-724,1},p1,177,quot}:
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1},p1, 177}.quot + (171 * div(heapIs))
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 177).rem) = 0 * 30269
```

 $\rho_{funcstart_724,1}.p2, 176).rem))$._replace(p3 \rightarrow ((-63 * div(heapIs

```
\rightarrow [simplify]
[1.36] -32769 < ([0 < ((-171 * div(heapIs $heap_{tuncstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs} \text{Sheap}_{funcstart\_724,1},
\theta_{uncstart_{724,1},p1,177,quot}): 30269, \theta_{uncstart_{724,1},p1,177,quot}: 30269, \theta_{uncstart_{724,1},p1,177,quot}:
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1},p1, 177}.rem): 0)
\rightarrow [move guard outside expression]
 \label{eq:continuous} \mbox{$[1.37]$ ([0 < ((-171 * div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p1, \ ]) ) ) ) $$} } 
177).rem) + (2 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart\_724,1}, \text{\$heap}_{funcstart\_724,1}.p1,
177).quot))]: -32769 < 30269, [0 < ((-2 * div(heapIs $heap_{funcstart\_724,1}, 
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\frac{\text{sheap}_{funcstart\_724,1.p1, 177}.rem)}{\text{rem}} : -32769 < 0
\rightarrow [simplify]
 [1.39] \; ([0 < ((-171 * \operatorname{div}(\mathbf{heapIs} \; \$ \operatorname{heap}_{funcstart\_724,1}, \, \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, \, ) 
177).rem) + (2 * \text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724.1}, \$ \text{heap}_{funcstart\_724.1}.\text{p1},
177).quot))]: true, [0 < ((-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724.1}, 
\text{Sheap}_{funcstart\_724.1.p1, 177}.\text{quot}) + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724.1},
heap_{funcstart_{-724,1}.p1, 177).rem}): true
\rightarrow [all guards have equal guarded terms]
[1.40] true
Proof of verification condition: Arithmetic result of operator '*' is within
limit of type 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (68,25)
Condition defined at:
To prove: (asType<int>($heap_{724,1;749,8}.M1) *
\mathbf{asType} < \mathbf{int} > (\mathbf{static\_cast} < \mathbf{integer}) < (\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{724,1:749.8}.\mathrm{p1}) < (\$ \mathrm{heap}_{724,1:749.8}.\mathrm{p1})
(int)(0)) \le maxof(int)
Given:
heap_{init}.LIMIT == (int)80
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
\theta
\theta
\theta
\rho_{init}.r2 == asType < short int > ((int)172)
\theta
```

```
\theta sheap<sub>init</sub>.b2 == asType<short int>((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
heap_{init}.b3 == asType < short int > ((int)63)
\theta
\theta
\theta = asType < short int > ((int)3)
invariant
1(heap<br/>Is \theta_{funcstart\_724,1}
div1 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1})) \ / \\
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))) = =
asType<integer>(div1.quot)
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(asType < integer > ($heap_{funcstart\_724,1}.p1) < 
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) ==
asType<integer>(div1.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathtt{a1}) \leq
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1})) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p2})) \ / \\
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))) ==
asType<integer>(div2.quot)
(asType < integer > (asType < int > (\$heap_{tuncstart\_724.1}.p2)) \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
```

```
(asType < integer > (\$heap_{funcstart_{-724,1}}.p2) = =
asType<integer>(div2.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
(asType<int>(asType<int>($heap_{tuncstart\_724.1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}))~\%
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a3}))) = =
asType<integer>(div3.rem)
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(asType < integer > ($heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a3) \le
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})) => !(0 ==
asType<integer>(div3.quot))
!(0 == asTvpe < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
\$heap_{724,1;745,8} == \$heap_{funcstart\_724,1}.\_\mathbf{replace}(p1 \to \mathbf{asType} < \mathbf{short}
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{tuncstart\_724.1}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1.quot})) * \mathbf{asType}{<} \mathbf{int}{>} (\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
-{\bf asType}{<}{\bf integer~const}{>}(\${\rm heap}_{724,1;745,8}.{\rm M1})<
asType<integer>($heap<sub>724,1:745,8</sub>.p1)
!(0 == asType < integer > (\$heap_{724,1:745.8}.p1))
asType<integer>($heap<sub>724.1:745.8</sub>.p1) <
asType<integer>($heap<sub>724,1:745,8</sub>.M1)
\text{sheap}_{724,1;747,8} == \text{sheap}_{724,1;745,8}.\text{replace}(p2 \to asType < short)
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724,1;745,8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType< int>($heap_{724,1:745,8}.b2))))
-asType < integer const > (\$heap_{724,1:747.8}.M2) < 
asType<integer>($heap<sub>724.1:747.8</sub>.p2)
```

```
!(0 == asType < integer > (\$heap_{724.1:747.8}.p2))
asType<integer>($heap<sub>724.1:747.8</sub>.p2) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;747,8}.\mathrm{M2})
heap_{724,1;749,8} == heap_{724,1;747,8}.replace(p3 \rightarrow asType<short
\mathbf{int}{>}((\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{short}\ \mathbf{int}{>}(\mathbf{div3.rem}))\ ^*
asType < int > (\$heap_{724.1:747.8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap<sub>724,1:747,8</sub>.b3))))
-asType<integer const>($heap<sub>724,1:749,8</sub>.M3) <
asType<integer>($heap<sub>724,1:749,8</sub>.p3)
!(0 == asType < integer > (\$heap_{724,1;749,8}.p3))
asType<integer>($heap<sub>724,1:749,8</sub>.p3) <
asType<integer>($heap<sub>724,1:749,8</sub>.M3)
Proof:
[Take given term]
[11.0] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}),
asType < int > (\$heap_{funcstart\_724,1}.a1))
\rightarrow [simplify]
[11.1] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType < int > (\$heap_{funcstart\_724,1}.a1))
\rightarrow [const static or extern object]
[11.2] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType < int > (\$heap_{init}.a1))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
[11.3] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType<int>(asType<short int>((int)177)))
\rightarrow [simplify]
[11.6] div1 == div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1, 177)
[Take given term]
[27.0] \operatorname{div2} == \operatorname{div}(\mathbf{heapIs} \ \operatorname{\$heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
\rightarrow [simplify]
[27.1] div2 == div(heapIs \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}
asType < int > (\$heap_{funcstart\_724,1}.a2))
\rightarrow [const static or extern object]
```

```
\label{eq:continuous} \mbox{[27.2] div2} == \mbox{div}(\mathbf{heapIs} \ \$\mbox{heap}_{funcstart\_724,1}, \ \$\mbox{heap}_{funcstart\_724,1}.\mbox{p2},
asType < int > (\$heap_{init}.a2))
\rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
[27.3]~{\rm div2} == {\rm div}(\mathbf{heapIs}~\$ \mathrm{heap}_{funcstart\_724,1},~\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2},
asType<int>(asType<short int>((int)176)))
\rightarrow [simplify]
[27.6] div2 == div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p2, 176)
[Take given term]
[43.0] div3 == div(heapIs $heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724.1}.p3),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a3}))
\rightarrow [simplify]
[43.1] \ \mathrm{div3} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3},
asType < int > (\$heap_{funcstart\_724,1}.a3))
\rightarrow [const static or extern object]
[43.2] div3 == div(heapIs $heap_{funcstart\_724.1}, $heap_{funcstart\_724.1}.p3,
asType < int > (\$heap_{init}.a3))
\rightarrow [expand definition of constant 'a3' at prang.c (26,20)]
[43.3] \ \mathrm{div3} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3},
asType<int>(asType<short int>((int)178)))
\rightarrow [simplify]
[43.6] \ \mathrm{div3} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}, \ 178)
[Take given term]
[59.0] \rho_{1745,8} == \rho_{1745
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1}.\mathbf{quot})) * \mathbf{asType}{<} \mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1}}.p1, 177
[59.1] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div(heapIs $heap_{funcstart_724.1},))
\text{sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}) * asType<int>(\text{sheap}_{funcstart\_724,1}.\text{r1})) -
(asType<int>(asType<short int>(div1.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [simplify]
[59.3] \theta == 
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
```

```
asType < int > (\$heap_{tuncstart-724.1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
\rightarrow [const static or extern object]
[59.4] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType < int > (\$heap_{init}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
\rightarrow [expand definition of constant 'r1' at prang.c (15,20)]
[59.5] \rho_{1745,8} == \rho_{1745
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType < int > (asType < short int > ((int)171))) -
(asType<int>(asType<short int>(div1.quot)) *
\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
\rightarrow [simplify]
[59.8] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem * 171)
- (asType<int>(asType<short int>(div1.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart_{-724,1}},
heap_{funcstart_{-724,1}}.p1, 177
[59.9] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((171 * div(heapIs \$heap_{funcstart\_724.1}, \$heap_{funcstart\_724.1}, p1, 177).rem)
- (asType<int>(asType<short int>(div(heapIs $heap_{tuncstart}, 724.1),
heap_{funcstart_{-724,1}}.p1, 177).quot) *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [simplify]
[59.11] \theta == 
int>((171 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [const static or extern object]
[59.12] \$ \text{heap}_{724,1;745,8} == \$ \text{heap}_{funcstart\_724,1}.\_\textbf{replace} (\text{p1} \rightarrow \textbf{asType} < \textbf{short}
int>((171 * div(heapIs \$heap_{tuncstart\_724.1}, \$heap_{tuncstart\_724.1}, p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType < int > (\$heap_{init}.b1)))
\rightarrow [expand definition of constant 'b1' at prang.c (17,20)]
[59.13] \$ heap_{724,1;745,8} == \$ heap_{funcstart\_724,1}.\_\mathbf{replace} (p1 \to \mathbf{asType} < \mathbf{short})
int>((171 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724.1}, \$ \text{heap}_{funcstart\_724.1}.\text{p1}, 177).\text{quot} *
asType<int>(asType<short int>((int)2))))
```

```
\rightarrow [simplify]
[59.19] $\text{heap}_{724,1:745,8} == \text{$heap}_{funcstart\_724,1}._\text{$replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).rem)))
[Take given term]
[61.0]!(0 == asType < integer > (\$heap_{724,1:745,8}.p1))
\rightarrow [from term 59.19, $heap<sub>724,1;745,8</sub> is equal to
heap_{funcstart\_724.1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724.1}),
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs p_{funcstart\_724,1}),
heap_{funcstart_{724,1}}.p1, 177).rem)
[61.1] !(0 == asType<integer>($heap_{funcstart\_724,1}.replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).rem))).p1))
\rightarrow [simplify]
[61.3]!(0 == ((-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1,
177).quot) + (171 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart\_724,1}, \text{\$heap}_{funcstart\_724,1}.\text{p1},
177).rem)))
[Take given term]
[63.0] $\text{heap}_{724,1:747,8} == $\text{heap}_{724,1:745,8}._\text{replace}(p2 \to \text{asType} < \text{short}
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724,1:745,8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724,1:745,8</sub>.b2))))
\rightarrow [from term 59.19, $heap<sub>724,1;745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724,1}),
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs p_{funcstart\_724,1}),
\$heap_{funcstart\_724,1}.p1,\ 177).rem))]
[63.1] $heap<sub>724,1:747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724,1;745,8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1},p2,176}
[63.2] \theta == 
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
(177).rem))._replace(p2 \rightarrow asType < short)
int>((asType<int>(asType<short int>(div(heapIs $heap_{tuncstart_724.1},))
```

```
\text{Sheap}_{funcstart_724,1}.\text{p2}, 176).\text{rem}) * asType < int > (\text{Sheap}_{724,1:745,8}.\text{r2})) -
(asType<int>(asType<short int>(div2.quot)) *
asType < int > (\$heap_{724,1;745,8}.b2))))
\rightarrow [simplify]
[63.4] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
\rho_{funcstart_{724,1}}, \rho_{funcstart_{724,1}}, \rho_{funcstart_{724,1}}, \rho_{funcstart_{724,1}}, \rho_{funcstart_{724,1}}
asType < int > (\$heap_{724,1:745,8}.r2)) - (asType < int > (asType < short)
\mathbf{int}{>}(\text{div2.quot})) \ * \ \mathbf{asType}{<} \mathbf{int}{>} (\$\text{heap}_{724,1;745,8}.\text{b2}))))
\rightarrow [from term 59.19, $heap<sub>724,1;745,8</sub> is equal to
heap_{funcstart\_724.1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724.1}),
heap_{funcstart_{724,1},p1,177}, quot) + (171 * div(heapIs $heap_{funcstart_{724,1}})
heap_{funcstart_{724,1}}.p1, 177).rem)
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((\operatorname{div}(\mathbf{heapIs}))))
\rho_{funcstart_{-724,1}}, \rho_{funcstart_{-724,1}}, \rho_{funcstart_{-724,1}}, \rho_{funcstart_{-724,1}}, \rho_{funcstart_{-724,1}}
\mathbf{asType} \small{<} \mathbf{int} \small{>} (\$ \mathbf{heap}_{funcstart\_724,1}. \_\mathbf{replace} (\mathtt{p1} \rightarrow ((-2 \ ^* \ \mathrm{div} (\mathbf{heapIs}
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}. p1, 177).quot) + (171 * div(heapIs
heap_{funcstart_{724.1}}, heap_{funcstart_{724.1}}, 177).rem)).r2)) -
(asType<int>(asType<short int>(div2.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{b2}))))
\rightarrow [const member of object with modified fields]
[63.6] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
e_{funcstart\_724,1}, e_{funcstart\_724,1}.p2, 176).rem *
asType < int > (\$heap_{funcstart\_724.1}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [const static or extern object]
[63.7] \rho_{17,1747,8} == \rho_{17,1747,8} 
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
(177).rem))._replace(p2 \rightarrow asType<short int>((div(heapIs))).
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem *
asType < int > (\$heap_{init}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType< int>($heap_{724,1:745,8}.b2))))
\rightarrow [expand definition of constant 'r2' at prang.c (20,20)]
```

```
[63.8] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, \ 177).\operatorname{quot}) + (171 \ *
\label{eq:div_heap} \text{div}(\textbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
(177).rem)._replace(p2 \rightarrow asType<short int>((div(heapIs
\rho_{funcstart_{724,1}}, \rho_{funcstart_{724,1}}, \rho_{funcstart_{724,1}}, \rho_{funcstart_{724,1}}
asType<int>(asType<short int>((int)172))) -
(asType<int>(asType<short int>(div2.quot)) *
asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [simplify]
[63.11] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem))).\_\mathbf{replace}(p2 \to \mathbf{asType} < \mathbf{short\ int} > ((div(\mathbf{heapIs}
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1},p2, 176}.rem * 172) -
(asType<int>(asType<short int>(div2.quot)) *
asType < int > (\$heap_{724,1;745,8}.b2))))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{tuncstart_724.1},
heap_{funcstart_{-724,1}}.p2, 176
[63.12] \rho_{724,1;747,8} == \rho_{124,1,747,8} == \rho_{
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\text{Sheap}_{funcstart_{724,1}}, \text{Sheap}_{funcstart_{724,1}}, \text{p2}, 176).rem) -
(asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},))
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot}) * asType<int>(\text{Sheap}_{724,1;745,8.b2}))))
\rightarrow [simplify]
[63.14] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((172 * div(\mathbf{heapIs}))))
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
\text{Sheap}_{funcstart_{724,1}}, \text{Sheap}_{funcstart_{724,1}}, p2, 176).quot *
asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [from term 59.19, $heap<sub>724,1:745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724,1}),
heap_{funcstart_{724,1},p1, 177}, quot) + (171 * div(heapIs heap_{funcstart_{724,1},p1, 177})
heap_{funcstart_{-724,1},p1,177,rem}
[63.15] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem))).\_replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem}) - (\text{div}(\text{heapIs})
```

```
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}.p2, 176).quot *
\mathbf{asType}{<}\mathbf{int}{>}(\$\text{heap}_{funcstart\_724,1}.\_\mathbf{replace}(\text{p1} \rightarrow ((\text{-2} * \text{div}(\mathbf{heapIs}
\$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).quot) + (171 * div(\textbf{heapIs}) + (171 * div(\textbf{heapIs})) + (171
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 177).rem)).b2))))
\rightarrow [const member of object with modified fields]
[63.16] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 2, 176).quot *
asType < int > (\$heap_{funcstart\_724,1}.b2))))
\rightarrow [const static or extern object]
[63.17] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
\text{Sheap}_{funcstart_{-724,1}}, \text{Sheap}_{funcstart_{-724,1}}.p2, 176).quot *
asType < int > (\$heap_{init}.b2))))
\rightarrow [expand definition of constant 'b2' at prang.c (22,20)]
[63.18] $\text{heap}_{724,1;747,8} == \text{$heap}_{funcstart\_724,1}._\text{$replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}
asType<int>(asType<short int>((int)35)))))
\rightarrow [simplify]
[63.24] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724.1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724.1},
heap_{funcstart_{-724,1}}.p2, 176).rem)
[Take given term]
[67.0] $\text{heap}_{724,1:749,8} == $\text{heap}_{724,1:747,8}._\text{replace}(p3 \to \text{asType} < \text{short}
int>((asType<int>(asType<short int>(div3.rem)) *
asType < int > (\$heap_{724,1;747,8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType< int>($heap_{724.1:747.8}.b3))))
\rightarrow [from term 63.24, $heap<sub>724,1:747,8</sub> is equal to
```

```
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1},p1, 177}, quot) + (171 * div(heapIs heap_{funcstart_{724,1},p1, 177})
\theta_{funcstart\_724,1}.p1, 177).rem))._replace(p2 \rightarrow (-35 * div(\mathbf{heapIs})))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem))]
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724.1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{funcstart\_724,1.p2, 176}.rem))._replace(p3 \rightarrow asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType < int > (\$heap_{724 \cdot 1.747 \cdot 8.173})) - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap<sub>724,1:747,8</sub>.b3))))
\rightarrow [from term 43.6, div3 is equal to div(heapIs $heap_{funcstart_{724,1}},
heap_{funcstart_{-724,1}}.p3, 178
[67.2] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724.1}, \ \$heap_{funcstart\_724.1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2, 176}.rem))._replace(p3 \rightarrow asType<short
int>((asType < int > (asType < short int > (div(heapIs $heap_{funcstart\_724,1}, 
\text{sheap}_{funcstart\_724,1.p3}, 178).rem) * asType < int > (\text{sheap}_{724,1:747.8}.r3)) -
(asType<int>(asType<short int>(div3.quot)) *
asType<int>($heap<sub>724.1:747.8</sub>.b3))))
\rightarrow [simplify]
[67.4] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724.1.p2, 176}.rem)..replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem *
\mathbf{asType} \small{<} \mathbf{int} \small{>} (\$ \mathrm{heap}_{724,1;747,8}.\mathrm{r3})) \\ - (\mathbf{asType} \small{<} \mathbf{int} \small{>} (\mathbf{asType} \small{<} \mathbf{short} \\
int>(div3.quot)) * asType<int>($heap<sub>724.1:747.8</sub>.b3))))
\rightarrow [from term 63.24, $heap<sub>724,1:747,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1},p1, 177}, quot) + (171 * div(heapIs heap_{funcstart_{724,1},p1, 177})
\theta_{funcstart\_724,1}.p1, 177).rem))._replace(p2 \rightarrow (-35 * div(\mathbf{heapIs})))
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p2, 176).rem)
[67.5] heap_{724,1;749,8} == heap_{funcstart\_724,1}.\_replace(p1 \to ((-2 *
```

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\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2, 176}.rem))._replace(p3 \rightarrow asType<short
int>((\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.p3, 178).\text{rem} *
\mathbf{asType}{<}\mathbf{int}{>}(\$\text{heap}_{funcstart\_724,1}.\mathbf{\_replace}(\text{p1} \rightarrow ((\text{-2} * \text{div}(\mathbf{heapIs}
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs}))
\rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}
* div(\mathbf{heapIs} \ \$ heap_{funcstart\_724,1}, \ \$ heap_{funcstart\_724,1}.p2, \ 176).quot) + (172 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}. \operatorname{p2}, \ 176).\operatorname{rem}))).\operatorname{r3})) \ -
(asType<int>(asType<short int>(div3.quot)) *
asType<int>($heap<sub>724,1;747,8</sub>.b3))))
\rightarrow [const member of object with modified fields]
[67.7] $\text{heap}_{724,1;749,8} == $\text{heap}_{funcstart\_724,1}.$\text{-replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{tuncstart\_724.1.p2, 176}.rem))._replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem *
asType < int > (\$heap_{funcstart\_724.1}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap_{724,1;747,8}.b3))))
\rightarrow [const static or extern object]
[67.8] heap_{724,1;749,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{tuncstart_{724,1},p2,176,rem})._replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem *
asType < int > (\$heap_{init}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap<sub>724,1:747,8</sub>.b3))))
\rightarrow [expand definition of constant 'r3' at prang.c (25,20)]
[67.9] $\text{heap}_{724,1;749,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2, 176}.rem))._replace(p3 \rightarrow asType<short
int > ((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem *
asType < int > (asType < short int > ((int)170))) -
(asType<int>(asType<short int>(div3.quot)) *
```

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asType<int>($heap<sub>724.1:747.8</sub>.b3))))
\rightarrow [simplify]
[67.12] $\text{heap}_{724,1;749,8} == $\text{heap}_{funcstart_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{tuncstart, 724,1}, p2, 176).rem))._replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem * 170)
- (asType<int>(asType<short int>(div3.quot)) *
asType<int>($heap<sub>724.1:747.8</sub>.b3))))
\rightarrow [from term 43.6, div3 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p3, 178
[67.13] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs \rho_{tart\_724,1},
heap_{funcstart\_724,1.p2}, 176).quot) + (172 * div(heapIs heap_{funcstart\_724,1},
\rho_{tuncstart=724.1.p2, 176}.rem)._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) –
(asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724.1},
\text{sheap}_{funcstart\_724,1.p3}, 178).\text{quot})) * asType < int > (\text{sheap}_{724,1;747,8.b3}))))
\rightarrow [simplify]
[67.15] $\text{heap}_{724,1:749.8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}. p1, \ 177). \operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{tuncstart_724.1}.p2, 176).rem))._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) –
(div(heapIs $heap_tuncstart_724.1, $heap_tuncstart_724.1.p3, 178).quot *
asType < int > (\$heap_{724,1:747.8}.b3))))
\rightarrow [from term 63.24, $heap<sub>724,1:747,8</sub> is equal to
\text{Sheap}_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(\textbf{heapIs } \$heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).rem))).\_replace(p2 \rightarrow (-35 * div(heapIs))).
\text{Sheap}_{funcstart,724,1}, \text{Sheap}_{funcstart,724,1}, p2, 176). quot) + (172 * div(heapIs)
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, p2, 176).rem)
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}. \operatorname{pl},
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724,1},
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\text{Sheap}_{funcstart=724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart=724,1},
\rho_{uncstart\_724,1.p2, 176}.rem)._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) –
(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} *
asType < int > (\$heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * div(heapIs)))))))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).quot) + (171 * div(heapIs)
\rho_{tuncstart_{724,1}}, \rho_{tuncstart_{724,1}}, \rho_{tuncstart_{724,1}}, \rho_{tuncstart_{724,1}}, \rho_{tuncstart_{724,1}}, \rho_{tuncstart_{724,1}}
* div(\mathbf{heapIs} \ \$ heap_{funcstart\_724,1}, \ \$ heap_{funcstart\_724,1}.p2, \ 176).quot) + (172 \ *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p2, \ 176).rem))).b3))))
→ [const member of object with modified fields]
[67.18] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{uncstart_{-724,1},p2, 176,rem}))._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) –
(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724.1}, \$ \text{heap}_{funcstart\_724.1}. \text{p3}, 178).\text{quot} *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b3}))))
\rightarrow [const static or extern object]
[67.19] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{uncstart\_724,1.p2, 176).rem}))._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) -
(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} *
asType < int > (\$heap_{init}.b3))))
\rightarrow [expand definition of constant 'b3' at prang.c (27,20)]
[67.20] heap_{724,1;749,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724.1}, \ \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\theta_{funcstart\_724,1}.p2, 176.quot) + (172 * div(heapIs \theta_{funcstart\_724,1},
\rho_{tuncstart=724.1.p2, 176}.rem)._replace(p3 \rightarrow asType<short int>((170
* \operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p3, \ 178).rem) -
(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} *
asType<int>(asType<short int>((int)63)))))
\rightarrow [simplify]
[67.26] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
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\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2}, 176).quot) + (172 * div(heapIs \rho_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem}))._replace(p3 \rightarrow ((-63 * div(heapIs)
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).quot) + (170 * div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 178).rem)
[Take goal term]
[1.0] (asType<int>($heap<sub>724,1:749.8</sub>.M1) *
asType<int>(static_cast<integer>(asType<int>($heap<sub>724.1:749.8</sub>.p1) <
(int)(0)) \le maxof(int)
\rightarrow [from term 67.26, $heap<sub>724,1;749,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1},p1, 177}, quot) + (171 * div(heapIs p_{funcstart_{724,1},p1, 177}), quot)
\rho_{funcstart\_724,1}.p1, 177).rem))._replace\rho_{funcstart\_724,1}.p1, 177).rem))._replace
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p_{funcstart_{724,1}}, p_{funcstart_{724,1}}, p_{funcstart_{724,1}}
\$heap_{funcstart\_724,1},\,\$heap_{funcstart\_724,1}.p2,\,176).rem))).\_\mathbf{replace}(p3\rightarrow(-63\ *Coloredge))
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).quot) + (170 \ *
\operatorname{div}(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).rem))]
[1.1] (asType<int>($heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
\rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}
* div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, p2, 176).quot) + (172 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p2,
176).rem)))._replace(p3 \rightarrow ((-63 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} + (170 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p3, 178).rem})).M1) *
asType<int>(static_cast<integer>(asType<int>($heap<sub>724.1:749.8</sub>.p1) <
(int)(0)) \le maxof(int)
\rightarrow [const member of object with modified fields]
[1.4] (asType<int>($heap_{tuncstart\_724,1}.M1) *
\mathbf{asType} < \mathbf{int} > (\mathbf{static\_cast} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{724,1;749,8}.\mathrm{p1}) < \mathsf{nt}) < \mathsf{nt} > \mathsf{nt} >
(\mathbf{int})(0)) \leq \mathbf{maxof}(\mathbf{int})
\rightarrow [const static or extern object]
[1.5] (asType<int>($heap<sub>init</sub>.M1) *
asType<int>(static_cast<integer>(asType<int>($heap<sub>724,1.749,8.</sub>p1) <
(int)(0)) \le maxof(int)
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[1.6] (asType<int>(asType<short int>((int)30269)) *
asType<int>(static_cast<integer>(asType<int>($heap_{724.1:749.8}.p1) <
(int)(0)) \le maxof(int)
\rightarrow [simplify]
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[1.9] (30269 *
asType<int>(static_cast<integer>(asType<int>($heap<sub>724.1:749.8</sub>.p1) <
(int)(0)) \le maxof(int)
\rightarrow [from term 67.26, $heap<sub>724.1:749.8</sub> is equal to
heap_{funcstart\_724.1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724.1},
\text{Sheap}_{funcstart_{724,1},p1, 177}.\text{quot}) + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart_{724,1}}),
\rho_{funcstart\_724,1}.p1, 177).rem))).\_replace(p2 \rightarrow ((-35 * div(heapIs)))._replace(p2 \rightarrow ((-35 * div(heapIs))))._replace(p2 \rightarrow ((-35 * div(heapIs))))._replace(p2 \rightarrow ((-35 * div(heapIs)))))._replace(p2 \rightarrow ((-35 * div(heapIs)))))._replace(p2 \rightarrow ((-35 * div(heapIs)))))._replace(p2 \rightarrow ((-35 * div(heapIs)))))._replace(p2 \rightarrow ((-35 * div(heapIs)))))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart\_724.1}, heap_{funcstart\_724.1}, p2, p2, p3, p4, p3, p4, p3, p4, p3, p4, 
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).quot) + (170 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).rem))]
[1.10] (30269 *
\mathbf{asType} < \mathbf{int} > (\mathbf{static\_cast} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}. \mathbf{\_replace} (\mathbf{p1})) + (\$ \mathbf{heap
\rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).quot) +
(171 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart\_724,1}, \text{\$heap}_{funcstart\_724,1}.\text{p1},
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{tuncstart\_724.1.p2, 176}.rem)._replace(p3 \rightarrow ((-63 * div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 178).quot) + (170 * div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p3, 178).rem))).p1) < (int)0))) \le
maxof(int)
\rightarrow [simplify]
[1.22] (30269 * asType<int>(([0 < ((-171 * div(heapIs $heap_{funcstart\_724.1},
\theta_{funcstart\_724,1}.p1, 177).rem + (2 * div(heapIs $heap_{funcstart\_724,1}, + div(heapIs $heap_{funcstart\_
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}): 1, []: 0))) \leq \max(\text{int})
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[1.23] (30269 * asType<int>(([0 < ((-171 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\text{Sheap}_{funcstart_{724,1},p1, 177}.\text{quot}): 1, [!(0 < ((-171 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p1, 177).rem) + (2 * div(heapIs
\{\text{heap}_{funcstart\_724.1}, \{\text{heap}_{funcstart\_724.1}, p_1, 177\}, \text{quot}\}\}\} \ge \max(\text{int})
\rightarrow [simplify]
[1.28] (30269 * asType<int>(([0 < ((-171 * div(heapIs $heap_{funcstart\_724,1}, 
\text{Sheap}_{funcstart\_724.1.pl}, 177).\text{rem} + (2 * \text{div}(\text{heapIs} \text{Sheap}_{funcstart\_724.1},
\theta_{funcstart_{-724,1},p1, 177,quot}): 1, [-1 < ((171 * div(heapIs))
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
\$ \mathrm{heap}_{funcstart\_724,1}, \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}, \ 177).\mathrm{quot}))] \colon 0))) \le \mathbf{maxof(int)}
\rightarrow [from term 61.3, -1 < ((-2 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\ 724,1}.p1,\ 177).quot) + (171 * div(\textbf{heapIs}\ \text{Sheap}_{funcstart\ 724,1},
\rho_{uncstart\_724,1.p1, 177).rem} is true if and only if 0 < ((-2 * div(\mathbf{heapIs})))
heap_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, 177).rem)
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[1.29] (30269 * asType<int>(([0 < ((-171 * div(heapIs $heap_{funcstart\_724.1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p1}, 177).\text{quot}): 1, [0 < ((-2 * \text{div}(\textbf{heapIs})))]: 1, [0 < ((-2 * \text{div}(\textbf{heapIs})))]:
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs}))
\{\text{heap}_{funcstart\_724,1}, \{\text{heap}_{funcstart\_724,1}.p1, 177).rem\}\}: 0))) \leq \max(\text{int})
\rightarrow [simplify]
[1.30] (30269 * ([0 < ((-171 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs} \text{Sheap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p1}, 177).\text{quot}): 1, [0 < ((-2 * \text{div}(\textbf{heapIs})))]: 1, [0 < ((-2 * \text{div}(\textbf{heapIs})))]:
\text{Sheap}_{funcstart\ 724.1}, \text{Sheap}_{funcstart\ 724.1}, \text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs})
\{\text{heap}_{funcstart\_724,1}, \{\text{heap}_{funcstart\_724,1}.p1, 177\}.rem\}\}: 0)) \leq \max(\text{int})
\rightarrow [move guard outside expression]
[1.31] ([0 < ((-171 * div(heapIs heapIs = f_{uncstart_{-724,1}}, heap_{funcstart_{-724,1}}, p_1, f_{uncstart_{-724,1}}]
177).rem) + (2 * \text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).quot))]: 1 * 30269, [0 < ((-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, 
\rho_{funcstart\_724,1.p1, 177}.quot) + (171 * div(heapIs \rho_{funcstart\_724,1}),
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}): 0 * 30269) \le \text{maxof(int)}
\rightarrow [simplify]
[1.35] (-1 + ([0 < ((-171 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\text{heap}_{funcstart\ 724.1.p1,\ 177}.quot))]: 30269, [0 < ((-2 * \text{div}(\textbf{heapIs})))]
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
\text{Sheap}_{funcstart_{724,1}}, \text{Sheap}_{funcstart_{724,1}}, \text{p1, 177}.\text{rem})): 0) < 32767
\rightarrow [move guard outside expression]
[1.36] ([0 < ((-171 * div(heapIs heapIs funcstart_{-724,1}, heap_{funcstart_{-724,1}}.p1,
177).rem) + (2 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1,
177).quot))]: -1 + 30269, [0 < ((-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, 
\theta_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs \theta_{funcstart\_724,1})
\frac{\text{heap}_{funcstart\_724,1.p1, 177}.rem)}{\text{rem}} : -1 + 0) < 32767
\rightarrow [simplify]
[1.39] \ 0 < (32767 + -([0 < ((-171 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\frac{\text{heap}_{funcstart\_724,1.p1, 177}.quot)}{177}: 30268, [0 < ((-2 * div(\mathbf{heapIs}))]
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).quot) + (171 * div(heapIs)
\{\text{heap}_{funcstart\_724,1}, \text{heap}_{funcstart\_724,1}.p1, 177).rem\}: -1))
\rightarrow [move guard outside expression]
[1.40] 0 < (32767 + ([0 < ((-171 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\frac{\text{heap}_{funcstart\_724,1.p1, 177}.\text{quot}}{\text{loc}} : -30268, [0 < ((-2 * \text{div}(\text{heapIs})))]
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1},p1, 177}.quot + (171 * div(heapIs))
\{\text{heap}_{funcstart\_724,1}, \{\text{heap}_{funcstart\_724,1}.p1, 177\}.rem\}\}: --1\}
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\rightarrow [simplify]
[1.42] \ 0 < (32767 + ([0 < ((-171 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs} \text{Sheap}_{funcstart\_724,1},
\rho_{uncstart_{-724,1},p1, 177,quot} = -30268, [0 < ((-2 * div(heapIs))]
\text{Sheap}_{funcstart\_724.1}, \text{Sheap}_{funcstart\_724.1}, \text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs}))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).rem): 1))
\rightarrow [move guard outside expression]
[1.43] 0 < ([0 < ((-171 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p1}, 177).\text{quot}): -30268 + 32767, [0 < ((-2 * \text{div}(\textbf{heapIs})))]: -30268 + 32767, [0 < ((-2 * \text{div}(\textbf{heapIs})))]: -30268 + 32767, [0 < ((-2 * \text{div}(\textbf{heapIs})))]:
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p1, 177).quot) + (171 * div(heapIs
\frac{\text{heap}_{funcstart\_724,1}, \text{heap}_{funcstart\_724,1.p1, 177}.rem)}{1 + 32767}
\rightarrow [simplify]
[1.45] 0 < ([0 < ((-171 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart_724,1},
\text{heap}_{funcstart\_724.1}.\text{p1}, 177).\text{quot}): 2499, [0 < ((-2 * \text{div}(\textbf{heapIs})))]: 2499, [0 < ((-2 * \text{div}(\textbf{heapIs})))]
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
\{\text{heap}_{funcstart\_724,1}, \{\text{heap}_{funcstart\_724,1}, \text{p1}, 177\}.\text{rem}\}\}: 32768\}
\rightarrow [move guard outside expression]
[1.46] \; ([0 < ((-171 * \operatorname{div}(\mathbf{heapIs} \; \$ \operatorname{heap}_{funcstart\_724,1}, \; \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, \;
177).rem) + (2 * \text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1},
(177).quot): 0 < 2499, [0 < ((-2 * div(heapIs $heap_{funcstart\_724.1}, 1.5])]
\theta_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1}, 177).quot) + (171 * div(heapIs $heap_{funcstart\_724,1}, 177).
\frac{\text{sheap}_{funcstart\_724,1.p1, 177}.rem)}{177}: 0 < 32768}
\rightarrow [simplify]
 \label{eq:continuous}  \mbox{$[1.48]$ ([0 < ((-171 * div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p1, \ ]) ) ) ) $$}  \mbox{$[-1.48]$ ([0 < ((-171 * div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p1, \ ]) ] ) ] $$}  \mbox{$[-1.48]$ ([0 < ((-171 * div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}] ] ] ] $$}  \mbox{$[-1.48]$ ([0 < ((-171 * div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{f
177).rem) + (2 * \text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724.1}, \$ \text{heap}_{funcstart\_724.1}.\text{p1},
177).quot))]: true, [0 < ((-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, 
\theta_{funcstart\_724,1.p1}, 177).quot) + (171 * div(heapIs \theta_{funcstart\_724,1},
\frac{\text{sheap}_{funcstart_{724.1}.p1, 177}.rem)}{\text{true}}
\rightarrow [all guards have equal guarded terms]
[1.49] true
Proof of verification condition: Type constraint satisfied in implicit
conversion from 'short int' to 'int'
```

Condition generated at: C:\Escher\Customers\prang\prang.c (68,5)

Condition defined at:

To prove: $minof(int) \leq $heap_{724,1;749,8}.p1$ Given:

```
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
heap_{init}.M2 == asType < short int > ((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart\_724,1})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}))\ /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(asType<int>(asType<int>($heap_{tuncstart\_724.1}.p1)) %
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p1) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(asType < integer > (\$heap_{funcstart\_724.1}.p1) = =
asType<integer>(div1.rem))
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
```

```
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p2})) \ / \\
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.quot)
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2})) \ \%
\mathbf{asType} {<} \mathbf{integer} {>} (\mathbf{asType} {<} \mathbf{int} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType < integer > (div2.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}) <
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a2})) =>
(asType < integer > (\$heap_{funcstart\_724.1}.p2) = =
asType<integer>(div2.rem))
(asType<integer>(sheap_{funcstart\_724,1}.a2) \leq
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})) => !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
asType < int > (\$heap_{funcstart\_724,1}.a3))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}))~\%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a3})) = >
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) ==
asType<integer>(div3.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a3}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
heap_{724,1;745,8} == heap_{funcstart\_724,1}.\_replace(p1 \rightarrow asType < short)
int>((asType<int>(asType<short int>(div1.rem)) *
\mathbf{asType} \hspace{-0.1em}<\hspace{-0.1em} \mathbf{int} \hspace{-0.1em}> \hspace{-0.1em} (\$ heap_{funcstart\_724,1}.r1)) - (\mathbf{asType} \hspace{-0.1em}<\hspace{-0.1em} \mathbf{int} \hspace{-0.1em}> \hspace{-0.1em} (\mathbf{asType} \hspace{-0.1em}<\hspace{-0.1em} \mathbf{short})
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
-asType < integer\ const > (\$heap_{724,1;745,8}.M1) < 1
```

```
asType<integer>($heap<sub>724.1:745.8</sub>.p1)
!(0 == asType < integer > (\$heap_{724,1:745.8} \cdot p1))
asType<integer>($heap<sub>724,1;745,8</sub>.p1) <
asType<integer>($heap<sub>724,1;745,8</sub>.M1)
heap_{724,1:747,8} == heap_{724,1:745,8}.replace(p2 \rightarrow asType<short
\mathbf{int}{>}((\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{short}\ \mathbf{int}{>}(\mathbf{div}2.\mathbf{rem}))\ ^*
\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{724,1;745,8}.\mathbf{r2})) - (\mathbf{asType} < \mathbf{int} > (\mathbf{asType} < \mathbf{short}))
int>(div2.quot)) * asType<int>($heap<sub>724,1:745,8</sub>.b2))))
-asType < integer\ const > (\$heap_{724,1;747,8}.M2) < 
asType<integer>($heap<sub>724.1:747.8</sub>.p2)
!(0 == \mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathrm{heap}_{724,1;747,8}.\mathrm{p2}))
asType<integer>($heap<sub>724.1:747.8</sub>.p2) <
asType<integer>($heap<sub>724,1:747,8</sub>.M2)
heap_{724,1:749,8} == heap_{724,1:747,8}.replace(p3 \rightarrow asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType < int > (\$heap_{724,1:747,8}.r3)) - (asType < int > (asType < short)
int > (div3.quot)) * asType < int > (\$heap_{724,1:747,8}.b3))))
-asType<integer const>($heap<sub>724,1;749,8</sub>.M3) <
asType<integer>($heap<sub>724,1;749,8</sub>.p3)
!(0 == \mathbf{asType} < \mathbf{integer} > (\$ heap_{724,1;749,8}.p3))
asType<integer>($heap<sub>724.1:749.8</sub>.p3) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;749,8}.\mathrm{M3})
Proof:
[Take given term]
[11.0] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
\rightarrow [simplify]
[11.1] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
asType < int > (\$heap_{funcstart\_724,1}.a1))
\rightarrow [const static or extern object]
[11.2]~{\rm div1} == {\rm div}(\mathbf{heapIs}~\$ \mathrm{heap}_{funcstart\_724,1},\,\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType < int > ($heap_{init}.a1))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
[11.3] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType<int>(asType<short int>((int)177)))
\rightarrow [simplify]
```

```
[11.6] div1 == div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177)
[Take given term]
[27.0] div2 == div(heapIs heap_{funcstart_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
\rightarrow [simplify]
[27.1] div2 == div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p2,
asType < int > (\$heap_{funcstart\_724,1}.a2))
\rightarrow [const static or extern object]
[27.2] \ \mathrm{div2} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2},
asType < int > (\$heap_{init}.a2))
\rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
[27.3]~{\rm div2} == {\rm div}(\mathbf{heapIs}~\$ \mathrm{heap}_{funcstart\_724,1},\,\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2},
asType<int>(asType<short int>((int)176)))
\rightarrow [simplify]
[27.6] \text{ div2} == \text{div}(\mathbf{heapIs} \$ heap_{funcstart\_724,1}, \$ heap_{funcstart\_724,1}.p2, 176)
[Take given term]
[43.0] div3 == div(heapIs $heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
asType < int > (\$heap_{funcstart\_724,1}.a3))
\rightarrow [simplify]
[43.1] \ \mathrm{div3} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
\rightarrow [const static or extern object]
[43.2] div3 == div(heapIs $heap_{funcstart\_724.1}, $heap_{funcstart\_724.1}.p3,
asType < int > (\$heap_{init}.a3))
\rightarrow [expand definition of constant 'a3' at prang.c (26,20)]
[43.3] \operatorname{div3} == \operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p3,
asType<int>(asType<short int>((int)178)))
\rightarrow [simplify]
[43.6] div3 == div(heapIs $heap_{funcstart\_724,1}$, $heap_{funcstart\_724,1}.p3, 178)
[Take given term]
[59.0] \rho_{1745,8} == \rho_{1745,8} == \rho_{1745,8} == \rho_{1745,8} - \rho_{1745,8} == \rho_{1745,8}
int>((asType<int>(asType<short int>(div1.rem)) *
\mathbf{asType} \small{<} \mathbf{int} \small{>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{r1})) - (\mathbf{asType} \small{<} \mathbf{int} \small{>} (\mathbf{asType} \small{<} \mathbf{short}
\mathbf{int}{>}(\mathbf{div1}.\mathbf{quot})) * \mathbf{asType}{<} \mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
```

```
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177)
[59.1] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div(heapIs $heap_{tuncstart\_724.1},
\theta_{tuncstart_{-724,1},p1,177,rem} * asType<int>($\text{heap}_{tuncstart_{-724,1},r1}$) -
(asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [simplify]
[59.3] \text{sheap}_{724,1;745,8} == \text{sheap}_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType < int > (\$heap_{tuncstart\_724.1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType<int>($heap_{funcstart\_724,1}.b1)))
\rightarrow [const static or extern object]
[59.4] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType < int > (\$heap_{init}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1.quot})) * \mathbf{asType}{<} \mathbf{int}{>} (\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
\rightarrow [expand definition of constant 'r1' at prang.c (15,20)]
[59.5] \rho_{1745,8} == \rho_{1745,8} == \rho_{1745,8} == \rho_{1745,8}._replace(p1 \rightarrow \rho_{1745,8} == \rho_{1745,8})
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType<int>(asType<short int>((int)171))) -
(asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724.1}.b1))))
\rightarrow [simplify]
[59.8] \rho_{724,1;745,8} == \rho_{funcstart\_724,1}.\_replace(p1 \rightarrow asType < short)
int > ((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem * 171)
- (asType<int>(asType<short int>(div1.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart_724,1},
heap_{funcstart_{724,1}}.p1, 177
[59.9] \rho_{1745,8} == \rho_{1745,8} == \rho_{1745,8} == \rho_{1745,8}._replace(p1 \rightarrow \rho_{1745,8} == \rho_{1745,8})
int>((171 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)
- (asType<int>(asType<short int>(div(heapIs $heap_{funcstart_724.1},
heap_{funcstart_{724,1}}.p1, 177).quot) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [simplify]
[59.11] \$ heap_{724,1;745,8} == \$ heap_{funcstart\_724,1}.\_\mathbf{replace} (p1 \to \mathbf{asType} < \mathbf{short})
int>((171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
```

```
\rightarrow [const static or extern object]
[59.12] \rho_{12} = \rho_{124,1;745,8} = \rho_{124,1;74
int>((171 * div(heapIs $heap_{funcstart_724,1}, $heap_{funcstart_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType < int > (\$heap_{init}.b1)))
\rightarrow [expand definition of constant 'b1' at prang.c (17,20)]
[59.13] \$ heap_{724,1;745,8} == \$ heap_{funcstart\_724,1}.\_\mathbf{replace} (p1 \to \mathbf{asType} < \mathbf{short})
\mathbf{int} > ((171 * \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, 177).\operatorname{rem})
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType < int > (asType < short int > ((int)2))))
\rightarrow [simplify]
[59.19] \text{Sheap}_{724,1;745,8} == \text{Sheap}_{funcstart\_724,1}.\_\mathbf{replace}(\text{p1} \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).rem)))
[Take given term]
[60.0] -asType<integer const>($heap_{724,1;745,8}.M1) <
asType<integer>($heap<sub>724.1:745.8</sub>.p1)
\rightarrow [from term 59.19, $heap<sub>724,1;745,8</sub> is equal to
heap_{funcstart\_724.1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724.1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1}}.p1, 177).rem)
[60.1] -asType < integer\ const > (\$heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * funcstart\_724,1)))))
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).rem))).M1) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{p1})
→ [const member of object with modified fields]
[60.2] - \mathbf{asType} < \mathbf{integer\ const} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{M1}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{p1})
\rightarrow [const static or extern object]
[60.3] -asType<integer const>(\text{$heap}_{init}.M1) <
asType<integer>($heap<sub>724,1;745,8</sub>.p1)
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[60.4] -asType<integer const>(asType<short int>((int)30269)) <
asType<integer>($heap<sub>724,1:745,8</sub>.p1)
\rightarrow [simplify]
[60.8] -30269 < asType < integer > ($heap_{724.1:745.8}.p1)
\rightarrow [from term 59.19, $heap<sub>724,1;745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs $heap_{funcstart\_724,1},
```

```
\text{Sheap}_{funcstart_{-724,1},p1, 177}.\text{quot}) + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart_{-724,1}})
heap_{funcstart_{-724,1}}.p1, 177).rem)
[60.9] -30269 < asType<integer>($heap_{funcstart\_724.1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).rem))).p1)
\rightarrow [simplify]
\label{eq:continuous} \textit{[60.11]} \; -30269 < ((-2 * \text{div}(\textbf{heapIs} \; \$ \text{heap}_{funcstart\_724,1}, \; \$ \text{heap}_{funcstart\_724,1}.\text{p1}, \\
177).quot) + (171 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).rem))
[Take given term]
[63.0] $\text{heap}_{724,1;747,8} == $\text{heap}_{724,1;745,8}._\text{replace}(p2 \rightarrow \text{asType} < \text{short}
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724,1:745,8}.r2)) - (asType < int > (asType < short)
\mathbf{int}{>}(\text{div2.quot})) \ * \ \mathbf{asType}{<} \mathbf{int}{>} (\$\text{heap}_{724,1;745,8}.\text{b2}))))
\rightarrow [from term 59.19, $heap<sub>724,1;745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724,1}),
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs p_{funcstart\_724,1}),
heap_{funcstart_{724,1},p1,177,rem})
[63.1] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}. p1, \ 177). \operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
(177).rem))._replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724,1;745,8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType< int>($heap_{724,1:745,8}.b2))))
\rightarrow [from term 27.6, div2 is equal to div(heap
Is $heap_funcstart_724,1,
heap_{funcstart_{724,1}}.p2, 176
[63.2] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem))).\_\mathbf{replace}(p2 \rightarrow \mathbf{asType} < \mathbf{short}
int>((asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},
\text{sheap}_{funcstart\_724,1.p2}, 176).rem) * asType < int > (\text{sheap}_{724,1;745,8.r2})) -
(asType<int>(asType<short int>(div2.quot)) *
asType < int > (\$heap_{724,1;745,8}.b2))))
\rightarrow [simplify]
[63.4] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((\operatorname{div}(\mathbf{heapIs}))))
\text{Sheap}_{funcstart_{-724,1}}, \text{Sheap}_{funcstart_{-724,1}}.p2, 176).rem *
```

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asType < int > (\$heap_{724.1:745.8}.r2)) - (asType < int > (asType < short)
\mathbf{int}{>}(\text{div2.quot})) \ * \ \mathbf{asType}{<} \mathbf{int}{>} (\$\text{heap}_{724,1;745,8}.\text{b2}))))
\rightarrow [from term 59.19, $heap<sub>724,1:745,8</sub> is equal to
heap_{funcstart\_724.1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724.1}),
heap_{funcstart_{724,1},p1, 177}, quot) + (171 * div(heapIs p_{funcstart_{724,1},p1, 177}), quot)
\$heap_{funcstart\_724,1}.p1,\ 177).rem))]
[63.5] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
div(\mathbf{heapIs} \ \text{$heap}_{funcstart\_724,1}, \ \text{$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((\operatorname{div}(\mathbf{heapIs}))))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem *
asType < int > (\$heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * div(heapIs)))))))
\rho_{tuncstart_{-724,1}}, \rho_{tuncstart_{-724,1}}, 177).quot + (171 * div(heapIs)
\text{Sheap}_{funcstart_{-724,1}}, \text{Sheap}_{funcstart_{-724,1}}.p1, 177).rem))).r2)) -
(asType<int>(asType<short int>(div2.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\${\rm heap}_{724,1;745,8}.{\rm b2}))))
→ [const member of object with modified fields]
[63.6] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}. p1, \ 177). \operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((\operatorname{div}(\mathbf{heapIs}))))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem *
asType < int > (\$heap_{funcstart\_724,1}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType< int>($heap_{724.1:745.8}.b2))))
\rightarrow [const static or extern object]
[63.7] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem *
asType < int > (\$heap_{init}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType< int>($heap_{724,1:745,8}.b2))))
\rightarrow [expand definition of constant 'r2' at prang.c (20,20)]
[63.8] $heap<sub>724.1:747.8</sub> == $heap<sub>funcstart_724.1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((\operatorname{div}(\mathbf{heapIs}))))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem *
asType<int>(asType<short int>((int)172))) -
(asType<int>(asType<short int>(div2.quot)) *
asType < int > (\$heap_{724,1;745,8}.b2))))
\rightarrow [simplify]
```

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[63.11] $\text{heap}_{724,1;747,8} == \text{$heap}_{funcstart_724,1}._\text{$\mathbf{replace}$}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\label{eq:div_heap} \text{div}(\textbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
(177).rem))._replace(p2 \rightarrow asType<short int>((div(heapIs)))._replace(p2)
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p2, 176).rem * 172) -
(asType<int>(asType<short int>(div2.quot)) *
asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{tuncstart_{724.1}},
heap_{funcstart_{-724,1}}.p2, 176
[63.12] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem}) -
(asType < int > (asType < short int > (div(heapIs $heap_{funcstart\_724,1}, 
\text{sheap}_{funcstart\_724,1.p2}, 176).\text{quot}) * asType<int>(\text{sheap}_{724,1:745,8}.\text{b2}))))
\rightarrow [simplify]
[63.14] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1},p2,176}.quot *
asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [from term 59.19, $heap<sub>724,1;745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1}, 177).quot) + (171 * div(heapIs $heap_{funcstart\_724,1}, 17
heap_{funcstart} 724.1.p1, 177).rem))]
[63.15] $\text{heap}_{724,1;747,8} == \text{$heap}_{funcstart\_724,1}._\text{$replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((172 * div(\mathbf{heapIs}
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}.p2, 176).quot
\mathbf{asType}{<}\mathbf{int}{>}(\$\text{heap}_{funcstart\_724,1}.\mathbf{\_replace}(\text{p1} \rightarrow ((\text{-}2 * \text{div}(\mathbf{heapIs}
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1},p1, 177}.quot + (171 * div(heapIs))
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 177).rem)).b2))))
\rightarrow [const member of object with modified fields]
[63.16] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
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\theta_{funcstart_{-724,1}}, \theta_{funcstart_{-724,1},p2, 176}.rem) - (div(heapIs)
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}.p2, 176).quot *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b2}))))
\rightarrow [const static or extern object]
[63.17] $\text{heap}_{724,1;747,8} == $\text{heap}_{funcstart_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 2, 176).quot *
asType < int > (\$heap_{init}.b2))))
\rightarrow [expand definition of constant 'b2' at prang.c (22,20)]
[63.18] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 2, 176).quot *
asType<int>(asType<short int>((int)35)))))
\rightarrow [simplify]
[63.24] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p2, 176).rem)
[Take given term]
[67.0] $\text{heap}_{724,1;749,8} == $\text{heap}_{724,1;747,8}._\text{replace}(p3 \to \text{asType} < \text{short}
int>((asType<int>(asType<short int>(div3.rem)) *
asType < int > (\$heap_{724,1:747,8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap<sub>724,1:747,8</sub>.b3))))
\rightarrow [from term 63.24, $\$heap_{724,1;747,8}$ is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs *heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart_{-724,1}},
heap_{funcstart\_724.1}.p1, 177).rem))._replace(p2 \rightarrow (-35 * div(heapIs)))._
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p2, 176).rem)
[67.1] \theta == 
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
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\text{Sheap}_{funcstart_{-724,1},p2, 176}.quot) + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart_{-724,1}},
\hat{p}_{funcstart\_724,1.p2, 176}.rem))._replace(p3 \rightarrow asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType < int > (\$heap_{724,1:747,8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap<sub>724,1:747,8</sub>.b3))))
\rightarrow [from term 43.6, div3 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1}}.p3, 178
[67.2] $\text{heap}_{724,1;749,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart} \ 724.1, \ \$ \operatorname{heap}_{funcstart} \ 724.1.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{funcstart\_724,1}.p2, 176).rem))).replace(p3 \rightarrow asType < short)
int>((asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},
\text{sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{rem}) * \mathbf{asType} < \mathbf{int} > (\text{sheap}_{724,1;747,8}.\text{r3})) -
(asType<int>(asType<short int>(div3.quot)) *
asType < int > (\$heap_{724,1;747,8}.b3))))
\rightarrow [simplify]
[67.4] $heap<sub>724,1:749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724.1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724.1},
\theta_{uncstart_724.1.p2, 176}.rem)._replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem *
asType < int > (\$heap_{724,1;747,8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap<sub>724.1:747.8</sub>.b3))))
\rightarrow [from term 63.24, $heap<sub>724,1:747,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs p_{funcstart\_724,1})
\theta_{funcstart\_724,1}.p1, 177).rem))._replace(p2 \rightarrow (-35 * div(\mathbf{heapIs})))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, p2, 176).rem)
[67.5] heap_{724,1;749,8} == heap_{funcstart\_724,1}.\_replace(p1 \to ((-2 * 
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{funcstart\_724,1}.p2, 176).rem))._replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem *
asType < int > (\$heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * div(heapIs))))))
\rho_{tuncstart_{-724,1}}, \rho_{tuncstart_{-724,1},1}, 177).quot + (171 * div(heapIs)
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
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* div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, p2, 176).quot) + (172 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p2, 176).rem))).r3)) -
(asType<int>(asType<short int>(div3.quot)) *
asType < int > (\$heap_{724,1;747,8}.b3))))
→ [const member of object with modified fields]
[67.7] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\rho_{tuncstart_{-724.1},p2, 176} + (172 * div(heapIs $heap_{tuncstart_{-724.1},p2})
\theta_{funcstart\_724,1}.p2, 176).rem))._replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem *
asType < int > (\$heap_{funcstart\_724,1}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType< int>($heap_{724.1:747.8}.b3))))
\rightarrow [const static or extern object]
[67.8] heap_{724,1;749,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{tuncstart_724.1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs} \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2, 176}.rem))._replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem *
asType < int > (\$heap_{init}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType< int>($heap_{724.1:747.8}.b3))))
\rightarrow [expand definition of constant 'r3' at prang.c (25,20)]
[67.9] $\text{heap}_{724,1;749,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724.1},
\rho_{funcstart\_724,1.p2}, 176).quot) + (172 * div(heapIs \rho_{funcstart\_724,1},
\rho_{tuncstart\_724.1.p2, 176}.rem))._replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724.1}, \$heap_{funcstart\_724.1}.p3, 178).rem *
asType<int>(asType<short int>((int)170))) -
(asType<int>(asType<short int>(div3.quot)) *
asType<int>($heap<sub>724.1:747.8</sub>.b3))))
\rightarrow [simplify]
[67.12] $\text{heap}_{724,1;749,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(\text{p1} \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724,1},
\theta_{funcstart_{-724,1},p2,176}.quot) + (172 * div(heapIs \theta_{funcstart_{-724,1},p2,176}).
\theta_{funcstart_{724,1},p2,176,rem})._replace(p3 \rightarrow asType<short
```

```
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem * 170)
- (asType<int>(asType<short int>(div3.quot))
asType < int > (\$heap_{724,1;747,8}.b3))))
\rightarrow [from term 43.6, div3 is equal to div(heapIs $heap_{tuncstart_{724.1}},
heap_{funcstart_{-724,1}}.p3, 178
[67.13] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\rho_{tuncstart_{724,1},p2, 176} = 176 \cdot (172 * div(heapIs $heap_{tuncstart_{724,1}})
\rho_{uncstart\_724,1.p2, 176).rem}))._replace(p3 \rightarrow asType<short int>((170
* \operatorname{div}(\mathbf{heapIs} \ \text{$heap}_{funcstart\_724,1}, \ \text{$heap}_{funcstart\_724,1}.p3, \ 178).rem) -
(asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724.1},
\text{sheap}_{funcstart\_724,1.p3}, 178).\text{quot}) * asType < int > (\text{sheap}_{724,1:747.8.b3})))
\rightarrow [simplify]
[67.15] $\text{heap}_{724,1;749,8} == \text{$heap}_{funcstart\_724,1}._\text{$-replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{tuncstart_724.1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs} \text{Sheap}_{funcstart\_724,1}),
\frac{\text{sheap}_{funcstart\_724,1.p2, 176}.rem)}{\text{.replace}(p3 \rightarrow asType < short int} > ((170))
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) –
(\text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724.1}, \ \$ \text{heap}_{funcstart\_724.1}. \text{p3}, \ 178). \text{quot} \ *
asType < int > (\$heap_{724,1:747.8}.b3))))
\rightarrow [from term 63.24, $heap<sub>724,1;747,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.p1, 177).quot) + (171 * div(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).rem)._replace(p2 \rightarrow (-35 * div(heapIs)))._
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, p2, 176).rem)
[67.16] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724.1}, \ \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\theta_{funcstart\_724,1}.p2, 176.quot) + (172 * div(heapIs \theta_{funcstart\_724,1},
\rho_{tuncstart=724.1.p2, 176}.rem)._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) –
(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} *
\mathbf{asType}{<}\mathbf{int}{>}(\$\text{heap}_{funcstart\_724,1}.\_\mathbf{replace}(\text{p1} \rightarrow ((\text{-2} * \text{div}(\mathbf{heapIs}
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1},p1, 177}.quot) + (171 * div(heapIs)
\rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}
* div(heapIs heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 176).quot) + (172 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p2, \ 176).rem))).b3))))
```

```
\rightarrow [const member of object with modified fields]
[67.18] $\text{heap}_{724,1:749.8} == $\text{heap}_{funcstart_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{tuncstart_724.1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{tuncstart\_724,1.p2, 176}.rem)._replace(p3 \rightarrow asType<short int>((170
* \operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p3, \ 178).rem) -
(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} *
asType < int > (\$heap_{funcstart\_724,1}.b3))))
\rightarrow [const static or extern object]
[67.19] heap_{724,1;749,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{tuncstart\_724.1.p2, 176).rem})._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) –
(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} *
asType < int > (\$heap_{init}.b3)))
\rightarrow [expand definition of constant 'b3' at prang.c (27,20)]
[67.20] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2, 176).rem})).\_replace(p3 \rightarrow asType < short int > ((170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}, 178).rem) –
(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} *
asType<int>(asType<short int>((int)63))))
\rightarrow [simplify]
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{tuncstart_{-724,1},p2, 176,rem})._replace(p3 \rightarrow ((-63 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
\$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem)))
[Take goal term]
[1.0] minof(int) \leq $heap<sub>724,1:749,8</sub>.p1
```

```
\rightarrow [simplify]
[1.1] -32768 \leq $heap<sub>724.1:749.8</sub>.p1
\rightarrow [from term 67.26, $heap<sub>724.1:749.8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs *heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs p_{funcstart\_724,1}),
\rho_{funcstart\_724,1}.p1, 177).rem))).\_replace(p2 \rightarrow ((-35 * div(heapIs))).\_replace(p2 \rightarrow ((-35 * div(heapIs)))).\_replace(p2 \rightarrow ((-35 * div(heapIs)))))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).quot) + (170 *
\operatorname{div}(\mathbf{heapIs} \ \$ heap_{funcstart\_724,1}, \ \$ heap_{funcstart\_724,1}.p3, \ 178).rem))]
[1.2] -32768 \leq $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p1, 177).quot) + (171 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
* div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, p2, 176).quot) + (172 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724.1}, \ \$ \operatorname{heap}_{funcstart\_724.1}.p2,
176).rem)))._replace(p3 \rightarrow ((-63 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724.1.p3}, 178).\text{quot} + (170 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724.1},
heap_{funcstart_{-724,1}.p3, 178, rem})).p1
\rightarrow [simplify]
 \label{eq:continuous} \mbox{$[1.7]$ -32769} < ((-2 * \mbox{div}(\mathbf{heapIs} \ \$ \mbox{$heap}_{funcstart\_724,1}, \$ \mbox{$heap}_{funcstart\_724,1}.\mbox{$p$}_1,
177).quot) + (171 * div(heapIs heapIs = f_{uncstart_{-724,1}}, heap_{funcstart_{-724,1}}.p1,
177).rem))
\rightarrow [from term 60.11, literala < ((-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1},p1, 177}, quot) + (171 * div(heapIs heap_{funcstart_{724,1},p1, 177})
heap_{funcstart\_724,1}.p1, 177).rem is true whenever (-1 + literala) < -30269
    Proof of rule precondition:
    [1.7.0](-32769 + -1) < -30269
    \rightarrow [simplify]
    [1.7.2] true
[1.8] true
Proof of verification condition: Type constraint satisfied in implicit
conversion from 'short int' to 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (68,5)
Condition defined at:
To prove: heap_{724,1;749,8}.p1 \le maxof(int)
```

Given:

 $heap_{init}.LIMIT == (int)80$

```
heap_{init}.M1 == asType < short int > ((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta = asType < short int > ((int)2)
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart_{724,1}})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724.1}.p1),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ / \ 
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}))~\%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p1) = =
asType<integer>(div1.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathtt{a1}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
```

```
asType < int > (\$heap_{funcstart\_724.1}.a2))
(asType<integer>(asType<int>($heap_{funcstart\_724,1}.p2)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.rem)
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}) ==
asType<integer>(div2.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a2) \le
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2})) = > !(0 = =
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})) \ / \\
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))) ==
asType<integer>(div3.quot)
(asType<int>(asType<int>($heap_funcstart_724.1.p3)) %
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.rem)
(asType < integer > ($heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.a3) \leq
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})) => !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
heap_{724,1;745,8} == heap_{funcstart\_724,1}.\_replace(p1 \rightarrow asType < short)
\mathbf{int}{>}((\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{short}\ \mathbf{int}{>}(\mathbf{div}1.\mathbf{rem}))\ ^*
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1.quot})) * \mathbf{asType}{<} \mathbf{int}{>} (\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
-asType < integer const > (\$heap_{724,1;745,8}.M1) < 
asType<integer>($heap<sub>724 1:745 8</sub>.p1)
```

```
!(0 == asType < integer > (\$heap_{724,1:745.8}.p1))
asType<integer>($heap<sub>724.1:745.8</sub>.p1) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{M1})
heap_{724,1;747,8} == heap_{724,1;745,8}.replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724.1:745.8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724,1:745,8</sub>.b2))))
-asType<integer const>($heap<sub>724,1:747,8</sub>.M2) <
asType<integer>($heap<sub>724,1:747,8</sub>.p2)
!(0 == asType < integer > (\$heap_{724,1;747,8}.p2))
asType<integer>($heap<sub>724,1:747,8</sub>.p2) <
asType<integer>($heap<sub>724,1:747,8</sub>.M2)
\text{heap}_{724.1:749.8} == \text{heap}_{724.1:747.8}._replace(p3 \rightarrow asType<short)
int>((asType<int>(asType<short int>(div3.rem))
asType < int > (\$heap_{724,1;747,8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap<sub>724,1;747,8</sub>.b3))))
-{\bf asType}{<} {\bf integer~const}{>} (\${\rm heap}_{724,1;749,8}.{\rm M3}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;749,8}.\mathrm{p3})
!(0 == asType < integer > (\$heap_{724,1;749,8}.p3))
\mathbf{asType}{<}\mathbf{integer}{>}(\$ heap_{724,1;749,8}.p3) <
asType<integer>($heap<sub>724,1:749,8</sub>.M3)
Proof:
[Take given term]
[11.0] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
asType < int > (\$heap_{funcstart\_724.1}.a1))
\rightarrow [simplify]
[11.1] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
asType < int > (\$heap_{funcstart\_724,1}.a1))
\rightarrow [const static or extern object]
[11.2] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType < int > (\$heap_{init}.a1))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
[11.3] div1 == div(heapIs \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}
asType<int>(asType<short int>((int)177)))
\rightarrow [simplify]
[11.6] div1 == div(heapIs $heap<sub>funcstart_724,1</sub>, $heap<sub>funcstart_724,1</sub>.p1, 177)
```

```
[Take given term]
[27.0] \operatorname{div2} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
\rightarrow [simplify]
[27.1] div2 == div(heapIs $heap_{funcstart\_724.1}, $heap_{funcstart\_724.1}.p2,
asType < int > (\$heap_{funcstart\_724,1}.a2))
\rightarrow [const static or extern object]
\label{eq:continuous} \mbox{[27.2]} \mbox{ div2} == \mbox{div}(\mbox{\bf heapIs} \mbox{ \$heap}_{funcstart\_724,1}, \mbox{ \$heap}_{funcstart\_724,1}.\mbox{p2},
\mathbf{asType}{<}\mathbf{int}{>}(\$\text{heap}_{init}.\text{a2}))
\rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
[27.3] div2 == div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2,
asType<int>(asType<short int>((int)176)))
\rightarrow [simplify]
[27.6] div2 == div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p2, 176)
[Take given term]
[43.0] div3 == div(heapIs $heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
asType < int > (\$heap_{funcstart\_724,1}.a3))
\rightarrow [simplify]
[43.1] \ \mathrm{div3} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3},
asType < int > (\$heap_{funcstart\_724,1}.a3))
\rightarrow [const static or extern object]
[43.2] div3 == div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p3,
asType < int > (\$heap_{init}.a3))
\rightarrow [expand definition of constant 'a3' at prang.c (26,20)]
[43.3] \ \mathrm{div3} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3},
asType<int>(asType<short int>((int)178)))
\rightarrow [simplify]
[43.6] \ \mathrm{div3} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}, \ 178)
[Take given term]
[59.0] \rho_{1745,8} == \rho_{1745
int>((asType<int>(asType<short int>(div1.rem)) *
\mathbf{asType} \hspace{-0.1em}<\hspace{-0.1em} \mathbf{int} \hspace{-0.1em}> \hspace{-0.1em} (\$ heap_{funcstart\_724,1}.r1)) - (\mathbf{asType} \hspace{-0.1em}<\hspace{-0.1em} \mathbf{int} \hspace{-0.1em}> \hspace{-0.1em} (\mathbf{asType} \hspace{-0.1em}<\hspace{-0.1em} \mathbf{short})
\mathbf{int}{>}(\mathbf{div1}.\mathbf{quot})) \ * \ \mathbf{asType}{<} \mathbf{int}{>} (\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
```

```
heap_{funcstart_{-724,1}}.p1, 177
[59.1] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},
\rho_{uncstart\_724,1.p1, 177}.rem) * asType < int > (\rho_{uncstart\_724,1.r1}) - (\rho_{uncstart\_724,1.
(asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724.1}.b1))))
\rightarrow [simplify]
[59.3] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>(heap_{funcstart\_724,1}.b1)))
\rightarrow [const static or extern object]
[59.4] \rho_{1745,8} == \rho_{1745,8} == \rho_{1745,8} == \rho_{1745,8}._replace(p1 \rightarrow \rho_{1745,8} == \rho_{1745,8})
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType < int > (\$heap_{init}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1.quot})) * \mathbf{asType}{<} \mathbf{int}{>} (\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
\rightarrow [expand definition of constant 'r1' at prang.c (15,20)]
[59.5] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType < int > (asType < short int > ((int)171))) -
(asType < int > (asType < short int > (div1.quot)) *
asType < int > (\$heap_{funcstart\_724,1}.b1)))
\rightarrow [simplify]
[59.8] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem * 171)
- (asType<int>(asType<short int>(div1.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177
[59.9] \text{sheap}_{724,1;745,8} == \text{sheap}_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).rem)
- (asType<int>(asType<short int>(div(heapIs $heap_{funcstart_724.1},
heap_{funcstart_{724,1},p1, 177}, quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [simplify]
[59.11] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
\mathbf{int} > ((171 * \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, 177).\operatorname{rem})
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [const static or extern object]
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[59.12] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).rem)
 - (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType < int > (\$heap_{init}.b1)))
\rightarrow [expand definition of constant 'b1' at prang.c (17,20)]
[59.13] \rho_{13} = \rho_
int>((171 * div(heapIs $heap_{funcstart_724,1}, $heap_{funcstart_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType<int>(asType<short int>((int)2))))
\rightarrow [simplify]
[59.19] $heap<sub>724,1;745,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).rem)))
[Take given term]
[62.0] asType<integer>($heap_{724,1;745,8}.p1) <
asType<integer>($heap<sub>724.1:745.8</sub>.M1)
\rightarrow [from term 59.19, $heap<sub>724,1;745,8</sub> is equal to
heap_{funcstart\_724.1}._replace(p1 \rightarrow (-2 * div(heapIs $heap_{funcstart\_724.1},
heap_{funcstart_{724,1},p1, 177}, quot) + (171 * div(heapIs p_{funcstart_{724,1},p1, 177}).
heap_{funcstart_{-724,1}}.p1, 177).rem)
[62.1] asType<integer>(p1 \rightarrow ((-2 * p1)^2))
div(\mathbf{heapIs} \ \$heap_{funcstart\_724.1}, \ \$heap_{funcstart\_724.1}.p1, \ 177).quot) + (171 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p1, \ 177).rem))).p1) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{M1})
\rightarrow [simplify]
[62.3] ((-2 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).quot) + (171 * div(heapIs \theta_{funcstart_{-724,1}}, \theta_{funcstart_{-724,1}}, p1,
(177).rem) < asType < integer > ($heap_{724,1;745,8}.M1)
\rightarrow [from term 59.19, $heap<sub>724,1;745,8</sub> is equal to
heap_{funcstart\_724.1}._replace(p1 \rightarrow (-2 * div(heapIs $heap_{funcstart\_724.1},
\text{Sheap}_{funcstart\_724,1.p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\$heap_{funcstart\_724,1}.p1,\ 177).rem))]
[62.4] ((-2 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).quot) + (171 * div(heapIs heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p_1,
177).rem)) < asType<integer>($heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).rem))).M1)
→ [const member of object with modified fields]
[62.5] ((-2 * div(heapIs $heap_{funcstart_{-724.1}}, $heap_{funcstart_{-724.1}}.p1,]
177).quot) + (171 * \text{div}(\textbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1},
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(177).rem) < asType < integer > (\$heap_{funcstart_724.1}.M1)
\rightarrow [const static or extern object]
[62.6] ((-2 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1,
177).quot) + (171 * div(heapIs heapIs = f_{uncstart_{-724,1}}, heap_{funcstart_{-724,1}}.p1,
(177).rem) < asType < integer > (\$heap_{init}.M1)
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[62.7] ((-2 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).quot) + (171 * div(heapIs heap_{funcstart\_724.1}, heap_{funcstart\_724.1}.p1,
177).rem)) < asType<integer>(asType<short int>((int)30269))
\rightarrow [simplify]
[62.17] -30269 < ((-171 * div(heapIs $heap<sub>funcstart_724,1</sub>,
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177).quot)
[Take given term]
[63.0] $heap<sub>724.1:747.8</sub> == $heap<sub>724.1:745.8</sub>._replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724,1;745,8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType< int>($heap_{724,1;745,8}.b2))))
\rightarrow [from term 59.19, $heap<sub>724,1:745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724,1}),
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1}, 177).quot) + (171 * div(heapIs $heap_{funcstart\_724,1}, 17
heap_{funcstart_{-724,1}.p1, 177).rem}
[63.1] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724.1}, \ \$heap_{funcstart\_724.1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724.1}, \ \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724.1:745.8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType< int>($heap_{724,1;745.8}.b2))))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p2, 176
[63.2] \rho_{724,1;747,8} == \rho_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
(177).rem))).\_replace(p2 \rightarrow asType < short)
int>((asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},
\text{sheap}_{funcstart\_724,1.p2, 176}.\text{rem}) * asType<int>(\text{sheap}_{724,1:745,8.r2})) -
(asType<int>(asType<short int>(div2.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\${\rm heap}_{724,1;745,8}.{\rm b2}))))
\rightarrow [simplify]
```

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[63.4] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\label{eq:div_heap} \text{div}(\textbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
(177).rem))._replace(p2 \rightarrow asType<short int>((div(heapIs)))._replace(p2)
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}.p2, 176).rem *
asType < int > (\$heap_{724,1:745.8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [from term 59.19, $heap<sub>724,1;745,8</sub> is equal to
heap_{funcstart\_724.1}._replace(p1 \rightarrow (-2 * div(heapIs $heap_{funcstart\_724.1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1}, 177).quot) + (171 * div(heapIs $heap_{funcstart\_724,1}, 17
\$heap_{funcstart\_724,1}.p1,\ 177).rem))]
[63.5] \rho_{724,1;747,8} == \rho_{11,747,8} == \rho_{12,11,124,1} ._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((\operatorname{div}(\mathbf{heapIs}))))
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}.p2, 176).rem *
asType < int > (\$heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * div(heapIs))))))
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 177).quot) + (171 * div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).rem))).r2)) -
(asType<int>(asType<short int>(div2.quot)) *
asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [const member of object with modified fields]
[63.6] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((\operatorname{div}(\mathbf{heapIs}))))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem *
asType < int > (\$heap_{funcstart\_724,1}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType< int>($heap_{724,1;745,8}.b2))))
\rightarrow [const static or extern object]
[63.7] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724.1}, \ \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((\operatorname{div}(\mathbf{heapIs}))))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem *
asType < int > (\$heap_{init}.r2)) - (asType < int > (asType < short)
int > (div2.quot)) * asType < int > (\$heap_{724,1:745,8}.b2))))
\rightarrow [expand definition of constant 'r2' at prang.c (20.20)]
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
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\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem *
asType<int>(asType<short int>((int)172))) -
(asType<int>(asType<short int>(div2.quot)) *
asType < int > (\$heap_{724,1;745,8}.b2))))
\rightarrow [simplify]
[63.11] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem * 172) -
(asType<int>(asType<short int>(div2.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{b2}))))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{tuncstart_{724.1}},
heap_{funcstart_{-724,1}}.p2, 176
[63.12] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, p_{176}.rem) -
(asType < int > (asType < short int > (div(heapIs $heap_{funcstart\_724,1}, 
\text{sheap}_{funcstart\_724,1.p2}, 176).\text{quot}) * asType < int > (\text{sheap}_{724,1:745,8}.b2))))
\rightarrow [simplify]
[63.14] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1},p2,176}.quot *
asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [from term 59.19, $heap<sub>724,1;745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1},p1, 177}, quot) + (171 * div(heapIs heap_{funcstart_{724,1},p1, 177})
heap_{funcstart_{724,1},p1,177,rem})
[63.15] $\text{heap}_{724.1:747.8} == \text{$heap}_{funcstart\_724.1}._\text{$replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem}) - (\text{div}(\text{heapIs}))
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 2, 176).quot *
asType < int > (\$heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * div(heapIs))))))
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).rem))).b2))))
```

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\rightarrow [const member of object with modified fields]
[63.16] $\text{heap}_{724,1:747,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1},p2,176}.quot
\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{b2}))))
\rightarrow [const static or extern object]
[63.17] $\text{heap}_{724,1;747,8} == \text{$heap}_{funcstart\_724,1}._\text{$replace}(p1 \to ((-2 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\text{Sheap}_{funcstart\_724.1}, \text{Sheap}_{funcstart\_724.1}.p2, 176).rem) - (div(heapIs)
\text{Sheap}_{funcstart_{724,1}}, \text{Sheap}_{funcstart_{724,1}}, p2, 176).quot *
asType < int > (\$heap_{init}.b2))))
\rightarrow [expand definition of constant 'b2' at prang.c (22,20)]
[63.18] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}.p2, 176).quot *
asType<int>(asType<short int>((int)35)))))
\rightarrow [simplify]
[63.24] $\text{heap}_{724,1;747,8} == \text{$heap}_{funcstart\_724,1}._\text{$replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724.1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p2, 176).rem)
[Take given term]
[67.0] $\text{heap}_{724,1:749,8} == $\text{heap}_{724,1:747,8}._\text{replace}(p3 \to \text{asType} < \text{short}
int>((asType<int>(asType<short int>(div3.rem)) *
asType < int > (\$heap_{724.1:747.8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap<sub>724,1:747,8</sub>.b3))))
\rightarrow [from term 63.24, $heap<sub>724,1:747,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs *heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1}, 177).quot) + (171 * div(heapIs $heap_{funcstart\_724,1}, 17
heap_{funcstart\_724.1}.p1, 177).rem)._replace(p2 \rightarrow (-35 * div(heapIs)))._
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
```

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heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, 176).rem)
[67.1] $\text{heap}_{724,1;749,8} == $\text{heap}_{funcstart_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724.1},
\theta_{funcstart\_724,1}.p2, 176.quot) + (172 * div(heapIs \theta_{funcstart\_724,1},
\theta_{funcstart\_724,1}.p2, 176).rem))._replace(p3 \rightarrow asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType < int > (\$heap_{724.1:747.8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap<sub>724.1:747.8</sub>.b3))))
\rightarrow [from term 43.6, div3 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p3, 178
[67.2] heap_{724,1;749,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724.1}, \ \$heap_{funcstart\_724.1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\rho_{funcstart_{-724,1},p2, 176} + (172 * div(heapIs $heap_{funcstart_{-724,1},p2})
\theta_{uncstart_724.1.p2, 176}.rem)._replace(p3 \rightarrow asType<short
int>((asType<int>(asType<short int>(div(heapIs $heap_{funcstart_724,1},))
\text{sheap}_{funcstart\_724,1.p3}, 178).rem) * asType < int > (\text{sheap}_{724,1;747,8.r3})) -
(asType<int>(asType<short int>(div3.quot)) *
asType < int > (\$heap_{724,1;747,8}.b3))))
\rightarrow [simplify]
[67.4] $\text{heap}_{724,1;749,8} == $\text{heap}_{funcstart\_724,1}.$\text{-replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{uncstart\_724,1.p2, 176).rem}))._replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem *
asType < int > (\$heap_{724,1:747,8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap<sub>724,1:747,8</sub>.b3))))
\rightarrow [from term 63.24, $\$heap_{724,1;747,8}$ is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs *heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724.1}.p1, 177).rem))._replace(p2 \rightarrow (-35 * div(heapIs)))._
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p2, 176).rem)
[67.5] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}. p1, \ 177). \operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
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\rho_{uncstart_{-724,1},p2, 176,rem)}._replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem *
\mathbf{asType} \small{<} \mathbf{int} \small{>} (\$ \mathbf{heap}_{funcstart\_724,1}. \_\mathbf{replace} (\mathtt{p1} \rightarrow ((-2 * \operatorname{div}(\mathbf{heapIs}
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1, 177).quot) + (171 * div(heapIs
\rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}
* div(heapIs heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 176).quot) + (172 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p2, 176).rem))).r3)) -
(asType<int>(asType<short int>(div3.quot)) *
asType<int>($heap<sub>724.1:747.8</sub>.b3))))
\rightarrow [const member of object with modified fields]
[67.7] $\text{heap}_{724,1;749,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{funcstart_{-724,1},p2, 176,p2}...replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem *
asType < int > (\$heap_{funcstart\_724.1}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap_{724,1;747,8}.b3))))
\rightarrow [const static or extern object]
[67.8] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{uncstart\_724,1.p2, 176).rem}).replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem *
asType < int > (\$heap_{init}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap<sub>724.1:747.8</sub>.b3))))
\rightarrow [expand definition of constant 'r3' at prang.c (25,20)]
[67.9] heap_{724,1;749,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\theta_{funcstart\_724,1}.p2, 176.quot) + (172 * div(heapIs \theta_{funcstart\_724,1},
\rho_{funcstart=724.1.p2, 176}.rem)._replace(p3 \rightarrow asType<short
\mathbf{int}{>}((\mathrm{div}(\mathbf{heapIs}\ \$\mathrm{heap}_{funcstart\_724,1},\ \$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3},\ 178).\mathrm{rem}\ *
asType<int>(asType<short int>((int)170))) -
(asType<int>(asType<short int>(div3.quot)) *
asType < int > (\$heap_{724,1;747,8}.b3))))
\rightarrow [simplify]
[67.12] $\text{heap}_{724,1:749,8} == \text{$heap}_{funcstart\_724,1}._\text{$replace}(p1 \to ((-2 *
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\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2, 176}.rem))._replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem * 170)
- (asType<int>(asType<short int>(div3.quot)) *
asType<int>($heap<sub>724.1:747.8</sub>.b3))))
\rightarrow [from term 43.6, div3 is equal to div(heapIs $heap_{funcstart_724.1},
heap_{funcstart_{-724,1}}.p3, 178
[67.13] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{uncstart\_724,1.p2, 176).rem}))._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) –
(asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},))
\rho_{uncstart_{724,1},p3,178,quot}) * asType < int > (\rho_{uncstart_{724,1},p3,178,quot}))
\rightarrow [simplify]
[67.15] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{uncstart\_724,1.p2, 176).rem}))._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) -
(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{724,1;747,8}.\mathrm{b3}))))
\rightarrow [from term 63.24, heap_{724,1;747,8} is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.p1, 177).quot) + (171 * div(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).rem))._replace(p2 \rightarrow (-35 * div(\mathbf{heapIs})))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p2, 176).rem)
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{tuncstart\_724,1.p2, 176}.rem)._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) –
(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} *
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asType < int > (\$heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * div(heapIs)))))))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs})
\$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem))).\_\mathbf{replace}(p2 \rightarrow ((-35), -20)))
* div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p2, \ 176).quot) + (172 \ *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p2, \ 176).rem))).b3))))
→ [const member of object with modified fields]
[67.18] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{tuncstart}, 724.1,
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs} \text{Sheap}_{funcstart\_724,1}),
\rho_{tuncstart\_724,1.p2, 176}.rem)._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) –
(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} *
asType < int > (\$heap_{funcstart\_724,1}.b3))))
\rightarrow [const static or extern object]
[67.19] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart} \ 724.1, \ \$ \operatorname{heap}_{funcstart} \ 724.1, \ p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{tuncstart_724.1}.p2, 176).rem))._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) –
(\text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724.1}, \ \$ \text{heap}_{funcstart\_724.1}. \text{p3}, \ 178). \text{quot} \ *
asType < int > (\$heap_{init}.b3)))
\rightarrow [expand definition of constant 'b3' at prang.c (27,20)]
[67.20] heap_{724,1;749,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724.1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724.1},
\rho_{tuncstart\_724.1.p2, 176).rem})._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) –
(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} *
asType<int>(asType<short int>((int)63)))))
\rightarrow [simplify]
[67.26] $\text{heap}_{724,1;749,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724,1},
\rho_{funcstart_{-724,1},p2,176} (unit) + (172 * div(heapIs \rho_{funcstart_{-724,1},p2}
\rho_{funcstart\_724,1.p2, 176}.rem)._replace(p3 \rightarrow ((-63 * div(heapIs
```

```
[Take goal term]
[1.0] $\text{heap}_{724,1;749,8}.p1 \leq \text{maxof(int)}
\rightarrow [from term 67.26, $heap<sub>724,1;749,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1},p1, 177}, quot) + (171 * div(heapIs p_{funcstart_{724,1},p1, 177}).
heap_{funcstart\_724,1}.p1, 177).rem))).\_replace(p2 \rightarrow ((-35 * div(heapIs))).\_replace(p2 \rightarrow ((-35 * div(heapIs)))).\_replace(p2 \rightarrow ((-35 * div(heapIs)))))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).quot) + (170 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).rem))]
[1.1] heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1},p1, 177}.quot + (171 * div(heapIs))
\rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p2},
176).rem)))._replace(p3 \rightarrow ((-63 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} + (170 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{funcstart_{-724,1}.p3, 178}.rem))).p1 \leq \max_{f(int)}
\rightarrow [simplify]
[1.18] -32768 < ((-171 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177).quot)
\rightarrow [from term 62.17, literala < ((-171 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724.1.p1, 177}.rem) + (2 * div(heapIs $heap_{funcstart\_724.1.p1, 177})
heap_{funcstart-724,1}.p1, 177).quot) is true whenever (-1 + literala) < -30269
       Proof of rule precondition:
       [1.18.0] (-32768 + -1) < -30269
       \rightarrow [simplify]
       [1.18.2] true
[1.19] true
Proof of verification condition: Type constraint satisfied in implicit
conversion from 'int' to 'short int'
Condition generated at: C:\Escher\Customers\prang\prang.c (68,8)
Condition defined at:
To prove: minof(short int) < ((asType<int>($heap<sub>724 1.749 8.</sub>M1) *
asType<int>(static_cast<integer>(asType<int>($heap_{724.1:749.8}.p1) <
```

 $heap_{funcstart_724,1}$, $heap_{funcstart_724,1}$.p3, 178).quot) + (170 * div(heapIs

 $heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 178).rem)$

```
(int)(0) + asType<int>($heap<sub>724.1:749.8</sub>.p1))
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta
heap_{init}.M2 == asType < short int > ((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta == asType<short int>((int)35)
\theta = asType < short int > ((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart\_724,1})
div1 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1})) \ / \\
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))) ==
asType<integer>(div1.quot)
(asType<integer>(asType<int>($heap_{tuncstart\_724.1}.p1)) %
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}))) = =
asType<integer>(div1.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1})) =>
(asType < integer > (\$heap_{funcstart\_724,1}.p1) = =
asType<integer>(div1.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a1) \le
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1})) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
```

```
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a2}))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.quot)
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2})) \%
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.rem)
(asType<integer>($heap_funcstart_724.1.p2) <
asType < integer > (\$heap_{funcstart_{-724,1}}.a2)) = >
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) ==
asType<integer>(div2.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a2}) \leq
asType < integer > (\$heap_{funcstart\_724.1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
asType < int > (\$heap_{funcstart\_724,1}.a3))
(asType<int>(asType<int>($heap_{tuncstart}, 724.1.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))) ==
asType<integer>(div3.rem)
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) ==
asType<integer>(div3.rem))
(asType < integer > (\$heap_{funcstart\_724.1}.a3) \le
asType < integer > (\$heap_{funcstart\_724,1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
\$heap_{724,1:745,8} == \$heap_{funcstart\_724,1}.\_\mathbf{replace}(p1 \to \mathbf{asType} < \mathbf{short}
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
```

```
\mathbf{int}{>}(\mathbf{div1.quot})) \ * \ \mathbf{asType}{<} \mathbf{int}{>} (\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
-asType < integer const > (\$heap_{724,1:745.8}.M1) < 
asType<integer>($heap<sub>724.1:745.8</sub>.p1)
!(0 == asType < integer > (\$heap_{724,1:745.8}.p1))
asType<integer>($heap<sub>724,1:745,8</sub>.p1) <
asType<integer>($heap<sub>724,1:745,8</sub>.M1)
\$heap_{724,1;747.8} == \$heap_{724,1;745,8}.\mathbf{\_replace}(p2 \rightarrow \mathbf{asType} < \mathbf{short}
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724.1:745.8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
-asType<integer const>($heap<sub>724,1:747,8</sub>.M2) <
asType<integer>($heap<sub>724,1;747,8</sub>.p2)
!(0 == \mathbf{asType} {<} \mathbf{integer} {>} (\$ heap_{724,1;747,8}.p2))
asType<integer>($heap<sub>724,1:747,8</sub>.p2) <
asType<integer>($heap<sub>724,1:747,8</sub>.M2)
\text{heap}_{724,1:749,8} == \text{heap}_{724,1:747,8}. \text{replace}(p3 \to asType < short)
int>((asType<int>(asType<short int>(div3.rem)) *
asType < int > (\$heap_{724,1;747,8}.r3)) - (asType < int > (asType < short)
int > (div3.quot)) * asType < int > (\$heap_{724,1:747,8}.b3))))
-{\bf asType}{<}{\bf integer~const}{>}(\${\rm heap}_{724,1;749,8}.{\rm M3}) <
asType<integer>($heap<sub>724,1:749,8</sub>.p3)
!(0 == asType < integer > (\$heap_{724,1;749,8}.p3))
asType<integer>($heap<sub>724,1:749,8</sub>.p3) <
asType<integer>($heap<sub>724,1:749,8</sub>.M3)
Proof:
[Take given term]
[11.0] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
\rightarrow [simplify]
[11.1]~{\rm div1} == {\rm div}(\mathbf{heapIs}~\$ \mathrm{heap}_{funcstart\_724,1}, \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
\rightarrow [const static or extern object]
[11.2] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType < int > (\$heap_{init}.a1))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
[11.3] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
```

```
asType<int>(asType<short int>((int)177)))
\rightarrow [simplify]
[11.6] div1 == div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177)
[Take given term]
[27.0] div2 == div(heapIs heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
\rightarrow [simplify]
[27.1] div2 == div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2,
asType < int > (\$heap_{funcstart\_724.1}.a2))
\rightarrow [const static or extern object]
[27.2] div2 == div(heapIs $heap_{funcstart\_724.1}, $heap_{funcstart\_724.1}.p2,
asType < int > (\$heap_{init}.a2))
\rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
[27.3] div2 == div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2,
\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{short}\ \mathbf{int}{>}((\mathbf{int})176)))
\rightarrow [simplify]
[27.6] div2 == div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2, 176)
[Take given term]
[43.0] div3 == div(heapIs $heap<sub>funcstart_724,1</sub>,
asType < int > (\$heap_{funcstart\_724,1}.p3),
asType < int > (\$heap_{funcstart\_724,1}.a3))
\rightarrow [simplify]
[43.1] \ \mathrm{div3} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3},
asType < int > (\$heap_{funcstart\_724,1}.a3))
\rightarrow [const static or extern object]
[43.2] div3 == div(heapIs $heap_{funcstart\_724.1}, $heap_{funcstart\_724.1}.p3,
asType < int > (\$heap_{init}.a3))
\rightarrow [expand definition of constant 'a3' at prang.c (26,20)]
[43.3] \ \mathrm{div3} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3},
asType<int>(asType<short int>((int)178)))
\rightarrow [simplify]
[43.6] \text{ div3} == \text{div}(\mathbf{heapIs} \$ heap_{funcstart\_724,1}, \$ heap_{funcstart\_724,1}.p3, 178)
[Take given term]
\text{[59.0] \$heap}_{724,1;745,8} == \$heap_{funcstart\_724,1}.\_\textbf{replace}(p1 \rightarrow \textbf{asType} < \textbf{short}
int>((asType<int>(asType<short int>(div1.rem)) *
```

```
asType < int > (\$heap_{tuncstart\_724.1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart_724,1},
heap_{funcstart_{-724,1}}.p1, 177
[59.1] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div(heapIs $heap_{tuncstart_724.1},))
\text{sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}) * asType<int>(\text{sheap}_{funcstart\_724,1}.\text{r1})) -
(asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [simplify]
[59.3] heap_{724,1:745,8} == heap_{funcstart\_724,1}-replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
\mathbf{asType} \small{<} \mathbf{int} \small{>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{r1})) \\ - (\mathbf{asType} \small{<} \mathbf{int} \small{>} (\mathbf{asType} \small{<} \mathbf{short}
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
\rightarrow [const static or extern object]
[59.4] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType < int > (\$heap_{init}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1.quot})) * \mathbf{asType}{<} \mathbf{int}{>} (\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
\rightarrow [expand definition of constant 'r1' at prang.c (15,20)]
[59.5] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType<int>(asType<short int>((int)171))) -
(asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [simplify]
[59.8] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem * 171)
- (asType < int > (asType < short int > (div1.quot))
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart_{-724,1}},
heap_{funcstart_{724,1}}.p1, 177
[59.9] \rho == \rho_{1.745,8} == \rho_{1.
int>((171 * div(heapIs $heap_tuncstart_724.1, $heap_tuncstart_724.1.p1, 177).rem)
- (asType<int>(asType<short int>(div(heapIs $heap_{funcstart 724.1},
heap_{funcstart_{724,1},p1,177}, quot)) *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [simplify]
[59.11] \text{sheap}_{724.1:745.8} == \text{sheap}_{funcstart\_724.1}._replace(p1 \rightarrow asType<short
int>((171 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)
```

```
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [const static or extern object]
[59.12] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((171 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724.1}, \$ \text{heap}_{funcstart\_724.1}. p1, 177).\text{quot} *
asType < int > (\$heap_{init}.b1))))
\rightarrow [expand definition of constant 'b1' at prang.c (17,20)]
[59.13] \theta_{13} = \theta_
int > ((171 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724.1}, \$ \text{heap}_{funcstart\_724.1}.\text{p1}, 177).\text{quot} *
asType<int>(asType<short int>((int)2))))
\rightarrow [simplify]
[59.19] $\text{heap}_{724,1;745,8} == \text{$heap}_{funcstart\_724,1}._\text{$replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, \ 177).\operatorname{rem})))
[Take given term]
[60.0] -asType<integer const>($heap_{724.1:745.8}.M1) <
asType<integer>($heap<sub>724.1:745.8</sub>.p1)
\rightarrow [from term 59.19, $heap<sub>724,1:745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs p_{funcstart\_724,1}),
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1}, 177).quot) + (171 * div(heapIs $heap_{funcstart\_724,1}, 17
heap_{funcstart_{-724,1}}.p1, 177).rem)
[60.1] -asType<integer const>(p1 \rightarrow (-2 * p1))
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).rem))).M1) <
asType<integer>($heap<sub>724,1:745,8</sub>.p1)
\rightarrow [const member of object with modified fields]
[60.2] - \mathbf{asType} < \mathbf{integer\ const} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{M1}) <
asType<integer>($heap<sub>724,1:745,8</sub>.p1)
\rightarrow [const static or extern object]
[60.3] -asType<integer const>($heap_{init}.M1) <
asType < integer > (\$heap_{724,1;745,8}.p1)
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[60.4] -asType<integer const>(asType<short int>((int)30269)) <
asType<integer>($heap<sub>724.1:745.8</sub>.p1)
\rightarrow [simplify]
[60.8] - 30269 < asType < integer > (\$heap_{724.1:745.8}.p1)
```

```
\rightarrow [from term 59.19, $heap<sub>724.1:745.8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs p_{funcstart\_724,1}),
\text{Sheap}_{funcstart\_724,1}.p1, 177).quot) + (171 * div(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177).rem
[60.9] -30269 < asType<integer>($heap_{funcstart\_724.1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).rem))).p1)
\rightarrow [simplify]
\label{eq:continuous} \textit{[60.11]} \; -30269 < ((-2 \; * \; \mathrm{div}(\mathbf{heapIs} \; \$ \mathrm{heap}_{funcstart\_724,1}, \; \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
177).quot) + (171 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).rem))
[Take given term]
[61.0]!(0 == asType < integer > ($heap_{724,1:745.8}.p1))
\rightarrow [from term 59.19, $heap<sub>724.1:745.8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs p_{funcstart\_724,1}),
heap_{funcstart_{-724,1}}.p1, 177).rem)
[61.1] !(0 == asType<integer>(\ensuremath{$^{\circ}$} heap \ensuremath{$^{\circ}$} nucstart_724,1._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).rem))).p1))
\rightarrow [simplify]
\textit{[61.3] !} (0 == ((-2 * \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1},
(177).quot + (171 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1,
177).rem)))
[Take given term]
[63.0] $\text{heap}_{724,1:747,8} == $\text{heap}_{724,1:745,8}._\text{replace}(p2 \rightarrow \text{asType} < \text{short}
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724,1:745,8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType< int>($heap_{724,1:745,8}.b2))))
\rightarrow [from term 59.19, $heap<sub>724.1:745.8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724,1}),
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs p_{funcstart\_724,1}),
heap_{funcstart_{-724,1}}.p1, 177).rem)
[63.1] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
(177).rem))).\_replace(p2 \rightarrow asType < short)
\mathbf{int}{>}((\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{short}\ \mathbf{int}{>}(\mathbf{div2.rem}))\ ^*
asType < int > (\$heap_{724.1:745.8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType< int>($heap_{724,1;745,8}.b2))))
```

```
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p2, 176)
[63.2] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724.1}, \ \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},))
\text{sheap}_{funcstart\_724,1.p2}, 176).rem) * asType < int > (\text{sheap}_{724,1;745,8.r2})) -
(asType<int>(asType<short int>(div2.quot)) *
asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [simplify]
[63.4] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((\operatorname{div}(\mathbf{heapIs}))))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem *
\mathbf{asType} < \mathbf{int} > (\$ heap_{724,1;745,8}.r2)) - (\mathbf{asType} < \mathbf{int} > (\mathbf{asType} < \mathbf{short})
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [from term 59.19, $heap<sub>724,1:745.8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724,1}),
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs p_{funcstart\_724,1})
heap_{funcstart_{-724,1}.p1, 177).rem}
[63.5] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
\text{Sheap}_{funcstart_{-724,1}}, \text{Sheap}_{funcstart_{-724,1}}.p2, 176).rem *
asType < int > (\$heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * div(heapIs)))))))
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p1, 177).quot) + (171 * div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 177).rem)).r2)) -
(asType<int>(asType<short int>(div2.quot)) *
asType < int > (\$heap_{724,1;745,8}.b2))))
→ [const member of object with modified fields]
[63.6] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((\operatorname{div}(\mathbf{heapIs}))))
\rho_{funcstart_{-724,1}}, \rho_{funcstart_{-724,1}}, \rho_{funcstart_{-724,1}}, \rho_{funcstart_{-724,1}}, \rho_{funcstart_{-724,1}}
asType < int > (\$heap_{funcstart-724,1}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [const static or extern object]
[63.7] heap_{724,1:747,8} == heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 *
```

```
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
(177).rem))._replace(p2 \rightarrow asType<short int>((div(heapIs)
\text{Sheap}_{funcstart_{-724,1}}, \text{Sheap}_{funcstart_{-724,1}}.p2, 176).rem *
asType < int > (\$heap_{init}.r2)) - (asType < int > (asType < short)
int > (div2.quot)) * asType < int > ($heap_{724,1:745.8}.b2))))
\rightarrow [expand definition of constant 'r2' at prang.c (20,20)]
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart} \ 724.1, \ \$ \operatorname{heap}_{funcstart} \ 724.1.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((\operatorname{div}(\mathbf{heapIs}))))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem *
asType<int>(asType<short int>((int)172))) -
(asType<int>(asType<short int>(div2.quot)) *
asType < int > (\$heap_{724,1:745,8}.b2))))
\rightarrow [simplify]
[63.11] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart} \ 724.1, \ \$ \operatorname{heap}_{funcstart} \ 724.1, \ p1,
(177).rem)._replace(p2 \rightarrow asType<short int>((div(heapIs)
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}.p2, 176).rem * 172) -
(asType<int>(asType<short int>(div2.quot)) *
asType < int > (\$heap_{724.1:745.8}.b2))))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1}}.p2, 176
\operatorname{div}(\mathbf{heapIs} \ \text{$heap}_{funcstart\_724,1}, \ \text{$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem}) -
(asType<int>(asType<short int>(div(heapIs $heap_{tuncstart\_724.1},
\text{sheap}_{funcstart\_724.1.p2, 176}.\text{quot}) * asType < int > (\text{sheap}_{724.1.745.8.b2})))
\rightarrow [simplify]
[63.14] $\text{heap}_{724,1;747,8} == \text{$heap}_{funcstart\_724,1}._\text{$replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}. p1, \ 177). \operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem}) - (\text{div}(\text{heapIs})
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1},p2,176}.quot *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{b2}))))
\rightarrow [from term 59.19, $heap<sub>724,1;745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724,1}),
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\text{Sheap}_{funcstart_{-724,1},p1, 177}.\text{quot}) + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart_{-724,1}})
heap_{funcstart_{-724,1}}.p1, 177).rem)
[63.15] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 2, 176).quot *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathbf{\_replace}(\mathrm{p1} \rightarrow ((\text{-}2\ *\ \mathrm{div}(\mathbf{heapIs}
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).rem))).b2))))
\rightarrow [const member of object with modified fields]
[63.16] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\mathrm{div}(\mathbf{heapIs}\ \$\mathrm{heap}_{funcstart\_724,1},\ \$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},\ 177).\mathrm{quot}) + (171\ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1},p2,176}.quot *
asType < int > (\$heap_{funcstart\_724,1}.b2))))
\rightarrow [const static or extern object]
[63.17] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}. p1, \ 177). \operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((172 * div(\mathbf{heapIs}))))
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{init}.\mathrm{b2}))))
\rightarrow [expand definition of constant 'b2' at prang.c (22,20)]
[63.18] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, 2, 176).quot *
asType<int>(asType<short int>((int)35)))))
\rightarrow [simplify]
[63.24] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart} \ 724.1, \ \$ \operatorname{heap}_{funcstart} \ 724.1.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p2, 176).rem)
```

```
[Take given term]
[67.0] $\text{heap}_{724,1:749,8} == $\text{heap}_{724,1:747,8}._\text{replace}(p3 \to \text{asType} < \text{short}
int>((asType<int>(asType<short int>(div3.rem)) *
asType < int > (\$heap_{724.1:747.8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap<sub>724.1:747.8</sub>.b3))))
\rightarrow [from term 63.24, $heap<sub>724.1:747.8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1},p1, 177}, quot) + (171 * div(heapIs p_{funcstart_{724,1},p1, 177}).
\theta_{funcstart\_724,1}.p1, 177).rem))._replace(p2 \rightarrow (-35 * div(\mathbf{heapIs})))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
\$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p2, 176).rem))]
[67.1] \theta == 
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{uncstart_724.1.p2, 176}.rem)._replace(p3 \rightarrow asType<short
int>((asType<int>(asType<short int>(div3.rem))
asType < int > (\$heap_{724.1:747.8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap<sub>724,1:747,8</sub>.b3))))
\rightarrow [from term 43.6, div3 is equal to div(heapIs $heap_{funcstart_724,1},
heap_{funcstart_{724,1}}.p3, 178
[67.2] $\text{heap}_{724,1;749,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{tuncstart\ 724.1}, p2, 176).rem)))._replace(p3 \rightarrow asType<short
int>((asType < int > (asType < short int > (div(heapIs $heap_{funcstart\_724,1}, 
\text{sheap}_{funcstart\_724,1.p3}, 178).rem) * asType<int>(\text{sheap}_{724,1:747,8.r3})) -
(asType<int>(asType<short int>(div3.quot)) *
asType < int > (\$heap_{724,1;747,8}.b3))))
\rightarrow [simplify]
[67.4] heap_{724,1;749,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs} \text{Sheap}_{funcstart\_724,1},
\$ heap_{funcstart\_724,1}.p2,\,176).rem))).\_\textbf{replace}(p3 \rightarrow \textbf{asType} < \textbf{short}
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem *
asType < int > (\$heap_{724.1:747.8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap<sub>724.1:747.8</sub>.b3))))
```

```
\rightarrow [from term 63.24, $heap<sub>724.1:747.8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs p_{funcstart\_724,1}),
heap_{funcstart_{724,1},p1, 177}, quot) + (171 * div(heapIs heap_{funcstart_{724,1},p1, 177})
heap_{funcstart\_724,1}.p1, 177).rem)._replace(p2 \rightarrow (-35 * div(heapIs)))._
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p2, 176).rem)
[67.5] heap_{724,1;749,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{uncstart_724.1.p2, 176}.rem)._replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724.1}, \$heap_{funcstart\_724.1}.p3, 178).rem *
asType < int > (\$heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * div(heapIs)))))))
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1},p1, 177}.quot) + (171 * div(heapIs)
\rho_{tuncstart_{724,1}}, \rho_{tuncstart_{724,1}}, \rho_{tuncstart_{724,1}}, \rho_{tuncstart_{724,1}}, \rho_{tuncstart_{724,1}}, \rho_{tuncstart_{724,1}}
* div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, p2, 176).quot) + (172 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p2}, \ 176).\operatorname{rem}))).\operatorname{r3})) \ -
(asType<int>(asType<short int>(div3.quot)) *
asType<int>($heap<sub>724,1:747,8</sub>.b3))))
→ [const member of object with modified fields]
[67.7] $\text{heap}_{724,1;749,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724,1},
\text{Sheap}_{funcstart\_724.1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724.1},
\theta_{funcstart\_724,1.p2, 176).rem}))._replace(p3 \rightarrow asType<short
int>((div(heapIs $heap_{funcstart_{-724,1}}, $heap_{funcstart_{-724,1}}.p3, 178).rem *
\mathbf{asType} \hspace{-0.1em}<\hspace{-0.1em} \mathbf{int} \hspace{-0.1em}> \hspace{-0.1em} (\$ heap_{funcstart\_724,1}.r3)) - (\mathbf{asType} \hspace{-0.1em}<\hspace{-0.1em} \mathbf{int} \hspace{-0.1em}> \hspace{-0.1em} (\mathbf{asType} \hspace{-0.1em}<\hspace{-0.1em} \mathbf{short})
int>(div3.quot)) * asType< int>($heap_{724.1:747.8}.b3))))
\rightarrow [const static or extern object]
[67.8] heap_{724,1;749,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\theta_{funcstart\_724,1}.p2, 176.quot) + (172 * div(heapIs \theta_{funcstart\_724,1},
\rho_{tuncstart\_724.1.p2, 176}.rem))._replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem *
asType < int > (\$heap_{init}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType< int>($heap_{724.1:747.8}.b3))))
\rightarrow [expand definition of constant 'r3' at prang.c (25,20)]
[67.9] $\text{heap}_{724,1;749,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \rightarrow ((-2 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
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\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{funcstart\_724,1}.p2, 176).rem))._replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem *
asType<int>(asType<short int>((int)170))) -
(asType<int>(asType<short int>(div3.quot)) *
asType<int>($heap<sub>724.1:747.8</sub>.b3))))
\rightarrow [simplify]
[67.12] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\label{eq:div_heap} \text{div}(\textbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724.1.p2, 176}.rem)..replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem * 170)
- (asType<int>(asType<short int>(div3.quot)) *
asType<int>($heap<sub>724.1:747.8</sub>.b3))))
\rightarrow [from term 43.6, div3 is equal to div(heapIs $heap_{funcstart_724,1},
heap_{funcstart_{724,1}}.p3, 178
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{uncstart\_724,1.p2, 176).rem}))._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart\_724.1}, heap_{funcstart\_724.1}, n_{funcstart\_724.1}, n_{funcstart\_724.1}
(asType<int>(asType<short int>(div(heapIs $heap_{tuncstart\_724.1},
\text{sheap}_{funcstart\_724,1.p3}, 178).\text{quot}) * asType < int > (\text{sheap}_{724,1;747,8.b3})))
\rightarrow [simplify]
[67.15] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\theta_{funcstart\_724,1}.p2, 176.quot) + (172 * div(heapIs \theta_{funcstart\_724,1},
\rho_{tuncstart=724.1.p2, 176}.rem)._replace(p3 \rightarrow asType<short int>((170
* \operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p3, \ 178).rem) -
(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} *
asType < int > (\$heap_{724,1;747,8}.b3))))
\rightarrow [from term 63.24, $heap<sub>724.1:747.8</sub> is equal to
\text{Sheap}_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1}), the sheap_{funcstart\_724,1}).
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).rem))).\_replace(p2 \rightarrow (-35 * div(heapIs))).
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heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 2, 176).rem
[67.16] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{uncstart\_724,1.p2, 176).rem}))._replace(p3 \rightarrow asType<short int>((170
* \operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p3, \ 178).rem) -
(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} *
asType < int > (\$heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * div(heapIs)))))))
\text{Sheap}_{funcstart\_724.1}, \text{Sheap}_{funcstart\_724.1}, \text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs}))
\theta_{uncstart_{-724,1}}, \theta_{uncstart_{-724,1},p1, 177}.rem))._replace(p2 \rightarrow ((-35)
* div(\mathbf{heapIs} \ \$ heap_{funcstart\_724,1}, \ \$ heap_{funcstart\_724,1}.p2, \ 176).quot) + (172 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p2}, \ 176).\operatorname{rem}))).\operatorname{b3}))))
\rightarrow [const member of object with modified fields]
[67.18] heap_{724,1;749,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{uncstart_724,1}.p2, 176).rem))._replace(p3 \rightarrow asType<short int>((170
* \operatorname{div}(\mathbf{heapIs} \ \text{$heap}_{funcstart\_724,1}, \ \text{$heap}_{funcstart\_724,1}.p3, \ 178).rem) -
(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} *
asType < int > (\$heap_{funcstart\_724,1}.b3))))
\rightarrow [const static or extern object]
[67.19] $\text{heap}_{724,1:749.8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\label{eq:div_heap} \text{div}(\textbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart_{-724,1},p2,176,rem})._replace(p3 \rightarrow asType<short int>((170
* \operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p3, \ 178).rem) -
(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).quot *
asType < int > (\$heap_{init}.b3))))
\rightarrow [expand definition of constant 'b3' at prang.c (27,20)]
[67.20] heap_{724,1;749,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724.1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724.1},
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) –
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(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} *
asType<int>(asType<short int>((int)63))))
\rightarrow [simplify]
[67.26] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2, 176}.rem)._replace(p3 \rightarrow ((-63 * div(heapIs
\text{Sheap}_{funcstart\ 724.1}, \text{Sheap}_{funcstart\ 724.1}, \text{p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs}))
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 178).rem))
[Take goal term]
[1.0]  minof(short int) \leq ((asType < int > (\$heap_{724.1:749.8}.M1) *
asType<int>(static_cast<integer>(asType<int>($heap_{724,1:749,8}.p1) <
(int)(0) + asType<int>($heap<sub>724,1:749,8</sub>.p1))
\rightarrow [simplify]
[1.1] -32768 \leq ((asType<int>($heap<sub>724,1;749,8</sub>.M1) *
asType < int > (static\_cast < integer > (asType < int > (\$heap_{724,1:749,8}.p1) < int > (\$heap_{
(int)(0) + asType<int>($heap<sub>724,1:749,8</sub>.p1))
\rightarrow [from term 67.26, $heap<sub>724,1;749,8</sub> is equal to
heap_{funcstart\_724.1}._replace(p1 \rightarrow ((-2 * div(heapIs heap_{funcstart\_724.1}),
\text{Sheap}_{funcstart_{724,1},p1, 177}.\text{quot}) + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart_{724,1}}),
\rho_{uncstart\_724,1}.p1, 177).rem))).\_replace(p2 \rightarrow ((-35 * div(heapIs))).\_replace(p2 \rightarrow ((-35 * div(heapIs)))).\_replace(p2 \rightarrow ((-35 * div(heapIs)))).\_replace(p2 \rightarrow ((-35 * div(heapIs)))))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}. p2, p2, p2, p3, p2, p3, p4, p3, p4, 
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem)))._replace(p3 \rightarrow (-63 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).quot) + (170 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).rem))]
[1.2] -32768 \le ((asType < int > (\$heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * 
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart_724,1}.p2, 176).rem))._replace(p3 \rightarrow ((-63 * div(heapIs
\text{Sheap}_{funcstart\_724.1}, \text{Sheap}_{funcstart\_724.1}.p3, 178).quot) + (170 * div(heapIs)
\text{Sheap}_{funcstart_{724,1}}, \text{Sheap}_{funcstart_{724,1}}.p3, 178).rem))).M1) *
asType<int>(static_cast<integer>(asType<int>($heap_{724.1:749.8}.p1) <
(int)(0) + asType < int > ($heap_{724.1:749.8}.p1)
\rightarrow [const member of object with modified fields]
[1.5] -32768 \leq ((asType<int>($heap_{funcstart\_724,1}.M1) *
asType<int>(static_cast<integer>(asType<int>($heap<sub>724,1:749,8</sub>.p1) <
(int)(0) + asType < int > ($heap_{724.1:749.8}.p1)
```

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\rightarrow [const static or extern object]
[1.6] -32768 \le ((asType < int > (\$heap_{init}.M1) *
asType<int>(static_cast<integer>(asType<int>($heap<sub>724.1:749.8</sub>.p1) <
(int)(0) + asType<int>($heap<sub>724.1:749.8</sub>.p1))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[1.7] -32768 \leq ((asType<int>(asType<short int>((int)30269)) *
asType<int>(static_cast<integer>(asType<int>($heap<sub>724,1:749,8.</sub>p1) <
(int)(0) + asType<int>($heap<sub>724,1:749,8</sub>.p1))
\rightarrow [simplify]
[1.10] -32768 \le ((30269 *
\mathbf{asType} < \mathbf{int} > (\mathbf{static\_cast} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{724,1;749,8}.\mathrm{p1}) < \mathsf{nt}) < \mathsf{nt} > \mathsf{nt} >
(int)(0) + asType<int>($heap<sub>724,1:749,8</sub>.p1))
\rightarrow [from term 67.26, $heap<sub>724.1:749.8</sub> is equal to
\text{Sheap}_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1}), the sheap funcstart\_724,1).
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1}, 177).quot) + (171 * div(heapIs $heap_{funcstart\_724,1}, 17
\rho_{uncstart_724,1}.p1, 177).rem))).\_replace(p2 \rightarrow ((-35 * div(heapIs)))._replace(p2 \rightarrow ((-35 * div(heapIs))))._replace(p2 \rightarrow ((-35 * div(heapIs))))._replace(p2 \rightarrow ((-35 * div(heapIs)))))._replace(p2 \rightarrow ((-35 * div(heapIs)))))._replace(p2 \rightarrow ((-35 * div(heapIs)))))._replace(p2 \rightarrow ((-35 * div(heapIs)))))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem)))._replace(p3 \rightarrow (-63 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).quot) + (170 \ *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724.1}, \ \$heap_{funcstart\_724.1}.p3, \ 178).rem))]
[1.11] -32768 < ((30269 *
asType < int > (static\_cast < integer > (asType < int > (\$heap_{funcstart\_724.1}.\_replace(p1))
\rightarrow ((-2 * \text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724.1}, \$ \text{heap}_{funcstart\_724.1}. p1, 177).\text{quot}) +
(171 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart\_724,1}, \text{\$heap}_{funcstart\_724,1}.\text{p1},
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724.1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724.1},
\rho_{funcstart_724,1}.p2, 176).rem))._replace(p3 \rightarrow ((-63 * div(heapIs
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}.p3, 178).quot) + (170 * div(heapIs)
\text{Sheap}_{funcstart_{-724.1}}, \text{Sheap}_{funcstart_{-724.1}}.p3, 178).rem))).p1) < (int)0))) +
asType < int > (\$heap_{724,1;749,8}.p1))
\rightarrow [simplify]
[1.23] -32768 < ((30269 * asType < int > (([0 < ((-171 * div(heapIs))))))))))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}) + (2 * \text{div}(\text{heapIs}))
\theta_{funcstart_{-724,1}}, \theta_{funcstart_{-724,1}}, 177).quot))]: 1, []: 0))) +
asType<int>($heap<sub>724,1:749,8</sub>.p1))
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[1.24] -32768 \leq ((30269 * asType<int>(([0 < ((-171 * div(heapIs)))))
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p1, 177).rem) + (2 * div(heapIs
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1},p1, 177}.quot)): 1, [!(0 < ((-171 *
div(heapIs \$heap_{funcstart_{-724,1}}, \$heap_{funcstart_{-724,1}}.p1, 177).rem) + (2 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p1, \ 177).quot)))]: 0))) +
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\rightarrow [simplify]
[1.29] -32768 < ((30269 * asType < int > (([0 < ((-171 * div(heapIs)))))))))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}) + (2 * \text{div}(\text{heapIs}))
\label{eq:heap-funcstart_724,1} $ heap_{funcstart\_724,1}.p1,\ 177).quot))]:\ 1,\ [-1 < ((171 * Plane + Plane
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).rem) + (-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{$heap}_{funcstart\_724,1}, \ \text{$heap}_{funcstart\_724,1}.p1, \ 177).quot))]: 0))) +
asType<int>($heap<sub>724.1:749.8</sub>.p1))
\rightarrow [from term 61.3, -1 < ((-2 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.p1, 177).quot + (171 * div(\textbf{heapIs } \text{Sheap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} is true if and only if 0 < ((-2 * \text{div}(\text{heapIs})))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1, 177).quot) + (171 * div(heapIs)
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1, 177).rem))]
[1.30] -32768 \leq ((30269 * asType<int>(([0 < ((-171 * div(heapIs)))))
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p1, 177).rem) + (2 * div(heapIs
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).rem))]: 0))) +
asType<int>($heap<sub>724.1:749.8</sub>.p1))
\rightarrow [simplify]
[1.31] -32768 \leq ((30269 * ([0 < ((-171 * div(heapIs $heap_{funcstart}, 724.1)]
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p1, 177}.quot): 1, [0 < ((-2 * div(heapIs))]:
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).quot) + (171 * div(heapIs)
\{\text{heap}_{funcstart\_724,1}, \{\text{heap}_{funcstart\_724,1}, \text{p1}, 177\}.\text{rem}\}\}: 0)) +
asType<int>($heap<sub>724,1:749,8</sub>.p1))
\rightarrow [move guard outside expression]
[1.32] -32768 \leq (([0 < ((-171 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{uncstart_{-724,1},p1,177,quot}): 1 * 30269, [0 < ((-2 * div(heapIs))]
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).quot) + (171 * div(heapIs)
\frac{\text{sheap}_{funcstart_{-724,1}}, \text{sheap}_{funcstart_{-724,1}}.\text{p1}, 177).\text{rem}}{\text{length}} : 0 * 30269} +
asType<int>($heap<sub>724.1:749.8</sub>.p1))
\rightarrow [simplify]
[1.34] -32768 \leq (([0 < ((-171 * div(heapIs $heap<sub>funcstart_724,1</sub>,
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\label{eq:heapfuncstart_724,1.p1, 177).quot} $$ \hat{s} = \frac{1}{2} ((-2 * div(\mathbf{heapIs}))) : 30269, [0 < ((-2 * div(\mathbf{heapIs})))] : 30269, [0 < ((-2 * div(\mathbf{heapIs}))] : 30269, [0 < ((-2 * di
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs})
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 177).rem): 0) +
asType < int > ($heap_{724.1:749.8}.p1))
\rightarrow [from term 67.26, $heap<sub>724,1;749,8</sub> is equal to
```

asType<**int**>(\$heap_{724,1:749,8}.p1))

```
\text{Sheap}_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(\text{heapIs } \text{Sheap}_{funcstart\_724,1}),
heap_{funcstart_{724,1},p1, 177}, quot) + (171 * div(heapIs heap_{funcstart_{724,1},p1, 177})
\rho_{funcstart\_724,1.p1, 177}.rem))._replace\rho_{funcstart\_724,1.p1, 177}.rem))._replace
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem)))._replace(p3 \rightarrow (-63 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).quot) + (170 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).rem))]
[1.35] -32768 \leq (([0 < ((-171 * div(heapIs $heap<sub>funcstart_724,1</sub>,
\text{Sheap}_{funcstart_{724,1},p1, 177}.\text{rem}) + (2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart_{724,1},p1}))
\theta_{1} = \theta_{1} = \theta_{2} = \theta_{1} = \theta_{2} = \theta_{2
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1},p1, 177}.quot + (171 * div(heapIs))
\frac{\text{sheap}_{funcstart_{724,1}}, \text{sheap}_{funcstart_{724,1},p1, 177).rem}}{177).rem}
asType < int > (\$heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * div(heapIs))))))
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}
\rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}
* div(heapIs heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 176).quot) + (172 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p2,
176).rem)))._replace(p3 \rightarrow ((-63 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p3, 178).rem)).p1)
\rightarrow [simplify]
 [1.40] \ -32768 \leq ((-2 * \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1},
177).quot) + (171 * \text{div}(\text{heapIs } \text{heap}_{funcstart\_724,1}, \text{heap}_{funcstart\_724,1}.p1,
177).rem) + ([0 < ((-171 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\text{heap}_{funcstart_{724,1},p1, 177}, quot))]: 30269, [0 < ((-2 * \text{div}(\textbf{heapIs})))]
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).quot) + (171 * div(heapIs)
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1},p1, 177}.rem) = 0)
\rightarrow [move guard outside expression]
[1.41] -32768 \leq ([0 < ((-171 * div(heapIs $heap<sub>funcstart_724,1</sub>,
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs} \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1},p1, 177,quot}): 30269 + (-2 * div(heapIs)
\$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).quot) + (171 * div(\textbf{heapIs}) + (171 * div(\textbf{heapIs})) + (171
\rho_{funcstart_{-724,1}}, \rho_{funcstart_{-724,1}}
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
[\text{heap}_{funcstart\_724.1}, \text{heap}_{funcstart\_724.1}, \text{p1}, 177].rem)]: 0 + (-2 * div(heapIs)
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, 177).rem
\rightarrow [simplify]
[1.44] -32769 < ([0 < ((-171 * div(heapIs $heap_{funcstart_724.1})])
\text{Sheap}_{funcstart_{-724,1},p1, 177}.\text{rem}) + (2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart_{-724,1}})
heap_{funcstart_{-724,1}.p1, 177}.quot): 30269 + (-2 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs})
```

```
\$heap_{funcstart\_724,1},\,\$heap_{funcstart\_724,1}.p1,\,177).rem),\,[0<((-2*div(\mathbf{heapIs}
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p1, 177).quot) + (171 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p1, 177).rem))]: (-2 * div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs}))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).rem)
\rightarrow [move guard outside expression]
[1.45] ([0 < ((-171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1,
177).rem) + (2 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).quot))]: -32769 < (30269 + (-2 * div(heapIs $heap_{tuncstart\_724,1},
\text{Sheap}_{funcstart\_724.1.p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724.1},
\text{Sheap}_{funcstart\_724,1.p1, 177}.\text{rem}), [0 < ((-2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\frac{\text{heap}_{funcstart\_724,1.p1, 177}.rem)}{\text{cm}}: -32769 < ((-2 * div(heapIs)))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs}))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).rem)))
\rightarrow [simplify]
[1.47] ([0 < ((-171 * div(heapIs heapIs = f_{uncstart_{-724,1}}, heap_{funcstart_{-724,1}}, p_1, f_{uncstart_{-724,1}}]
177).rem) + (2 * \text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1},
(-2 * div(\mathbf{heapIs} \$ heap_{funcstart, 724,1}, -63038 < ((-2 * div(\mathbf{heapIs} \$ heap_{funcstart, 724,1}, -63038))]
\text{Sheap}_{funcstart\_724,1.p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\text{Sheap}_{funcstart_{-724,1}}, p1, 177).rem)), [0 < ((-2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart_{-724,1}}), \text{ or } \text{div}(\text{heapIs } \text{Sheap}_{funcstart_{-724,1}})]
\text{Sheap}_{funcstart\_724.1.pl}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724.1},
\text{heap}_{funcstart_{-724,1},p1, 177}.\text{rem}): -32769 < ((-2 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs}))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).rem)))
\rightarrow [from term 60.11, literala < ((-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1},p1, 177}, quot) + (171 * div(heapIs *heap_{funcstart_{-724,1}}, 177)
heap_{funcstart\_724,1}.p1, 177).rem) is true whenever (-1 + literala) < -30269
       Proof of rule precondition:
       [1.47.0] (-63038 + -1) < -30269
       \rightarrow [simplify]
       [1.47.2] true
 [1.48] \; ([0 < ((-171 * \operatorname{div}(\mathbf{heapIs} \; \$ \operatorname{heap}_{funcstart\_724,1}, \; \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, \;
177).rem) + (2 * \text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).quot))]: true, [0 < ((-2 * div(\textbf{heapIs } \$heap_{funcstart\_724,1}, 
\text{Sheap}_{funcstart\_724,1.p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
[-32769 < ((-2 * div(heapIs))]: -32769 < ((-2 * div(heapIs))]: -32769 < ((-2 * div(heapIs)))]: -32769 < ((-2 * div(heapIs)))]
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs}))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).rem)))
\rightarrow [from term 60.11, literala < ((-2 * div(heapIs $heap_{funcstart\_724.1},
heap_{funcstart\_724.1}.p1, 177).quot + (171 * div(heapIs p_{funcstart\_724.1})
```

```
heap_{funcstart-724,1}.p1, 177).rem) is true whenever (-1 + literala) < -30269
   Proof of rule precondition:
   [1.48.0] (-32769 + -1) < -30269
   \rightarrow [simplify]
   [1.48.2] true
[1.49] ([0 < ((-171 * div(heapIs heapIs funcstart_{-724,1}, heap_{funcstart_{-724,1}}.p1,
177).rem) + (2 * \text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.p1,
177).quot))]: true, [0 < ((-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, 
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs p_{funcstart\_724,1})
heap_{funcstart_{-724,1}.p1, 177}.rem): true
\rightarrow [all guards have equal guarded terms]
[1.50] true
Proof of verification condition: Type constraint satisfied in implicit
conversion from 'int' to 'short int'
Condition generated at: C:\Escher\Customers\prang\prang.c (68,8)
Condition defined at:
To prove: ((asType<int>($heap<sub>724 1.749 8</sub>.M1) *
\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{static\_cast}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{724,1;749,8}.\mathrm{p1})<
(\mathbf{int})0))) + \mathbf{asType} {<} \mathbf{int} {>} (\$ \mathrm{heap}_{724,1;749,8}.\mathrm{p1})) \leq \mathbf{maxof} (\mathbf{short} \ \mathbf{int})
Given:
heap_{init}.LIMIT == (int)80
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta
heap_{init}.M2 == asType < short int > ((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta sheap<sub>init</sub>.b2 == asType<short int>((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType<short int>((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
```

```
\rho_{init}.p2 == asType < short int > ((int)2)
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart\_724,1})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}))~\%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(asType<integer>($heap_funcstart_724.1.p1) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p1) = =
asType<integer>(div1.rem))
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > ($heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.quot)
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2})) \ \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2})) =>
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}) ==
asType<integer>(div2.rem))
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}) \leq
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})) => !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
```

```
div3 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
(asType<int>(asType<int>($heap_{tuncstart\_724.1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(\mathbf{asType} {<} \mathbf{integer} {>} (\mathbf{asType} {<} \mathbf{int} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3})) \ \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathtt{a3}))) ==
asType<integer>(div3.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724.1}.a3)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}) ==
asType<integer>(div3.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a3}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
$heap_{724,1;745,8} == $heap_{funcstart\_724,1}.\_replace(p1 \rightarrow asType < short)
int>((asType<int>(asType<short int>(div1.rem)) *
asType<int>($heap_tuncstart_724.1.r1)) - (asType<int>(asType<short
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
-asType < integer const > (\$heap_{724,1:745.8}.M1) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{p1})
!(0 == asType < integer > (\$heap_{724,1;745,8}.p1))
asType < integer > (\$heap_{724,1;745,8}.p1) <
asType<integer>($heap<sub>724.1:745.8</sub>.M1)
\text{heap}_{724.1:747.8} == \text{heap}_{724.1:745.8}._replace(p2 \rightarrow asType<short)
int>((asType<int>(asType<short int>(div2.rem))
asType < int > (\$heap_{724,1;745,8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724,1:745,8</sub>.b2))))
-asType<integer const>($heap<sub>724.1:747.8</sub>.M2) <
asType<integer>($heap<sub>724.1:747.8</sub>.p2)
!(0 == asType < integer > (\$heap_{724,1:747.8}, p2))
asType < integer > (\$heap_{724,1;747,8}.p2) <
asType<integer>($heap<sub>724,1:747,8</sub>.M2)
\$heap_{724,1;749,8} == \$heap_{724,1;747,8}.\mathbf{\_replace}(p3 \rightarrow \mathbf{asType} {<} \mathbf{short}
int>((asType<int>(asType<short int>(div3.rem)) *
asType < int > (\$heap_{724.1:747.8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType< int>($heap_{724,1;747.8}.b3))))
```

```
-{\bf asType}{<}{\bf integer~const}{>}(\${\rm heap}_{724,1;749,8}.{\rm M3}) <
asType<integer>($heap<sub>724,1:749,8</sub>.p3)
!(0 == \mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathrm{heap}_{724,1;749,8}.\mathrm{p3}))
asType<integer>($heap<sub>724,1;749,8</sub>.p3) <
asType<integer>($heap<sub>724,1;749,8</sub>.M3)
Proof:
[Take given term]
[11.0] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
\rightarrow [simplify]
[11.1]~{\rm div1} == {\rm div}(\mathbf{heapIs}~\$ \mathrm{heap}_{funcstart\_724,1},\,\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
\rightarrow [const static or extern object]
[11.2] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \ \text{$heap}_{funcstart\_724,1}, \ \text{$heap}_{funcstart\_724,1}.p1,
asType < int > (\$heap_{init}.a1))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
\textit{[11.3]} \ \text{div1} == \text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
asType<int>(asType<short int>((int)177)))
\rightarrow [simplify]
[11.6] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}, \ 177)
[Take given term]
[27.0] \operatorname{div2} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
\rightarrow [simplify]
[27.1] \ \mathrm{div2} == \ \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
\rightarrow [const static or extern object]
\label{eq:continuous} \mbox{[27.2]} \mbox{ div2} == \mbox{div}(\mbox{\bf heapIs} \mbox{ \$heap}_{funcstart\_724,1}, \mbox{ \$heap}_{funcstart\_724,1}.\mbox{p2},
asType < int > (\$heap_{init}.a2))
\rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
[27.3] \ \mathrm{div2} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2},
asType<int>(asType<short int>((int)176)))
\rightarrow [simplify]
[27.6] \text{ div2} == \text{div}(\mathbf{heapIs} \$ heap_{funcstart\_724,1}, \$ heap_{funcstart\_724,1}.p2, 176)
```

```
[Take given term]
[43.0] div3 == div(heapIs $heap<sub>funcstart_724,1</sub>,
asType < int > (\$heap_{funcstart\_724,1}.p3),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a3}))
\rightarrow [simplify]
[43.1] div3 == div(heapIs $heap_{funcstart\_724.1}, $heap_{funcstart\_724.1}.p3,
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
\rightarrow [const static or extern object]
[43.2] div3 == div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p3,
asType < int > (\$heap_{init}.a3))
\rightarrow [expand definition of constant 'a3' at prang.c (26,20)]
[43.3] \ \mathrm{div3} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3},
asType<int>(asType<short int>((int)178)))
\rightarrow [simplify]
[43.6] div3 == div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178)
[Take given term]
[59.0] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1.quot})) \ * \ \mathbf{asType}{<} \mathbf{int}{>} (\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart_{724,1}},
heap_{funcstart_{-724,1}}.p1, 177
[59.1] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div(heapIs $heap_{funcstart_724.1},))
\rho_{funcstart\_724,1.p1, 177}.rem) * asType < int > (\rho_{funcstart\_724,1.r1}) - (\rho_{funcstart\_724,1.r1}
(\mathbf{asType} {<} \mathbf{int} {>} (\mathbf{asType} {<} \mathbf{short} \ \mathbf{int} {>} (\mathbf{div1.quot})) \ ^*
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [simplify]
[59.3] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
\mathbf{asType} \hspace{-0.1em}<\hspace{-0.1em} \mathbf{int} \hspace{-0.1em}> \hspace{-0.1em} (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{r1})) - (\mathbf{asType} \hspace{-0.1em}<\hspace{-0.1em} \mathbf{int} \hspace{-0.1em}> \hspace{-0.1em} (\mathbf{asType} \hspace{-0.1em}<\hspace{-0.1em} \mathbf{short})
\mathbf{int}{>}(\mathbf{div1.quot})) * \mathbf{asType}{<} \mathbf{int}{>} (\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
\rightarrow [const static or extern object]
[59.4] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType < int > (\$heap_{init}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1}.\mathbf{quot})) * \mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
\rightarrow [expand definition of constant 'r1' at prang.c (15,20)]
```

```
[59.5] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType<int>(asType<short int>((int)171))) -
(asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [simplify]
[59.8] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem * 171)
- (asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\ 724.1}.b1))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177)
\text{[59.9] \$heap}_{724,1;745,8} == \$heap_{funcstart\_724,1}.\_\textbf{replace}(p1 \rightarrow \textbf{asType} < \textbf{short}
\mathbf{int} > ((171 * \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, 177).\operatorname{rem})
- (asType<int>(asType<short int>(div(heapIs $heap_{funcstart_724,1},))
heap_{funcstart_{-724,1}}.p1, 177).quot)
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [simplify]
[59.11] \theta_{13} = \theta_
int>((171 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\textbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [const static or extern object]
[59.12] \theta_{12} = \theta_{124,1;745,8} = \theta_{124,1;74
\mathbf{int} > ((171 * \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, 177).\operatorname{rem})
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType < int > (\$heap_{init}.b1)))
\rightarrow [expand definition of constant 'b1' at prang.c (17,20)]
[59.13] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType<int>(asType<short int>((int)2))))
\rightarrow [simplify]
[59.19] $\text{heap}_{724,1:745,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).rem)))
[Take given term]
[61.0]!(0 == asType < integer > (\$heap_{724,1;745,8}.p1))
\rightarrow [from term 59.19, $heap<sub>724,1;745,8</sub> is equal to
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heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724,1}),
heap_{funcstart_{724,1},p1, 177}, quot) + (171 * div(heapIs heap_{funcstart_{724,1},p1, 177})
heap_{funcstart_{-724,1}}.p1, 177).rem)
div(\mathbf{heapIs} \ \$heap_{funcstart\_724.1}, \ \$heap_{funcstart\_724.1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{$heap}_{funcstart\_724.1}, \ \text{$heap}_{funcstart\_724.1}.p1, \ 177).rem))).p1))
\rightarrow [simplify]
\textit{[61.3] !} (0 == ((-2 * \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1},
177).quot) + (171 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).rem)))
[Take given term]
[62.0] asType<integer>($heap_{724,1:745,8}.p1) <
asType<integer>($heap<sub>724.1:745.8</sub>.M1)
\rightarrow [from term 59.19, $heap<sub>724.1:745.8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs p_{funcstart\_724,1}),
heap_{funcstart_{-724,1}}.p1, 177).rem)
[62.1] asType<integer>(p1 \rightarrow ((-2 * p_{funcstart\_724,1}.\_replace))
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).rem))).p1) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{M1})
\rightarrow [simplify]
[62.3] ((-2 * div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}.p1,
(177).quot + (171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1,
(177).rem) < asType < integer > (\$heap_{724,1;745,8}.M1)
\rightarrow [from term 59.19, $heap_{724,1;745,8}$ is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724,1}),
heap_{funcstart_{-724,1},p1, 177}, quot) + (171 * div(heapIs heap_{funcstart_{-724,1},p1, 177})
heap_{funcstart_{-724,1}}.p1, 177).rem)
\textit{[62.4]} \ ((\text{-}2\ ^* \operatorname{div}(\mathbf{heapIs}\ \$ \operatorname{heap}_{funcstart\_724,1},\ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1},
177).quot) + (171 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).rem)) < asType<integer>($heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, \ 177).\operatorname{rem}))).\operatorname{M1})
\rightarrow [const member of object with modified fields]
[62.5] ((-2 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1,
177).quot) + (171 * div(heapIs \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}
177).\text{rem})) < \mathbf{asType} < \mathbf{integer} > (\$ \text{heap}_{funcstart\_724,1}.\text{M1})
\rightarrow [const static or extern object]
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[62.6] ((-2 * div(heapIs heap_{funcstart-724,1}, heap_{funcstart-724,1}.p1,
177).quot) + (171 * div(heapIs \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, p1,
(177).rem) < asType < integer > (\$heap_{init}.M1)
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[62.7] ((-2 * div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, -1),
177).quot) + (171 * div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, p1,
177).rem)) < asType<integer>(asType<short int>((int)30269))
\rightarrow [simplify]
[62.17] -30269 < ((-171 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart_724,1},
heap_{funcstart_{-724,1}}.p1, 177).quot)
[Take given term]
[63.0] $heap<sub>724.1:747.8</sub> == $heap<sub>724.1:745.8</sub>._replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724,1;745,8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType< int>($heap_{724,1;745,8}.b2))))
\rightarrow [from term 59.19, $heap<sub>724,1;745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724,1}),
heap_{funcstart_{724,1},p1, 177}, quot) + (171 * div(heapIs p_{funcstart_{724,1},p1, 177}).
heap_{funcstart_{-724,1}}.p1, 177).rem)
[63.1] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724.1}, \ \$heap_{funcstart\_724.1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{724,1;745,8}.\mathbf{r2})) - (\mathbf{asType} < \mathbf{int} > (\mathbf{asType} < \mathbf{short}))
int>(div2.quot)) * asType< int>($heap_{724,1;745.8}.b2))))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1}}.p2, 176
[63.2] $\text{heap}_{724,1;747,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short
\mathbf{int}{>}((\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{short}\ \mathbf{int}{>}(\mathbf{div}(\mathbf{heapIs}\ \$\mathbf{heap}_{funcstart\_724,1},
\text{sheap}_{funcstart\_724,1.p2, 176}.\text{rem}) * asType < int > (\text{sheap}_{724,1:745,8.r2})) -
(asType<int>(asType<short int>(div2.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\${\rm heap}_{724,1;745,8}.{\rm b2}))))
\rightarrow [simplify]
[63.4] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
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177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((\operatorname{div}(\mathbf{heapIs}))))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem *
asType < int > (\$heap_{724,1:745,8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType< int>($heap_{724,1:745,8}.b2))))
\rightarrow [from term 59.19, $heap<sub>724.1:745.8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\$heap_{funcstart\_724,1}.p1,\ 177).rem))]
[63.5] $heap<sub>724,1:747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\label{eq:div_heap} \text{div}(\textbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
(177).rem))._replace(p2 \rightarrow asType<short int>((div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem *
asType < int > (\$heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * div(heapIs)))))))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs}))
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}.p1, 177).rem)).r2)) -
(asType<int>(asType<short int>(div2.quot)) *
asType < int > (\$heap_{724,1:745.8}.b2))))
\rightarrow [const member of object with modified fields]
[63.6] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 176).rem *
asType < int > (\$heap_{funcstart\_724,1}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [const static or extern object]
[63.7] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}. \operatorname{pl},
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((\operatorname{div}(\mathbf{heapIs}))))
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1},p2,176}.rem *
asType < int > (\$heap_{init}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType< int>($heap_{724,1:745,8}.b2))))
\rightarrow [expand definition of constant 'r2' at prang.c (20,20)]
[63.8] \rho_{724,1;747,8} == \rho_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * -2.5) + -2.5)))
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem))).replace(p2 \rightarrow asType < short int > ((div(heapIs)))
e_{funcstart_{-}724,1}, e_{p_{funcstart_{-}724,1},p_{2},176}.rem *
asType<int>(asType<short int>((int)172))) -
(asType<int>(asType<short int>(div2.quot)) *
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asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [simplify]
[63.11] $\text{heap}_{724,1;747,8} == \text{$heap}_{funcstart_724,1}._{\text{replace}}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((\operatorname{div}(\mathbf{heapIs}))))
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p2, 176).rem * 172) -
(asType<int>(asType<short int>(div2.quot)) *
asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{funcstart_724.1},
heap_{funcstart_{724,1}}.p2, 176
[63.12] $\text{heap}_{724,1;747,8} == $\text{heap}_{funcstart_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\label{eq:div_heap} \text{div}(\textbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem}) -
(asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},))
\text{sheap}_{funcstart\_724,1.p2, 176}.\text{quot}) * asType < int > (\text{sheap}_{724,1;745,8.b2}))))
\rightarrow [simplify]
[63.14] $\text{heap}_{724,1:747,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem}) - (\text{div}(\text{heapIs})
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 2, 176.quot *
asType<int>($heap<sub>724,1;745,8</sub>.b2))))
\rightarrow [from term 59.19, $heap_{724,1;745,8}$ is equal to
heap_{funcstart\_724.1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724.1}),
\text{Sheap}_{funcstart_{-724,1},p1, 177}.\text{quot}) + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart_{-724,1}})
heap_{funcstart_{-724,1}}.p1, 177).rem)
[63.15] $\text{heap}_{724,1:747,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1},p2}, 176).quot *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathbf{\_replace}(\mathrm{p1} \rightarrow ((-2\ *\ \mathrm{div}(\mathbf{heapIs}
\text{Sheap}_{funcstart\_724.1}, \text{Sheap}_{funcstart\_724.1}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs})
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, 177).rem)).b2))))
\rightarrow [const member of object with modified fields]
[63.16] $\text{heap}_{724,1;747,8} == \text{$heap}_{funcstart\_724,1}._\text{$replace}(p1 \to ((-2 *
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\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}
asType < int > (\$heap_{funcstart\_724,1}.b2))))
\rightarrow [const static or extern object]
[63.17] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}. P2, 176).rem) - (div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 2, 176).quot *
asType < int > (\$heap_{init}.b2))))
\rightarrow [expand definition of constant 'b2' at prang.c (22,20)]
[63.18] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1},p2,176}, quot *
asType<int>(asType<short int>((int)35)))))
\rightarrow [simplify]
[63.24] $heap<sub>724,1:747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p2, 176).rem))
[Take given term]
[67.0] $\text{heap}_{724,1:749,8} == $\text{heap}_{724,1:747,8}._\text{replace}(p3 \rightarrow \text{asType} < \text{short}
int>((asType<int>(asType<short int>(div3.rem)) *
asType < int > (\$heap_{724.1:747.8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap<sub>724.1:747.8</sub>.b3))))
\rightarrow [from term 63.24, $heap<sub>724.1:747.8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.p1, 177).quot) + (171 * div(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).rem))).\_replace(p2 \rightarrow (-35 * div(heapIs))).
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem))]
[67.1] $\text{heap}_{724,1;749,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
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\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{funcstart\_724,1}.p2, 176).rem))._replace(p3 \rightarrow asType<short
int>((asType<int>(asType<short int>(div3.rem))
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{724,1;747,8}.\mathrm{r3})) - (\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{short}
int>(div3.quot)) * asType< int>($heap_{724.1:747.8}.b3))))
\rightarrow [from term 43.6, div3 is equal to div(heapIs $heap_{funcstart_724.1},
heap_{funcstart_{-724,1}}.p3, 178
[67.2] $\text{heap}_{724,1;749,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{funcstart\_724,1}.p2, 176).rem))._replace(p3 \rightarrow asType<short
int>((asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},))
\text{sheap}_{funcstart\_724,1.p3}, 178).\text{rem}) * asType < int > (\text{sheap}_{724.1:747.8}.\text{r3})) -
(asType<int>(asType<short int>(div3.quot)) *
asType<int>($heap<sub>724.1:747.8</sub>.b3))))
\rightarrow [simplify]
[67.4] $\text{heap}_{724,1;749,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{tuncstart\_724,1}, p2, 176).rem)))._replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem *
\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{724,1;747,8}.\mathrm{r3})) - (\mathbf{asType} < \mathbf{int} > (\mathbf{asType} < \mathbf{short}))
int>(div3.quot)) * asType< int>($heap_{724,1;747,8}.b3))))
\rightarrow [from term 63.24, $heap<sub>724,1:747,8</sub> is equal to
\text{Sheap}_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
\operatorname{Sheap}_{funcstart\_724,1}.p1, 177).\operatorname{quot} + (171 * \operatorname{div}(\mathbf{heapIs} \operatorname{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1}.p1, 177).rem))._replace\rho_{funcstart\_724,1}.p1, 177).rem))._replace
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p2, 176).rem
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2, 176}.rem))._replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem *
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asType < int > (\$heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * div(heapIs)))))))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs})
\rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}
* div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, p2, 176).quot) + (172 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p2, 176).rem))).r3)) -
(asType<int>(asType<short int>(div3.quot)) *
asType<int>($heap<sub>724.1:747.8</sub>.b3))))
→ [const member of object with modified fields]
[67.7] $heap<sub>724,1:749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}. p1, \ 177). \operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\rho_{funcstart_{-724,1},p2, 176} = 176, quot) + (172 * div(heapIs \rho_{funcstart_{-724,1},p2} = 176).
\theta_{funcstart\_724,1}.p2, 176).rem))._replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem *
asType < int > (\$heap_{funcstart-724,1}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType< int>($heap_{724,1;747,8}.b3))))
\rightarrow [const static or extern object]
[67.8] $heap<sub>724,1:749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724.1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724.1},
\theta_{uncstart_724.1.p2, 176}.rem)._replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem *
asType < int > (\$heap_{init}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType< int>($heap_{724.1:747.8}.b3))))
\rightarrow [expand definition of constant 'r3' at prang.c (25,20)]
[67.9] heap_{724,1;749,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{tuncstart_724.1},
\theta_{funcstart\_724,1}.p2, 176.quot) + (172 * div(heapIs \theta_{funcstart\_724,1},
\verb§heap$_{funcstart\_724,1}.p2,\ 176).rem))).\_\textbf{replace}(p3 \rightarrow \textbf{asType} < \textbf{short}
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem *
asType<int>(asType<short int>((int)170))) -
(asType<int>(asType<short int>(div3.quot)) *
asType < int > (\$heap_{724,1;747,8}.b3))))
\rightarrow [simplify]
[67.12] $\text{heap}_{724,1;749,8} == $\text{heap}_{funcstart_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
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177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs} \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2, 176}.rem))._replace(p3 \rightarrow asType<short
int > ((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem * 170)
 - (asType < int > (asType < short int > (div3.quot))
asType<int>($heap<sub>724,1;747,8</sub>.b3))))
\rightarrow [from term 43.6, div3 is equal to div(heapIs $heap_{tuncstart_{724.1}},
heap_{funcstart_{-724,1}}.p3, 178
[67.13] $\text{heap}_{724,1:749.8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart_{-724,1},p2,176,rem})._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) –
(asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724.1},
\text{sheap}_{funcstart\_724,1.p3}, 178).\text{quot}) * asType<int>(\text{sheap}_{724,1;747,8.b3}))))
\rightarrow [simplify]
[67.15] $\text{heap}_{724,1:749.8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724.1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724.1},
\rho_{tuncstart_{724,1},p2,176,rem})._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) –
(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} *
asType < int > (\$heap_{724.1:747.8}.b3)))
\rightarrow [from term 63.24, $heap<sub>724,1:747,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs p_{funcstart\_724,1})
\$heap_{funcstart\_724,1}.p1,\ 177).rem))).\_\textbf{replace}(p2 \rightarrow (-35\ *\ div(\textbf{heapIs}))).
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}. p_{funcstart\_724,1}. p_{funcstart\_7
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, p2, 176).rem)
[67.16] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1}.p2, 176).rem))._replace(p3 \rightarrow asType<short int>((170)
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) –
(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} *
asType<int>($heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 * div(heapIs
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1},p1, 177}.quot + (171 * div(heapIs))
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\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).rem))).\_replace(p2 \rightarrow ((-35))
* div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p2, \ 176).quot) + (172 \ *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p2, \ 176).rem))).b3))))
\rightarrow [const member of object with modified fields]
[67.18] $\text{heap}_{724,1;749,8} == \text{$heap}_{funcstart\_724,1}._\text{$replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{funcstart\_724,1.p2, 176}.rem)._replace(p3 \rightarrow asType<short int>((170
* \operatorname{div}(\mathbf{heapIs} \ \text{$heap}_{funcstart\_724,1}, \ \text{$heap}_{funcstart\_724,1}.p3, \ 178).rem) -
(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} *
asType < int > (\$heap_{funcstart\_724,1}.b3))))
\rightarrow [const static or extern object]
[67.19] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724.1}, \text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724.1},
\rho_{tuncstart,724,1},p2,176).rem)._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) –
(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} *
asType < int > (\$heap_{init}.b3)))
\rightarrow [expand definition of constant 'b3' at prang.c (27,20)]
[67.20] heap_{724,1;749,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{uncstart\_724,1.p2, 176).rem})).\_replace(p3 \rightarrow asType < short int > ((170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 - 170 -
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) –
(\text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724.1}, \ \$ \text{heap}_{funcstart\_724.1}. \text{p3}, \ 178).\text{quot} \ *
asType<int>(asType<short int>((int)63))))
\rightarrow [simplify]
[67.26] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{tuncstart\_724.1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2, 176}.rem)._replace(p3 \rightarrow ((-63 * div(heapIs
\text{Sheap}_{funcstart_{-724,1}}, \text{Sheap}_{funcstart_{-724,1}}.\text{p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs}))
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 178).rem)
```

```
[Take goal term]
[1.0] ((asType<int>($heap<sub>724.1:749.8</sub>.M1) *
asType<int>(static_cast<integer>(asType<int>($heap<sub>724.1:749.8</sub>.p1) <
(int)(0) + asType < int > (\$heap_{724,1:749.8}.p1) \le maxof(short int)
\rightarrow [from term 67.26, $heap<sub>724,1;749,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1},p1, 177}, quot) + (171 * div(heapIs heap_{funcstart_{724,1},p1, 177})
heap_{funcstart\_724,1}.p1, 177).rem))).\_replace(p2 \rightarrow ((-35 * div(heapIs)))._replace(p2 \rightarrow ((-35 * div(heapIs)))))._replace(p2 \rightarrow ((-35 * div(heapIs)))))
$heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs) 
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).quot) + (170 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).rem))]
[1.1] ((asType<int>($heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs)
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1},1}, 177).quot + (171 * div(heapIs)
\rho_{tuncstart,724,1}, \rho_{tuncstart,724,1}
* div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, p2, 176).quot) + (172 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p2,
176).rem)))._replace(p3 \rightarrow ((-63 * div(heapIs $heap_{funcstart_724.1},
\text{Sheap}_{funcstart\_724,1.p3}, 178).\text{quot} + (170 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{724,1}.p3, 178.rem})).M1) *
asType<int>(static_cast<integer>(asType<int>($heap_{724,1:749,8}.p1) <
(int)(0) + asType<int>($heap<sub>724,1:749,8</sub>.p1)) \leq maxof(short int)
→ [const member of object with modified fields]
[1.4] ((asType<int>($heap_{funcstart_724.1}.M1) *
asType<int>(static_cast<integer>(asType<int>($heap<sub>724.1:749.8</sub>.p1) <
(int)(0)) + asType < int > (\$heap_{724,1:749,8}.p1)) \le maxof(short int)
\rightarrow [const static or extern object]
[1.5] ((asType<int>($heap<sub>init</sub>.M1) *
asType<int>(static_cast<integer>(asType<int>($heap<sub>724.1:749.8</sub>.p1) <
(int)(0) + asType<int>($heap<sub>724.1:749.8</sub>.p1)) \leq maxof(short int)
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[1.6] ((asType<int>(asType<short int>((int)30269)) *
\mathbf{asType} < \mathbf{int} > (\mathbf{static\_cast} < \mathbf{integer}) < (\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{724,1;749,8}.\mathrm{p1}) < (\$ \mathrm{heap}_{724,1;749,8}.\mathrm{p2}) < (\$ \mathrm{heap}_{724,1;749,8}.\mathrm{p2})
(int)(0)) + asType < int > (\$heap_{724,1;749,8}.p1)) \le maxof(short int)
\rightarrow [simplify]
[1.9] ((30269 *
asType<int>(static_cast<integer>(asType<int>($heap<sub>724.1:749.8</sub>.p1) <
(int)(0)) + asType < int > (\$heap_{724,1:749.8}.p1)) \le maxof(short int)
\rightarrow [from term 67.26, $heap<sub>724,1;749,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.p1, 177).quot) + (171 * div(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
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\rho_{tuncstart\_724.1.p1, 177).rem}))._replace\rho_{tuncstart\_724.1.p1, 177).rem})
 heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
 \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}
 div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).quot) + (170 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p3, \ 178).\operatorname{rem}))]
 \mathbf{asType} < \mathbf{int} > (\mathbf{static\_cast} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}. \mathbf{\_replace} (\mathbf{p1})) + (\$ \mathbf{heap
 \rightarrow ((-2 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart\_724,1}, \text{\$heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}) +
(171 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart\_724.1}, \text{\$heap}_{funcstart\_724.1}.\text{p1},
 177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart_724,1}.p2, 176).rem))._replace(p3 \rightarrow ((-63 * div(heapIs
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{rem}))).\text{p1}) < (\text{int})0))) +
asType < int > (\$heap_{724,1:749,8}.p1)) \le maxof(short int)
 \rightarrow [simplify]
 [1.22] ((30269 * asType<int>(([0 < ((-171 * div(heapIs $heap_{tuncstart\_724.1},
 \text{Sheap}_{funcstart=724.1}, p1, 177).rem) + (2 * div(heapIs \text{Sheap}_{funcstart=724.1},
 \text{Sheap}_{funcstart_{724,1}}, p1, 177).quot))]: 1, []: 0))) +
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{724,1;749,8}.\mathrm{p1})) \leq \mathbf{maxof}(\mathbf{short}\ \mathbf{int})
 → [explicitly assert falsehood of skipped guards in subsequent guards]
 [1.23] ((30269 * asType<int>(([0 < ((-171 * div(heapIs $heap_{tuncstart\_724.1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{1} = \theta_{1} = \theta_{2} = \theta_{1} = \theta_{2} = \theta_{2
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}) + (2 * \text{div}(\text{heapIs}))
 \{\text{heap}_{funcstart\_724,1}, \{\text{heap}_{funcstart\_724,1}, \text{p1}, 177\}, \text{quot}\}\}\} +
asType < int > (\$heap_{724,1:749,8}.p1)) \le maxof(short int)
 \rightarrow [simplify]
 [1.28] ((30269 * asType<int>(([0 < ((-171 * div(heapIs $heap_{tuncstart\_724.1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
 \{\text{heap}_{funcstart\_724,1}.\text{p1}, 177\}.\text{quot}\}: 1, [-1 < ((171 * \text{div}(\text{heapIs})))]: 1, [-1 < ((171 * \text{div}(\text
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p1, 177).rem) + (-2 * div(heapIs
\frac{\text{sheap}_{funcstart_{-724,1}}, \frac{\text{sheap}_{funcstart_{-724,1}}, p_1, 177).quot)}{1} + \frac{1}{3}}
asType < int > (\$heap_{724,1:749,8}.p1)) \le maxof(short int)
 \rightarrow [from term 61.3, -1 < ((-2 * div(heapIs $heap_{funcstart\_724,1},
 heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1}, 177).quot) + (171 * div(heapIs $heap_{funcstart\_724,1}, 17
 heap_{funcstart\_724.1.p1}, 177).rem) is true if and only if 0 < ((-2 * div(heapIs)))
 heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p_1, 177).quot + (171 * div(heapIs))
 heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1, 177).rem)
 [1.29] ((30269 * asType<int>(([0 < ((-171 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs} \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177).quot): 1, [0 < ((-2 * div(heapIs))]: 1, [0 < ((-2 * div(heapIs))]:
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\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs})
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).rem))]: 0))) +
asType < int > (\$heap_{724,1:749,8}.p1)) \le maxof(short int)
\rightarrow [simplify]
[1.30] ((30269 * ([0 < ((-171 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p1}, 177).\text{quot}): 1, [0 < ((-2 * \text{div}(\textbf{heapIs})))]: 1, [0 < ((-2 * \text{div}(\textbf{heapIs})))]:
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).quot) + (171 * div(heapIs)
\frac{\text{sheap}_{funcstart_{724,1}}, \text{sheap}_{funcstart_{724,1}.p1, 177).rem}}{177).rem}
asType < int > (\$heap_{724,1;749,8}.p1)) \le maxof(short int)
\rightarrow [move guard outside expression]
[1.31] (([0 < ((-171 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).rem) + (2 * \text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).quot))]: 1 * 30269, [0 < ((-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, 
\text{Sheap}_{funcstart\_724,1.p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\frac{\text{sheap}_{funcstart_{724,1},p1, 177}.rem)}{1}: 0 * 30269} +
asType < int > (\$heap_{724,1:749,8}.p1)) \le maxof(short int)
\rightarrow [simplify]
[1.33] (([0 < ((-171 * div(heapIs p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1})])
177).rem) + (2 * \text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.p1,
(177).quot): 30269, [0 < ((-2 * div(heapIs $heap_{tuncstart 724.1}, 
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\frac{\text{sheap}_{funcstart\_724,1.p1, 177}.rem)}{0} + asType < int > (\frac{\text{sheap}_{724,1:749,8.p1}}{0})
\leq \max of(short int)
\rightarrow [from term 67.26, $heap<sub>724,1;749,8</sub> is equal to
\text{Sheap}_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1}), the sheap funcstart\_724,1).
\$heap_{funcstart\_724,1}.p1,\ 177).quot) + (171*div(\textbf{heapIs}\ \$heap_{funcstart\_724,1},
\rho_{funcstart\_724.1}.p1, 177).rem))._replace\rho_{funcstart\_724.1}.p1, 177).rem))
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem)))._replace(p3 \rightarrow (-63 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).quot) + (170 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p3, \ 178).\operatorname{rem}))]
177).rem) + (2 * \text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).quot))]: 30269, [0 < ((-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, 
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\frac{\text{heap}_{funcstart_{-724,1}.p1, 177}.rem)}{} : 0) +
asType < int > (\$heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * div(heapIs))))))
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p1, 177).quot) + (171 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
* div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, p2, 176).quot) + (172 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p2,
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176).rem)))._replace(p3 \rightarrow ((-63 * div(heapIs $heap_{funcstart_724.1},
\text{Sheap}_{funcstart\_724,1.p3}, 178).\text{quot} + (170 * \text{div}(\text{heapIs} \text{Sheap}_{funcstart\_724,1},
\{\text{heap}_{funcstart\_724,1}.\text{p3}, 178\}.\text{rem}\} )).\text{p1}) \leq \max\{\text{short int}\}
\rightarrow [simplify]
[1.39] ((-2 * div(heapIs $heap_{funcstart_{-724,1}}, $heap_{funcstart_{-724,1}}.p1, 177).quot)
+ (171 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem) +
([0<((\text{-}171 * \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem) + (2 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart\_724,1}, \text{\$heap}_{funcstart\_724,1}.p1,
177).quot))]: 30269, [0 < ((-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, 
\text{Sheap}_{funcstart\ 724.1.p1,\ 177}.\text{quot}) + (171 * \text{div}(\text{heapIs} \text{Sheap}_{funcstart\ 724.1.})
\$ heap_{funcstart\_724,1}.p1,\ 177).rem))]:\ 0)) \le \mathbf{maxof}(\mathbf{short\ int})
\rightarrow [move guard outside expression]
[1.40] ([0 < ((-171 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1,
177).rem) + (2 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart\_724,1}, \text{\$heap}_{funcstart\_724,1}.p1,
(177).quot): (30269 + (-2 * div(heapIs $heap_{funcstart\_724,1}, 
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}, [0 < ((-2 * \text{div}(\textbf{heapIs} \$ \text{heap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p1, 177}.quot) + (171 * div(heapIs \rho_{funcstart\_724,1})
[\text{heap}_{funcstart,724,1},\text{p1}, 177].\text{rem}]: 0 + (-2 * div(heapIs [\text{heap}_{funcstart,724,1},\text{p1}])
\text{Sheap}_{funcstart_{-724,1},p1, 177}.\text{quot}) + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart_{-724,1}})
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}) \leq \text{maxof}(\text{short int})
\rightarrow [simplify]
[1.43] (-1 + ([0 < ((-171 * div(heapIs heap_{funcstart_{-724,1}},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\frac{\text{sheap}_{funcstart\_724,1.p1, 177}.\text{quot}}{\text{li}} : 30269 + (-2 * \text{div}(\text{heapIs}))
\$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).quot) + (171 * div(\textbf{heapIs}) + (171 * div(\textbf{heapIs})) + (171
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).rem, [0 < ((-2 * div(\textbf{heapIs})))]
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, 177).rem): (-2 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\textbf{heapIs})
\$ heap_{funcstart\_724,1}, \$ heap_{funcstart\_724,1}.p1, 177).rem))) < 32767
\rightarrow [move guard outside expression]
\label{eq:loss_loss} $[1.44]$ ([0 < ((-171 * div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p1,
177).rem) + (2 * \text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).quot))]: -1 + (30269 + (-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, 
\theta_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1}, 177).quot) + (171 * div(heapIs $heap_{funcstart\_724,1}, 177).
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}, [0 < ((-2 * \text{div}(\textbf{heapIs} \$\text{heap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724.1.p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724.1},
heap_{funcstart_{-724,1}.p1, 177).rem}): -1 + ((-2 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs}))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).rem))) < 32767
\rightarrow [simplify]
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```
[1.48]\ 0 < (32767 + -([0 < ((-171 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\frac{\text{sheap}_{funcstart\_724,1.p1, 177}.\text{quot}}{\text{li}} : 30268 + (-2 * \text{div}(\text{heapIs}))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs}))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}, [0 < ((-2 * \text{div}(\textbf{heapIs})))]
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).quot) + (171 * div(heapIs)
\frac{\text{sheap}_{funcstart\_724,1}, \text{sheap}_{funcstart\_724,1}.p1, 177).rem}}{177).rem}: -1 + (-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, \ 177).\operatorname{rem})))
\rightarrow [move guard outside expression]
[1.49] \ 0 < (32767 + ([0 < ((-171 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart_{-724,1},p1, 177,quot}): -(30268 + (-2 * div(heapIs))
\theta_{funcstart_{-724,1}}, \theta_{funcstart_{-724,1}}, \theta_{funcstart_{-724,1}}, \theta_{funcstart_{-724,1}}, \theta_{funcstart_{-724,1}}
\$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)), [0 < ((-2 * div(\mathbf{heapIs}) + (-2 * div(\mathbf{heapIs
\theta_{funcstart-724,1}, \theta_{funcstart-724,1}, \theta_{funcstart-724,1}, \theta_{funcstart-724,1}, \theta_{funcstart-724,1}
\rho_{funcstart_{-724,1}}, \rho_{funcstart_{-724,1},p1, 177}.rem): -(-1 + (-2 * -1))
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \text{$heap}_{funcstart\_724,1}, \ \text{$heap}_{funcstart\_724,1}.p1, \ 177).rem))))
\rightarrow [simplify]
[1.61] 0 < (32767 + ([0 < ((-171 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart_724,1}),
\frac{\text{sheap}_{funcstart}}{1000} = \frac{1000}{1000} = \frac{1000}{1000
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p1, 177).quot), \theta_{funcstart\_724,1}
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
\text{Sheap}_{funcstart_{-724,1}}, \text{Sheap}_{funcstart_{-724,1}}.p1, 177).rem): 1 + (-171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1, 177).\operatorname{rem}) + (2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot})))
\rightarrow [move guard outside expression]
[1.62] 0 < ([0 < ((-171 * div(heapIs $heap_{tuncstart\_724.1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{uncstart_{-724,1},p1, 177,quot}): 32767 + (-30268 + (-171 * div(heapIs))
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p1, 177).rem) + (2 * div(heapIs
\text{Sheap}_{funcstart_{-724,1}}, \text{Sheap}_{funcstart_{-724,1}}.\text{p1}, 177).\text{quot}), [0 < ((-2 * 
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p1, \ 177).rem))]: 32767 +
(1 + (-171 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)
+ (2 * div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, 177).quot)))
\rightarrow [simplify]
[1.66] \ 0 < ([0 < ((-171 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs} \text{Sheap}_{funcstart\_724,1},
```

```
\frac{\text{sheap}_{funcstart_{-724,1},p1, 177}.quot)}{\text{cuot}}: 2499 + (-171 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p1, 177).rem) + (2 * div(heapIs
\$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).quot), [0 < ((-2 * div(\mathbf{heapIs}) + (-2 * div(\mathbf{heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).quot) + (171 * div(heapIs)
\rho_{funcstart_{-724,1}}, \rho_{funcstart_{-724,1},177}.p1, 177).rem): 32768 + (-171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1, 177).\operatorname{rem}) + (2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}))
\rightarrow [move guard outside expression]
\label{eq:loss_loss} $[1.67]$ ([0 < ((-171 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1,
177).rem) + (2 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart 724.1}, \text{\$heap}_{funcstart 724.1}, \text{$1, 1]})
177).quot))]: 0 < (2499 + (-171 * div(heapIs $heap_{funcstart\_724,1}, 
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs} \text{Sheap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}), [0 < ((-2 * \text{div}(\textbf{heapIs})))]
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1},p1, 177}.quot) + (171 * div(heapIs)
\rho_{uncstart_{-724,1}}, \rho_{uncstart_{-724,1}}, \rho_{uncstart_{-724,1}}, \rho_{uncstart_{-724,1}}, \rho_{uncstart_{-724,1}}, \rho_{uncstart_{-724,1}}
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).rem) + (2 *
\operatorname{div}(\mathbf{heapIs} \ \text{$heap}_{funcstart\_724,1}, \ \text{$heap}_{funcstart\_724,1}.p1, \ 177).quot)))
\rightarrow [simplify]
[1.69] ([0 < ((-171 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).rem) + (2 * \text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.p1,
177).quot))]: -2499 < ((-171 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart_724,1}),
heap_{funcstart_{-724,1},p1, 177,quot}), [0 < ((-2 * div(heapIs)))]
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs}))
\{\text{heap}_{funcstart\_724,1}, \{\text{heap}_{funcstart\_724,1}.p1, 177\}.rem\}\}: 0 < (32768 + (-171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1, 177).\operatorname{rem}) + (2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot)))
\rightarrow [from guard, literala < ((-171 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177).quot) is true whenever (-1 + literala) < 0
        Proof of rule precondition:
        [1.69.0](-2499 + -1) < 0
        \rightarrow [simplify]
        [1.69.2] true
\label{eq:continuous} \textit{[1.70]} \; ([0 < ((-171 \; * \; \mathrm{div}(\mathbf{heapIs} \; \$ \mathrm{heap}_{funcstart\_724,1}, \, \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
177).rem) + (2 * \text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).quot))]: true, [0 < ((-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, 
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\frac{\text{heap}_{funcstart\_724,1.p1, 177}.rem)}{0}: 0 < (32768 + (-171 * div(heapIs)))
\text{Sheap}_{funcstart\_724.1}, \text{Sheap}_{funcstart\_724.1}.\text{p1}, 177).\text{rem}) + (2 * \text{div}(\text{heapIs}))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).quot)))
```

```
\rightarrow [simplify]
\label{eq:continuous} \textit{[1.72]} \; ([0 < ((-171 \; * \; \mathrm{div}(\mathbf{heapIs} \; \$ \mathrm{heap}_{funcstart\_724,1}, \; \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}, \;
177).rem) + (2 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart\_724,1}, \text{\$heap}_{funcstart\_724,1}.p1,
177).quot))]: true, [0 < ((-2 * div(heapIs $heap_{funcstart\_724,1},
\theta_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs \theta_{funcstart\_724,1})
{\rm heap}_{funcstart\_724,1.p1,\ 177).rem}): -32768 < ((-171 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}) + (2 * \text{div}(\text{heapIs}))
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, 177).quot)))
\rightarrow [from term 62.17, literala < ((-171 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).rem + (2 * div(heapIs $heap_{funcstart\_724,1},
\theta_{uncstart\_724,1}.p1, 177).quot) is true whenever (-1 + literala) < -30269
    Proof of rule precondition:
    [1.72.0](-32768 + -1) < -30269
    \rightarrow [simplify]
    [1.72.2] true
 [1.73] \; ([0 < ((-171 * \operatorname{div}(\mathbf{heapIs} \; \$ \operatorname{heap}_{funcstart\_724,1}, \; \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, \;
177).rem) + (2 * \text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).quot))]: true, [0 < ((-2 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{funcstart\_724,1}.p1,\ 177).rem))]: true)
\rightarrow [all guards have equal guarded terms]
[1.74] true
Proof of verification condition: Type constraint satisfied in implicit
conversion from 'short int const' to 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (69,27)
Condition defined at:
To prove: minof(int) \le \text{$heap}_{724,1:752,8}.M2
Given:
heap_{init}.LIMIT == (int)80
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
\theta
\theta = asType < short int > ((int)2)
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
```

```
\theta_{init}.a2 == asType<short int>((int)176)
\theta
\theta sheap<sub>init</sub>.M3 == asType<short int>((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
heap_{init}.b3 == asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
invariant
1<br/>( \mathbf{heapIs}\ \$ \mathbf{heap}_{funcstart\_724,1})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \ \operatorname{\$heap}_{funcstart\_724,1},
\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(asType<int>(asType<int>($heap_{tuncstart\_724.1}.p1)) /
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}))) = =
asType<integer>(div1.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) ==
asType<integer>(div1.rem))
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) /
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))) ==
asType<integer>(div2.rem)
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) <
```

```
asType < integer > (\$heap_{funcstart_{-724,1}}.a2)) = >
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) ==
asType<integer>(div2.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a2}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
asType < int > (\$heap_{funcstart_{-724,1}}.a3))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(asType<int>(sheap<sub>funcstart_724,1.</sub>p3)) %
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))) ==
asType<integer>(div3.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) ==
asType<integer>(div3.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a3) \le
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})) => !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
\mathbf{asType} \hspace{-0.1em}<\hspace{-0.1em} \mathbf{int} \hspace{-0.1em}> \hspace{-0.1em} (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{r1})) - (\mathbf{asType} \hspace{-0.1em}<\hspace{-0.1em} \mathbf{int} \hspace{-0.1em}> \hspace{-0.1em} (\mathbf{asType} \hspace{-0.1em}<\hspace{-0.1em} \mathbf{short})
int>(div1.quot)) * asType<int>($heap_{funcstart\_724,1}.b1)))
-asType<integer const>($heap<sub>724,1:745,8</sub>.M1) <
asType<integer>($heap<sub>724,1:745,8</sub>.p1)
!(0 == asType < integer > (\$heap_{724,1:745.8}.p1))
asType<integer>($heap<sub>724.1:745.8</sub>.p1) <
asType<integer>($heap<sub>724,1:745,8</sub>.M1)
\$heap_{724,1;747,8} == \$heap_{724,1;745,8}. \textbf{\_replace}(p2 \rightarrow \textbf{asType} < \textbf{short}
int>((asType<int>(asType<short int>(div2.rem)) *
\mathbf{asType} < \mathbf{int} > (\$ heap_{724,1;745,8}.r2)) - (\mathbf{asType} < \mathbf{int} > (\mathbf{asType} < \mathbf{short})
int>(div2.quot)) * asType< int>($heap_{724,1:745,8}.b2))))
-asType < integer const > (\$heap_{724,1:747.8}.M2) <
```

```
asType<integer>($heap<sub>724.1:747.8</sub>.p2)
!(0 == \mathbf{asType} < \mathbf{integer} > (\$ heap_{724,1;747,8}.p2))
asType<integer>($heap<sub>724,1;747,8</sub>.p2) <
asType<integer>($heap<sub>724,1;747,8</sub>.M2)
\text{$heap}_{724,1;749,8} == \text{$heap}_{724,1;747,8}.\textbf{replace}(p3 \to \textbf{asType} < \textbf{short}
int>((asType<int>(asType<short int>(div3.rem)) *
asType < int > (\$heap_{724,1:747,8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap<sub>724,1:747,8</sub>.b3))))
-asType < integer const > (\$heap_{724,1;749,8}.M3) < 100
asType<integer>($heap<sub>724.1:749.8</sub>.p3)
!(0 == asType < integer > (\$heap_{724,1:749.8}.p3))
asType<integer>($heap<sub>724.1:749.8</sub>.p3) <
asType<integer>($heap<sub>724.1:749.8</sub>.M3)
heap_{724,1:752,8} == heap_{724,1:749,8}.replace(p1 \rightarrow asType<short
int>((asType<int>($heap<sub>724,1:749,8</sub>.M1) *
asType<int>(static_cast<integer>(asType<int>($heap_{724,1:749,8}.p1) <
(int)(0)) + asType < int > (\$heap_{724,1:749,8}.p1)))
Proof:
[Take goal term]
[1.0] minof(int) \leq $heap<sub>724,1;752,8</sub>.M2
\rightarrow [simplify]
[1.1] -32768 \leq $heap<sub>724,1;752,8</sub>.M2
\rightarrow [const static or extern object]
[1.2] -32768 \le \text{$heap}_{init}.M2
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[1.3] -32768 < asType<short int>((int)30307)
\rightarrow [simplify]
[1.6] true
Proof of verification condition: Type constraint satisfied in implicit
conversion from 'short int const' to 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (69,27)
Condition defined at:
To prove: heap_{724,1;752,8}.M2 \le maxof(int)
Given:
heap_{init}.LIMIT == (int)80
```

```
heap_{init}.M1 == asType < short int > ((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta = asType < short int > ((int)2)
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart_{724,1}})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724.1}.p1),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ / \ 
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}))~\%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p1) = =
asType<integer>(div1.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathtt{a1}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
```

```
asType < int > (\$heap_{funcstart\_724.1}.a2))
(asType<integer>(asType<int>($heap_{funcstart\_724,1}.p2)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.rem)
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}) ==
asType<integer>(div2.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a2) \le
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2})) = > !(0 = =
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}))\ /
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))) ==
asType<integer>(div3.quot)
(asType<int>(asType<int>($heap_funcstart_724.1.p3)) %
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.a3) \leq
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})) => !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
heap_{724,1;745,8} == heap_{funcstart\_724,1}.\_replace(p1 \rightarrow asType < short)
\mathbf{int}{>}((\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{short}\ \mathbf{int}{>}(\mathbf{div}1.\mathbf{rem}))\ ^*
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1.quot})) * \mathbf{asType}{<} \mathbf{int}{>} (\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
-asType < integer const > (\$heap_{724,1;745,8}.M1) < 
asType<integer>($heap<sub>724 1:745 8</sub>.p1)
```

```
!(0 == asType < integer > (\$heap_{724,1:745.8}.p1))
asType<integer>($heap<sub>724.1:745.8</sub>.p1) <
asType<integer>($heap<sub>724,1:745,8</sub>.M1)
heap_{724,1;747,8} == heap_{724,1;745,8}.replace(p2 \rightarrow asType<short
\mathbf{int}{>}((\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{short}\ \mathbf{int}{>}(\mathbf{div2.rem}))\ ^*
asType < int > (\$heap_{724.1:745.8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724,1:745,8</sub>.b2))))
-asType<integer const>($heap<sub>724,1:747,8</sub>.M2) <
asType<integer>($heap<sub>724,1:747,8</sub>.p2)
!(0 == asType < integer > (\$heap_{724,1;747,8}.p2))
asType<integer>($heap<sub>724,1:747,8</sub>.p2) <
asType<integer>($heap<sub>724,1:747,8</sub>.M2)
\text{heap}_{724.1:749.8} == \text{heap}_{724.1:747.8}._replace(p3 \rightarrow asType<short)
int>((asType<int>(asType<short int>(div3.rem))
asType < int > (\$heap_{724,1;747,8}.r3)) - (asType < int > (asType < short)
int > (div3.quot)) * asType < int > (\$heap_{724,1;747,8}.b3))))
-{\bf asType}{<} {\bf integer~const}{>} (\${\rm heap}_{724,1;749,8}.{\rm M3}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;749,8}.\mathrm{p3})
!(0 == asType < integer > (\$heap_{724,1;749,8}.p3))
asType<integer>($heap<sub>724,1:749,8</sub>.p3) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;749,8}.\mathrm{M3})
heap_{724,1:752.8} == heap_{724,1:749.8}.replace(p1 \rightarrow asType<short
\mathbf{int}{>}((\mathbf{asType}{<}\mathbf{int}{>}(\$\text{heap}_{724,1;749,8}.\text{M1}) \ *
asType<int>(static_cast<integer>(asType<int>($heap<sub>724.1:749.8</sub>.p1) <
(int)(0) + asType<int>($heap<sub>724.1:749.8</sub>.p1)))
Proof:
[Take goal term]
[1.0] $heap<sub>724,1:752,8</sub>.M2 \leq maxof(int)
\rightarrow [const static or extern object]
[1.1] $heap<sub>init</sub>.M2 \leq maxof(int)
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[1.2] asType<short int>((int)30307) < maxof(int)
\rightarrow [simplify]
[1.6] true
```

Proof of verification condition: Type constraint satisfied in implicit conversion from 'short int' to 'int'

```
Condition generated at: C:\Escher\Customers\prang\prang.c (69,17)
Condition defined at:
To prove: minof(int) \le \text{$heap}_{724,1:752.8}.p2
Given:
heap_{init}.LIMIT == (int)80
\theta
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta
heap_{init}.M2 == asType < short int > ((int)30307)
\theta
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
\theta = asType < short int > ((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart\_724,1})
div1 == div(\mathbf{heapIs} \$ heap_{funcstart\_724.1},
asType < int > (\$heap_{funcstart\_724.1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}))\ /
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))) = =
asType<integer>(div1.quot)
(asType < integer > (asType < int > (\$heap_{tuncstart\_724.1}.p1)) \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}))) = =
asType<integer>(div1.rem)
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p1) = =
asType<integer>(div1.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathtt{a1}) \leq
```

```
asType < integer > (\$heap_{funcstart-724.1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p2})) \ / \\
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.quot)
(asType<int>(asType<int>($heap_{tuncstart\_724.1}.p2)) %
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}) ==
asType<integer>(div2.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a2) \le
asType < integer > (\$heap_{funcstart\_724,1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
asType < int > (\$heap_{funcstart\_724,1}.a3))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724.1}.a3))) = =
asType<integer>(div3.quot)
(asType < int > (asType < int > (\$heap_{tuncstart\_724,1}.p3)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = = 
asType<integer>(div3.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a3) \le
asType < integer > (\$heap_{funcstart\_724.1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
```

```
\$heap_{724,1;745,8} == \$heap_{funcstart\_724,1}.\_\textbf{replace}(p1 \rightarrow \textbf{asType} < \textbf{short}
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
-asType < integer const > (\$heap_{724.1:745.8}.M1) < 
asType<integer>($heap<sub>724,1:745,8</sub>.p1)
!(0 == asType < integer > (\$heap_{724,1:745.8} \cdot p1))
asType<integer>($heap<sub>724,1:745,8</sub>.p1) <
asType<integer>($heap<sub>724,1:745,8</sub>.M1)
heap_{724,1:747,8} == heap_{724,1:745,8}.replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724.1:745.8}.r2)) - (asType < int > (asType < short)
int > (div2.quot)) * asType < int > (\$heap_{724,1:745,8}.b2))))
-\mathbf{asType}{<}\mathbf{integer\ const}{>}(\$\mathrm{heap}_{724,1;747,8}.\mathrm{M2}) <
asType<integer>($heap<sub>724.1:747.8</sub>.p2)
!(0 == \mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathrm{heap}_{724,1;747,8}.\mathrm{p2}))
asType<integer>($heap<sub>724,1:747,8</sub>.p2) <
asType<integer>($heap<sub>724.1:747.8</sub>.M2)
\text{heap}_{724.1:749.8} == \text{heap}_{724.1:747.8}._replace(p3 \rightarrow asType<short)
int>((asType<int>(asType<short int>(div3.rem)) *
asType < int > (\$heap_{724.1:747.8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap<sub>724.1:747.8</sub>.b3))))
-asType<integer const>($heap<sub>724,1:749,8</sub>.M3) <
asType<integer>($heap<sub>724.1:749.8</sub>.p3)
!(0 == asType < integer > (\$heap_{724\ 1.749\ 8.p3}))
asType<integer>($heap<sub>724,1:749,8</sub>.p3) <
asType<integer>($heap<sub>724,1:749,8</sub>.M3)
heap_{724,1;752,8} == heap_{724,1;749,8}.replace(p1 \rightarrow asType<short
int>((asType<int>($heap<sub>724.1:749.8</sub>.M1) *
asType<int>(static_cast<integer>(asType<int>($heap<sub>724.1:749.8</sub>.p1) <
(int)(0) + asType<int>($heap<sub>724.1:749.8</sub>.p1)))
Proof:
[Take goal term]
[1.0] minof(int) \leq $heap<sub>724,1:752,8</sub>.p2
\rightarrow [simplify]
[1.3] -32769 < $heap<sub>724.1:752.8</sub>.p2
→ [negate goal and search for contradiction]
[1.4]!(-32769 < \text{$heap}_{724,1;752,8}.p2)
```

```
\rightarrow [simplify]
[1.6] 32768 < -$heap<sub>724,1;752,8</sub>.p2
[Assume known post-assertion, class invariant or type constraint for term 1.6]
[72.0] minof(short int) \leq $heap<sub>724,1;752,8</sub>.p2
\rightarrow [simplify]
[72.3] -32769 < heap_{724,1;752,8}.p2
\rightarrow [from term 1.6, literala < $heap<sub>724,1;752,8</sub>.p2 is false whenever -2 < (32768)
+ literala)]
   Proof of rule precondition:
   [72.3.0] - 2 < (-32769 + 32768)
   \rightarrow [simplify]
   [72.3.2] true
[72.4] false
Proof of verification condition: Type constraint satisfied in implicit
conversion from 'short int' to 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (69,17)
Condition defined at:
To prove: heap_{724,1:752,8}.p2 \le maxof(int)
Given:
heap_{init}.LIMIT == (int)80
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
\theta
\theta
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
heap_{init}.a3 == asType<short int>((int)178)
heap_{init}.b3 == asType < short int > ((int)63)
```

```
\theta
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs $heap_{tuncstart_{724.1}})
div1 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ / \\
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}))) = =
asType<integer>(div1.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p1) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1})) =>
(asType < integer > (\$heap_{funcstart\_724,1}.p1) = =
asType<integer>(div1.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a1) \le
asType < integer > (\$heap_{funcstart\_724,1}.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart\_724.1},
asType < int > (\$heap_{funcstart\_724.1}.p2),
asType < int > (\$heap_{funcstart\_724.1}.a2))
(asType<integer>(asType<int>($heap_{funcstart\_724,1}.p2)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p2) = =
asType<integer>(div2.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a2) \le
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})) => !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
```

```
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a3}))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(\mathbf{asType} {<} \mathbf{integer} {>} (\mathbf{asType} {<} \mathbf{int} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3})) \ \%
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a3}))) = =
asType<integer>(div3.rem)
(asType<integer>($heap_{tuncstart\_724.1}.p3) <
asType < integer > (\$heap_{funcstart_{-724,1}}.a3)) = >
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) ==
asType<integer>(div3.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a3}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
\$heap_{724,1;745,8} == \$heap_{funcstart\_724,1}.\_\textbf{replace}(p1 \rightarrow \textbf{asType} < \textbf{short}
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{tuncstart\_724.1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType<int>($heap_{funcstart\_724,1}.b1)))
-{\bf asType}{<} {\bf integer~const}{>} (\${\rm heap}_{724,1;745,8}.{\rm M1}) <
asType<integer>($heap<sub>724,1:745,8</sub>.p1)
!(0 == asType < integer > (\$heap_{724,1;745,8}.p1))
asType<integer>($heap<sub>724,1;745,8</sub>.p1) <
asType<integer>($heap<sub>724.1:745.8</sub>.M1)
\text{heap}_{724.1:747.8} = \text{heap}_{724.1:745.8}._replace(p2 \rightarrow asType<short)
int>((asType<int>(asType<short int>(div2.rem)) *
\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{724,1;745,8}.\mathrm{r2})) - (\mathbf{asType} < \mathbf{int} > (\mathbf{asType} < \mathbf{short}))
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
-asType < integer\ const > (\$heap_{724,1;747,8}.M2) < 
asType<integer>($heap<sub>724,1:747,8</sub>.p2)
!(0 == asType < integer > (\$heap_{724,1:747.8}, p2))
asType<integer>($heap<sub>724,1.747,8.</sub>p2) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;747,8}.\mathrm{M2})
$heap_{724,1;749,8} == $heap_{724,1;747,8}.replace(p3 \rightarrow asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
```

```
asType < int > (\$heap_{724.1:747.8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap<sub>724,1:747,8</sub>.b3))))
-asType<integer const>($heap_{724,1:749,8}.M3) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;749,8}.\mathrm{p3})
!(0 == asType < integer > (\$heap_{724,1;749,8}.p3))
asType<integer>($heap<sub>724,1:749,8</sub>.p3) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;749,8}.\mathrm{M3})
heap_{724,1:752.8} == heap_{724,1:749.8}.replace(p1 \rightarrow asType<short
int>((asType<int>($heap<sub>724.1:749.8</sub>.M1) *
asType<int>(static_cast<integer>(asType<int>($heap_{724.1:749.8}.p1) <
(int)(0) + asType < int > ($heap_{724.1:749.8}.p1))
Proof:
[Take goal term]
[1.0] $heap<sub>724,1:752,8</sub>.p2 \leq maxof(int)
\rightarrow [simplify]
[1.9] -32768 < -\$heap_{724,1;752,8}.p2
\rightarrow [negate goal and search for contradiction]
[1.10]!(-32768 < -\$heap_{724.1:752.8}.p2)
\rightarrow [simplify]
[1.13] 32767 < $heap<sub>724,1;752,8</sub>.p2
[Assume known post-assertion, class invariant or type constraint for term 1.13]
[72.0] $heap<sub>724,1;752,8</sub>.p2 \leq maxof(short int)
\rightarrow [simplify]
[72.9] - 32768 < -\$heap_{724.1:752.8}.p2
\rightarrow [from term 1.13, literala < -$heap<sub>724.1:752.8</sub>.p2 is false whenever -2 <
(32767 + literala)
   Proof of rule precondition:
   [72.9.0] - 2 < (-32768 + 32767)
   \rightarrow [simplify]
   [72.9.2] true
[72.10] false
Proof of verification condition: Type constraint satisfied in explicit
```

Proof of verification condition: Type constraint satisfied in explicit conversion from 'integer' to 'int'

Condition generated at: C:\Escher\Customers\prang\prang.c (69,11)

```
Condition defined at:
To prove: minof(int) \le
static\_cast < integer > (asType < int > (\$heap_{724,1:752.8}.p2) < (int)0)
Given:
heap_{init}.LIMIT == (int)80
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
\theta
\theta
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
\theta = asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
heap_{init}.p3 == asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart\_724,1})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
(asType<integer>(asType<int>($heap_{tuncstart\_724.1}.p1)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
```

 $\begin{array}{l} (\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart_724,1}.\mathrm{p1}) < \\ \mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart_724,1}.\mathrm{a1})) = > \\ (\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart_724,1}.\mathrm{p1}) = = \\ \end{array}$

 $(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart_724,1}.\mathtt{a1}) \leq$

 $asType < integer > (\$heap_{funcstart_724,1}.p1)) => !(0 ==$

asType<integer>(div1.rem))

```
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724.1}.a2))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p2})) \ / \\
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.quot)
(asType<int>(asType<int>($heap_{funcstart\_724,1}.p2)) %
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) = =
asType<integer>(div2.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a2) \le
asType < integer > (\$heap_{funcstart\_724,1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a3}))
(\mathbf{asType} {<} \mathbf{integer} {>} (\mathbf{asType} {<} \mathbf{int} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3})) \ / \\
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.rem)
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a3})) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a3) \le
asType < integer > (\$heap_{funcstart\_724,1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
\rho_{724,1;745,8} == \rho_{funcstart_{724,1}}.\_replace(p1 \rightarrow asType < short)
```

```
int>((asType<int>(asType<short int>(div1.rem)) *
\mathbf{asType} \hspace{-0.1em}<\hspace{-0.1em} \mathbf{int} \hspace{-0.1em}> \hspace{-0.1em} (\$ heap_{funcstart\_724,1}.r1)) - (\mathbf{asType} \hspace{-0.1em}<\hspace{-0.1em} \mathbf{int} \hspace{-0.1em}> \hspace{-0.1em} (\mathbf{asType} \hspace{-0.1em}<\hspace{-0.1em} \mathbf{short})
\mathbf{int}{>}(\mathbf{div1.quot})) * \mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
-asType<integer const>($heap<sub>724.1:745.8</sub>.M1) <
asType < integer > ($heap_{724,1;745,8}.p1)
!(0 == asType < integer > (\$heap_{724,1:745.8}.p1))
asType<integer>($heap<sub>724.1:745.8</sub>.p1) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{M1})
\text{$heap}_{724,1;747,8} == \text{$heap}_{724,1;745,8}.\mathbf{replace}(p2 \to \mathbf{asType} < \mathbf{short})
int>((asType<int>(asType<short int>(div2.rem))
asType < int > (\$heap_{724.1:745.8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType< int>($heap_{724.1:745.8}.b2))))
-asType<integer const>($heap<sub>724,1:747,8</sub>.M2) <
asType<integer>($heap<sub>724,1:747,8</sub>.p2)
!(0 == asType < integer > (\$heap_{724,1:747.8}.p2))
asType<integer>($heap<sub>724,1:747,8</sub>.p2) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;747,8}.\mathrm{M2})
heap_{724,1;749,8} == heap_{724,1;747,8}.replace(p3 \rightarrow asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{724,1;747,8}.\mathrm{r3})) - (\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{short}
int>(div3.quot)) * asType<int>($heap<sub>724.1:747.8</sub>.b3))))
-asType<integer const>($heap<sub>724,1:749,8</sub>.M3) <
asType<integer>($heap<sub>724,1;749,8</sub>.p3)
!(0 == asType < integer > (\$heap_{724,1;749,8}.p3))
asType<integer>($heap<sub>724,1;749,8</sub>.p3) <
asType<integer>($heap<sub>724,1:749,8</sub>.M3)
\text{heap}_{724.1;752.8} == \text{heap}_{724.1;749.8}._replace(p1 \rightarrow asType < short
int>((asType<int>($heap<sub>724,1;749,8</sub>.M1) *
asType<int>(static_cast<integer>(asType<int>($heap<sub>724.1:749.8</sub>.p1) <
(int)(0) + asType<int>($heap<sub>724.1:749.8</sub>.p1)))
Proof:
[Take goal term]
[1.0] minof(int) \leq static_cast<integer>(asType<int>($heap<sub>724.1:752.8</sub>.p2)
< (int)0)
\rightarrow [simplify]
[1.6] -32768 \le ([0 < -\$heap_{724,1:752,8}.p2]: 1, []: 0)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
 [1.7] \ -32768 \le ([0 < -\$heap_{724,1;752,8}.p2] \colon 1, \ [!(0 < -\$heap_{724,1;752,8}.p2)] \colon 0)
```

```
\rightarrow [simplify]
[1.12] -32769 < ([0 < -$heap<sub>724,1:752,8</sub>.p2]: 1, [-1 < $heap<sub>724,1:752,8</sub>.p2]: 0)
\rightarrow [move guard outside expression]
[1.13] ([0 < -$heap<sub>724,1;752,8</sub>.p2]: -32769 < 1, [-1 < $heap<sub>724,1;752,8</sub>.p2]: -32769
< 0)
\rightarrow [simplify]
[1.15] ([0 < -$heap<sub>724,1:752,8</sub>.p2]: true, [-1 < $heap<sub>724,1:752,8</sub>.p2]: true)
\rightarrow [all guards have equal guarded terms]
[1.16] true
Proof of verification condition: Type constraint satisfied in explicit
conversion from 'integer' to 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (69,11)
Condition defined at:
To prove: static_cast<integer>(asType<int>($heap<sub>724.1:752.8</sub>.p2) <
(int)0) \le maxof(int)
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
\theta
heap_{init}.a1 == asType < short int > ((int)177)
\theta = asType < short int > ((int)2)
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta
\theta = asType < short int > ((int)30323)
\theta
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
```

```
invariant1(heapIs heap_{funcstart_{-724.1}})
div1 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(\mathbf{asType} {<} \mathbf{integer} {>} (\mathbf{asType} {<} \mathbf{int} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ \%
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}))) = =
asType<integer>(div1.rem)
(asType<integer>($heap_{funcstart\_724.1}.p1) <
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a1})) = >
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) = =
asType<integer>(div1.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a1}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
(asType<int>(asType<int>($heap_{tuncstart}, 724.1.p2)) /
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))) ==
asType<integer>(div2.rem)
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) ==
asType<integer>(div2.rem))
(asType < integer > (\$heap_{funcstart\_724.1}.a2) \le
asType < integer > (\$heap_{funcstart\_724,1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
```

```
(\mathbf{asType} {<} \mathbf{integer} {>} (\mathbf{asType} {<} \mathbf{int} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3})) \ / \\
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(asType<int>(asType<int>($heap_{funcstart\_724,1}.p3)) %
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
(asType < integer > (\$heap_{funcstart_{724,1}}.a3) \le
asType < integer > (\$heap_{funcstart\_724,1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1.quot})) * \mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
-asType<integer const>($heap_{724,1:745,8}.M1) <
asType<integer>($heap<sub>724.1:745.8</sub>.p1)
!(0 == asType < integer > (\$heap_{724,1:745.8}.p1))
asType<integer>($heap<sub>724.1:745.8</sub>.p1) <
asType<integer>($heap<sub>724,1:745,8</sub>.M1)
\text{$heap}_{724,1;747,8} == \text{$heap}_{724,1;745,8}.\_\textbf{replace}(p2 \to \textbf{asType} < \textbf{short}
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724.1:745.8}.r2)) - (asType < int > (asType < short)
int > (div2.quot)) * asType < int > ($heap_{724,1;745,8}.b2))))
-asType < integer const > (\$heap_{724,1:747,8}.M2) < 
asType<integer>($heap<sub>724,1:747,8</sub>.p2)
!(0 == \mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathrm{heap}_{724,1;747,8}.\mathrm{p2}))
asType < integer > ($heap_{724,1;747,8}.p2) < 
asType<integer>($heap<sub>724,1:747,8</sub>.M2)
\text{Sheap}_{724,1;749,8} == \text{Sheap}_{724,1;747,8}.\text{replace}(p3 \to asType < short)
int>((asType<int>(asType<short int>(div3.rem)) *
asType < int > (\$heap_{724,1;747,8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType< int>($heap_{724,1;747,8}.b3))))
-asType<integer const>($heap<sub>724.1:749.8</sub>.M3) <
asType<integer>($heap<sub>724.1:749.8</sub>.p3)
```

```
!(0 == asType < integer > (\$heap_{724.1:749.8}.p3))
asType<integer>($heap<sub>724.1:749.8</sub>.p3) <
asType<integer>($heap<sub>724,1:749,8</sub>.M3)
heap_{724,1;752,8} == heap_{724,1;749,8}.replace(p1 \rightarrow asType<short
int>((asType<int>($heap<sub>724,1;749,8</sub>.M1) *
asType<int>(static_cast<integer>(asType<int>($heap_{724.1:749.8}.p1) <
(int)(0) + asType < int > ($heap_{724,1:749,8}.p1))
Proof:
[Take goal term]
[1.0] static_cast<integer>(asType<int>($heap_{724,1:752,8}.p2) < (int)0) \leq
maxof(int)
\rightarrow [simplify]
[1.5] ([0 < -$heap<sub>724,1;752,8</sub>.p2]: 1, []: 0) \leq maxof(int)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[1.6] ([0 < -$heap<sub>724,1;752,8</sub>.p2]: 1, [!(0 < -$heap<sub>724,1;752,8</sub>.p2)]: 0) \leq
maxof(int)
\rightarrow [simplify]
[1.11] (-1 + ([0 < -\$heap_{724.1;752.8}.p2]: 1, [-1 < \$heap_{724.1;752.8}.p2]: 0)) < [-1.11]
32767
\rightarrow [move guard outside expression]
[1.12] \; ([0 < -\$heap_{724,1;752,8}.p2] \colon \text{-}1 + 1, \; [\text{-}1 < \$heap_{724,1;752,8}.p2] \colon \text{-}1 + 0) < 0 \leq 0 \leq 0 \leq 0
32767
\rightarrow [simplify]
[1.15] 0 < (32767 + -([0 < -\$heap_{724,1;752,8}.p2]: 0, [-1 < \$heap_{724,1;752,8}.p2]:
-1))
\rightarrow [move guard outside expression]
[1.16] 0 < (32767 + ([0 < -\$heap_{724,1;752,8}.p2]: -0, [-1 < \$heap_{724,1;752,8}.p2]:
--1))
\rightarrow [simplify]
[1.18] \ 0 < (32767 + ([0 < -\$heap_{724,1;752,8}.p2]: \ 0, \ [-1 < \$heap_{724,1;752,8}.p2]:
1))
\rightarrow [move guard outside expression]
[1.19] \ 0 < ([0 < -\$heap_{724,1;752,8}.p2]: 0 + 32767, [-1 < \$heap_{724,1;752,8}.p2]: 1
+32767)
\rightarrow [simplify]
[1.21] 0 < ([0 < -\$heap_{724,1:752,8},p2]: 32767, [-1 < \$heap_{724,1:752,8},p2]: 32768)
```

```
\rightarrow [move guard outside expression]
[1.22] ([0 < -$heap<sub>724.1:752.8</sub>.p2]: 0 < 32767, [-1 < $heap<sub>724.1:752.8</sub>.p2]: 0 <
32768)
\rightarrow [simplify]
[1.24] ([0 < -$heap<sub>724,1:752,8</sub>.p2]: true, [-1 < $heap<sub>724,1:752,8</sub>.p2]: true)
\rightarrow [all guards have equal guarded terms]
[1.25] true
Proof of verification condition: Arithmetic result of operator '*' is within
limit of type 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (69,25)
Condition defined at:
To prove: minof(int) \le (asType < int > (\$heap_{724,1:752.8}.M2) *
\mathbf{asType} < \mathbf{int} > (\mathbf{static\_cast} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{724,1;752,8}.\mathrm{p2}) < \mathsf{nt} > (\$ \mathrm{heap}_{724,1;752,8}.\mathrm{p2}) < \mathsf{nt
(\mathbf{int})(0)
Given:
heap_{init}.LIMIT == (int)80
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta = asType < short int > ((int)2)
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
heap_{init}.b2 == asType<short int>((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
heap_{init}.b3 == asType < short int > ((int)63)
\theta
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart\_724,1})
\mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1},
```

```
asType < int > (\$heap_{funcstart\_724,1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ / \\
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}))) = =
asType<integer>(div1.quot)
(asType < int > (asType < int > (\$heap_{funcstart\_724,1}.p1)) \%
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}))) = =
asType<integer>(div1.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p1) = =
asType<integer>(div1.rem))
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}) \leq
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1})) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.quot)
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}))~\%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a2})) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p2) = =
asType<integer>(div2.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a2) \le
asType < integer > (\$heap_{funcstart\_724,1}.p2)) => !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > ($heap_{funcstart\_724,1}.p3),
asType < int > (\$heap_{funcstart\_724,1}.a3))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724.1}.a3))) = =
```

```
asType<integer>(div3.quot)
(asType<integer>(asType<int>($heap_{tuncstart_724,1}.p3)) %
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart_{-724,1}}.a3)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a3}) \leq
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3})) = > !(0 = =
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
\$heap_{724,1;745,8} == \$heap_{funcstart\_724,1}.\_\mathbf{replace}(p1 \to \mathbf{asType} < \mathbf{short}
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724.1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>(heap_{funcstart\_724,1}.b1)))
-{\bf asType}{<} {\bf integer~const}{>} (\${\rm heap}_{724,1;745,8}.{\rm M1}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{p1})
!(0 == asType < integer > (\$heap_{724,1;745,8}.p1))
asType<integer>($heap<sub>724.1:745.8</sub>.p1) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{M1})
heap_{724,1:747,8} == heap_{724,1:745,8}.replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
\mathbf{asType} < \mathbf{int} > (\$ heap_{724,1:745,8}.r2)) - (\mathbf{asType} < \mathbf{int} > (\mathbf{asType} < \mathbf{short})
int>(div2.quot)) * asType< int>($heap_{724,1;745,8}.b2))))
-asType<integer const>($heap<sub>724.1:747.8</sub>.M2) <
asType<integer>($heap<sub>724.1:747.8</sub>.p2)
!(0 == asType < integer > (\$heap_{724,1:747.8}.p2))
asType<integer>($heap<sub>724.1:747.8</sub>.p2) <
asType<integer>($heap<sub>724.1:747.8</sub>.M2)
heap_{724,1:749,8} == heap_{724,1:747,8}.replace(p3 \rightarrow asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType < int > (\$heap_{724,1:747,8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType< int>($heap_{724,1:747.8}.b3))))
-asType<integer const>($heap<sub>724 1.749 8.</sub>M3) <
asType<integer>($heap<sub>724,1:749,8:p3</sub>)
!(0 == asType < integer > (\$heap_{724,1:749.8}.p3))
asType<integer>($heap<sub>724.1:749.8</sub>.p3) <
```

```
asType<integer>($heap<sub>724.1:749.8</sub>.M3)
heap_{724,1:752,8} == heap_{724,1:749,8}.replace(p1 \rightarrow asType<short
int>((asType<int>($heap<sub>724,1:749,8</sub>.M1) *
asType<int>(static_cast<integer>(asType<int>($heap_{724.1:749.8}.p1) <
(int)(0) + asType<int>($heap<sub>724.1:749.8</sub>.p1)))
Proof:
 [Take goal term]
 [1.0]  minof(int) \leq (asType < int > (\$heap_{724.1:752.8}.M2) *
\mathbf{asType} < \mathbf{int} > (\mathbf{static\_cast} < \mathbf{integer}) < (\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{724,1;752,8}.\mathrm{p2}) < (\$ \mathrm{heap}_{724,1;752,8}.\mathrm{p2})
(int)0)))
\rightarrow [simplify]
 [1.1] -32768 \leq (asType<int>($heap<sub>724.1:752.8</sub>.M2) *
asType<int>(static_cast<integer>(asType<int>($heap_{724.1:752.8}.p2) <
 (int)0)))
 \rightarrow [const static or extern object]
 [1.2] -32768 < (asType < int > (\$heap_{init}.M2) *
\mathbf{asType} < \mathbf{int} > (\mathbf{static\_cast} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{724,1;752,8}.\mathrm{p2}) < \mathsf{nt}) < \mathsf{neger} > (\mathsf{neger} > (\mathsf{neger
(\mathbf{int})(0)
 \rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[1.3] -32768 \leq (asType\leqint>(asType\leqshort int>((int)30307)) *
\mathbf{asType} < \mathbf{int} > (\mathbf{static\_cast} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{724,1;752,8}.\mathrm{p2}) < \mathsf{nt}) < \mathsf{neger} > (\mathsf{neger} > (\mathsf{neger
(int)0)))
 \rightarrow [simplify]
[1.11] -32768 \leq (30307 * asType<int>(([0 < -$heap<sub>724,1;752,8</sub>.p2]: 1, []: 0)))
 → [explicitly assert falsehood of skipped guards in subsequent guards]
[1.12] -32768 \leq (30307 * asType<int>(([0 < -$heap<sub>724,1;752,8</sub>.p2]: 1, [!(0 <
 -\$heap_{724,1:752,8}.p2): 0)))
\rightarrow [simplify]
 [1.16] -32768 \leq (30307 * ([0 < -$heap<sub>724,1;752,8</sub>.p2]: 1, [-1 <
heap_{724,1;752,8}.p2: 0)
\rightarrow [move guard outside expression]
[1.17] - 32768 \le ([0 < -\$heap_{724,1:752,8}.p2]: 1 * 30307, [-1 <
\rho_{724,1;752,8}.p2]: 0 * 30307
\rightarrow [simplify]
[1.21] -32769 < ([0 < -$heap<sub>724,1;752,8</sub>.p2]: 30307, [-1 < $heap<sub>724,1;752,8</sub>.p2]: 0)
\rightarrow [move guard outside expression]
```

```
[1.22] ([0 < -$heap<sub>724,1;752,8</sub>.p2]: -32769 < 30307, [-1 < $heap<sub>724,1;752,8</sub>.p2]:
-32769 < 0
\rightarrow [simplify]
[1.24] ([0 < -$heap<sub>724,1;752,8</sub>.p2]: true, [-1 < $heap<sub>724,1;752,8</sub>.p2]: true)
\rightarrow [all guards have equal guarded terms]
[1.25] true
Proof of verification condition: Arithmetic result of operator '*' is within
limit of type 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (69,25)
Condition defined at:
To prove: (asType<int>($heap<sub>724,1:752,8</sub>.M2) *
\mathbf{asType} < \mathbf{int} > (\mathbf{static\_cast} < \mathbf{integer}) < (\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{724,1;752,8}.\mathrm{p2}) < (\$ \mathrm{heap}_{724,1;752,8}.\mathrm{p2})
(int)(0)) \le maxof(int)
Given:
heap_{init}.LIMIT == (int)80
\theta
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
heap_{init}.M2 == asType < short int > ((int)30307)
\theta_{init}.r2 == asType<short int>((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta sheap<sub>init</sub>.b2 == asType<short int>((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
heap_{init}.b3 == asType < short int > ((int)63)
\theta
\theta
\theta = asType < short int > ((int)3)
invariant
1(heap<br/>Is heap_{funcstart\_724,1})
\mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1},
\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}),
```

```
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
(asType<integer>(asType<int>($heap_{funcstart\_724,1}.p1)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) ==
asType<integer>(div1.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a1) \le
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) = > !(0 = =
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}),
asType < int > (\$heap_{funcstart\_724,1}.a2))
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2})) \ / \\
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heap_{tuncstart}, 724.1.p2)) %
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p2) = =
asType<integer>(div2.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.a2) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p2)) => !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
asType < int > (\$heap_{funcstart\_724,1}.a3))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
```

```
(asType < int > (asType < int > (\$heap_{funcstart\_724,1}.p3)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.rem)
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(asType < integer > (\$heap_{funcstart\_724.1}.p3) = =
asType<integer>(div3.rem))
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a3}) \leq
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})) => !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
heap_{724,1;745,8} == heap_{funcstart\_724,1}.\_replace(p1 \rightarrow asType < short)
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1.quot})) \ * \ \mathbf{asType}{<} \mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
-asType < integer const > (\$heap_{724.1:745.8}.M1) < 
asType < integer > ($heap_{724,1;745,8}.p1)
!(0 == asType < integer > (\$heap_{724,1;745,8}.p1))
asType<integer>($heap<sub>724,1:745,8</sub>.p1) <
asType<integer>($heap<sub>724.1:745.8</sub>.M1)
\text{heap}_{724.1:747.8} == \text{heap}_{724.1:745.8}._replace(p2 \rightarrow asType<short)
int>((asType<int>(asType<short int>(div2.rem))
asType < int > (\$heap_{724,1:745,8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724,1:745,8</sub>.b2))))
-asType < integer\ const > (\$heap_{724,1;747,8}.M2) < 1
\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{724,1;747,8}.\mathrm{p2})
!(0 == asType < integer > (\$heap_{724,1:747.8}.p2))
asType<integer>($heap<sub>724.1:747.8</sub>.p2) <
asType<integer>($heap<sub>724.1:747.8</sub>.M2)
\text{$heap}_{724,1;749,8} == \text{$heap}_{724,1;747,8}.\mathbf{replace}(p3 \to \mathbf{asType} < \mathbf{short}
int>((asType<int>(asType<short int>(div3.rem)) *
\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{724,1;747,8}.\mathrm{r3})) - (\mathbf{asType} < \mathbf{int} > (\mathbf{asType} < \mathbf{short}))
int>(div3.quot)) * asType<int>($heap<sub>724.1:747.8</sub>.b3))))
-asType<integer const>($heap_{724,1:749,8}.M3) <
asType<integer>($heap<sub>724,1:749,8</sub>.p3)
!(0 == asType < integer > (\$heap_{724,1;749,8}.p3))
asType<integer>($heap<sub>724,1:749,8</sub>.p3) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;749,8}.\mathrm{M3})
```

```
heap_{724,1;752,8} == heap_{724,1;749,8}.replace(p1 \rightarrow asType<short
int>((asType<int>($heap<sub>724,1:749,8</sub>.M1) *
asType<int>(static_cast<integer>(asType<int>($heap_{724,1:749,8}.p1) <
(int)(0) + asType<int>($heap<sub>724,1:749,8</sub>.p1)))
Proof:
[Take goal term]
[1.0] (asType<int>($heap<sub>724,1:752.8</sub>.M2) *
\mathbf{asType} < \mathbf{int} > (\mathbf{static\_cast} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{724,1:752.8}.\mathrm{p2}) < \mathsf{nt}) < \mathsf{neget} > \mathsf{
(int)(0)) \le maxof(int)
\rightarrow [const static or extern object]
[1.1] (asType<int>($heap<sub>init</sub>.M2) *
asType<int>(static_cast<integer>(asType<int>($heap_{724,1:752,8}.p2) <
(int)(0)) \le maxof(int)
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[1.2] (asType<int>(asType<short int>((int)30307)) *
\mathbf{asType} < \mathbf{int} > (\mathbf{static\_cast} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{724,1;752,8}.\mathrm{p2}) < \mathsf{nt})
(int)(0)) \le maxof(int)
\rightarrow [simplify]
[1.10] (30307 * asType<int>(([0 < -$heap<sub>724,1;752,8</sub>.p2]: 1, []: 0))) \leq
maxof(int)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[1.11] (30307 * asType<int>(([0 < -$heap<sub>724,1;752,8</sub>.p2]: 1, [!(0 <
-\$heap_{724,1:752,8}.p2): 0))) \le maxof(int)
\rightarrow [simplify]
[1.15] (30307 * ([0 < -$heap<sub>724,1;752,8</sub>.p2]: 1, [-1 < $heap<sub>724,1;752,8</sub>.p2]: 0)) \leq
maxof(int)
\rightarrow [move guard outside expression]
[1.16] ([0 < -$heap<sub>724,1;752,8</sub>.p2]: 1 * 30307, [-1 < $heap<sub>724,1;752,8</sub>.p2]: 0 *
30307) \leq \maxof(int)
\rightarrow [simplify]
[1.20] (-1 + ([0 < -$heap<sub>724.1:752.8</sub>.p2]: 30307, [-1 < $heap<sub>724.1:752.8</sub>.p2]: 0)) <
32767
\rightarrow [move guard outside expression]
[1.21] ([0 < -$heap<sub>724,1:752,8</sub>.p2]: -1 + 30307, [-1 < $heap<sub>724,1:752,8</sub>.p2]: -1 +
0) < 32767
\rightarrow [simplify]
[1.24] 0 < (32767 + -([0 < -\$heap_{724,1;752,8}.p2]: 30306, [-1 < -\$heap_{724,1;752,8}.p2])
```

```
heap_{724,1;752,8}.p2: -1))
\rightarrow [move guard outside expression]
[1.25] 0 < (32767 + ([0 < -\$heap_{724,1:752.8}.p2]: -30306, [-1 <
heap_{724,1;752,8}.p2: --1)
\rightarrow [simplify]
[1.27] 0 < (32767 + ([0 < -\$heap_{724,1;752,8}.p2]): -30306, [-1 < -\$heap_{724,1;752,8}.p2]
heap_{724,1;752,8}.p2: 1)
\rightarrow [move guard outside expression]
[1.28] 0 < ([0 < -\$heap_{724,1;752,8}.p2]: -30306 + 32767, [-1 < -30306])
heap_{724,1;752,8}.p2: 1 + 32767)
\rightarrow [simplify]
[1.30] 0 < ([0 < -\$heap_{724,1:752,8}.p2]: 2461, [-1 < \$heap_{724,1:752,8}.p2]: 32768)
\rightarrow [move guard outside expression]
[1.31] ([0 < -$heap<sub>724,1:752,8</sub>.p2]: 0 < 2461, [-1 < $heap<sub>724,1:752,8</sub>.p2]: 0 <
32768)
\rightarrow [simplify]
[1.33] ([0 < -$heap<sub>724,1:752,8</sub>.p2]: true, [-1 < $heap<sub>724,1:752,8</sub>.p2]: true)
\rightarrow [all guards have equal guarded terms]
[1.34] true
Proof of verification condition: Type constraint satisfied in implicit
conversion from 'short int' to 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (69,5)
Condition defined at:
To prove: minof(int) \le \$heap_{724,1;752,8}.p2
Given:
heap_{init}.LIMIT == (int)80
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
```

```
\theta sheap<sub>init</sub>.b2 == asType<short int>((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
heap_{init}.b3 == asType < short int > ((int)63)
\theta
\theta
\theta = asType < short int > ((int)3)
invariant
1(heap<br/>Is \theta_{funcstart\_724,1}
div1 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ / \ 
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(asType < integer > ($heap_{funcstart\_724,1}.p1) < 
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) ==
asType<integer>(div1.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathtt{a1}) \leq
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1})) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p2})) \ / \\
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))) ==
asType<integer>(div2.quot)
(asType < integer > (asType < int > (\$heap_{tuncstart\_724.1}.p2)) \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.rem)
(asType<integer>($heap_{tuncstart\_724,1}.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
```

```
(asType < integer > (\$heap_{funcstart_{-724,1}}.p2) = =
asType<integer>(div2.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a2) \le
asType < integer > (\$heap_{funcstart\_724,1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
(asType<int>(asType<int>($heap_{tuncstart\_724.1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}))~\%
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a3}))) = =
asType<integer>(div3.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3})) =>
(asType < integer > ($heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a3) \le
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})) => !(0 ==
asType<integer>(div3.quot))
!(0 == asTvpe < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
\$heap_{724,1;745,8} == \$heap_{funcstart\_724,1}.\_\textbf{replace}(p1 \rightarrow \textbf{asType} < \textbf{short}
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{tuncstart\_724.1}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1}.\mathbf{quot})) * \mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
-{\bf asType}{<} {\bf integer~const}{>} (\${\rm heap}_{724,1;745,8}.{\rm M1}) <
asType<integer>($heap<sub>724,1:745,8</sub>.p1)
!(0 == asType < integer > (\$heap_{724,1:745.8}.p1))
asType<integer>($heap<sub>724.1:745.8</sub>.p1) <
asType<integer>($heap<sub>724.1:745.8</sub>.M1)
\text{sheap}_{724,1;747,8} == \text{sheap}_{724,1;745,8}.\text{-replace}(p2 \to asType < short)
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724,1;745,8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType< int>($heap_{724,1:745,8}.b2))))
-asType < integer const > (\$heap_{724,1:747.8}.M2) < 
asType<integer>($heap<sub>724.1:747.8</sub>.p2)
```

```
!(0 == asType < integer > (\$heap_{724.1:747.8}.p2))
asType<integer>($heap<sub>724.1:747.8</sub>.p2) <
asType<integer>($heap<sub>724,1:747,8</sub>.M2)
$heap_{724,1;749,8} == $heap_{724,1;747,8}.$_{replace}(p3 \rightarrow asType < short)
int>((asType<int>(asType<short int>(div3.rem)) *
asType < int > (\$heap_{724.1:747.8}.r3)) - (asType < int > (asType < short)
\mathbf{int}{>}(\text{div3.quot})) \ * \ \mathbf{asType}{<} \mathbf{int}{>} (\$\text{heap}_{724,1;747,8}.\text{b3}))))
-asType < integer\ const > (\$heap_{724,1;749,8}.M3) < 100
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;749,8}.\mathrm{p3})
!(0 == asType < integer > (\$heap_{724,1:749.8}.p3))
\mathbf{asType}{<}\mathbf{integer}{>}(\$ heap_{724,1;749,8}.p3) <
asType<integer>($heap<sub>724,1:749,8</sub>.M3)
\text{heap}_{724.1:752.8} == \text{heap}_{724.1:749.8}._replace(p1 \rightarrow asType<short)
int>((asType<int>($heap<sub>724.1:749.8</sub>.M1) *
\mathbf{asType} < \mathbf{int} > (\mathbf{static\_cast} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{724,1;749,8}.\mathrm{p1}) < \mathsf{nt}) < \mathsf{nt} > \mathsf{nt} >
(int)(0)) + asType < int > (\$heap_{724,1;749,8}.p1)))
Proof:
[Take goal term]
[1.0] minof(int) \leq $heap<sub>724,1:752,8</sub>.p2
\rightarrow [simplify]
[1.3] -32769 < $heap<sub>724,1;752,8</sub>.p2
\rightarrow [negate goal and search for contradiction]
[1.4]!(-32769 < \text{$heap}_{724.1:752.8}.p2)
\rightarrow [simplify]
[1.6] 32768 < -$heap<sub>724.1:752.8</sub>.p2
[Assume known post-assertion, class invariant or type constraint for term 1.6]
[72.0] minof(short int) \leq $heap<sub>724,1:752,8</sub>.p2
\rightarrow [simplify]
[72.3] -32769 < heap_{724,1;752,8}.p2
\rightarrow [from term 1.6, literala < $heap<sub>724.1:752.8</sub>.p2 is false whenever -2 < (32768)
+ literala)]
            Proof of rule precondition:
            [72.3.0] - 2 < (-32769 + 32768)
            \rightarrow [simplify]
            [72.3.2] true
```

[72.4] false

```
Proof of verification condition: Type constraint satisfied in implicit
conversion from 'short int' to 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (69,5)
Condition defined at:
To prove: $heap_{724,1;752,8}.p2 \le maxof(int)
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
heap_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta
heap_{init}.M2 == asType < short int > ((int)30307)
\rho_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta
\theta sheap<sub>init</sub>.M3 == asType<short int>((int)30323)
\theta
heap_{init}.a3 == asType < short int > ((int)178)
heap_{init}.b3 == asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart_{724,1}})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}),
asType < int > (\$heap_{funcstart_{-724,1}}.a1))
(asType<integer>(asType<int>($heap_{tuncstart}, 724,1.p1)) /
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}))) = =
asType<integer>(div1.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(asType < integer > ($heap_{funcstart\_724,1}.p1) <
```

```
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a1})) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) ==
asType<integer>(div1.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a1}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart_{-724,1}}.a2))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.quot)
(asType<int>(asType<int>($heap_{tuncstart\_724.1}.p2)) %
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p2) = =
asType<integer>(div2.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.a2) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724.1}.p3),
asType < int > (\$heap_{funcstart\_724,1}.a3))
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})) \ / \\
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathtt{a3}))) ==
asType<integer>(div3.quot)
(asType<integer>(asType<int>($heap_{tuncstart\_724.1}.p3)) %
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a3}))) = =
asType<integer>(div3.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(asType < integer > ($heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a3}) \leq
```

```
asType < integer > (\$heap_{funcstart\_724,1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
-asType<integer const>($heap<sub>724,1:745,8</sub>.M1) <
asType<integer>($heap<sub>724.1:745.8</sub>.p1)
!(0 == asType < integer > (\$heap_{724,1;745,8}.p1))
asType < integer > (\$heap_{724,1;745,8}.p1) <
asType<integer>($heap<sub>724,1:745,8</sub>.M1)
\text{heap}_{724.1:747.8} == \text{heap}_{724.1:745.8}._replace(p2 \rightarrow asType<short)
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724,1;745,8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType< int>($heap_{724,1;745,8}.b2))))
-asType<integer const>($heap<sub>724.1:747.8</sub>.M2) <
asType<integer>($heap<sub>724.1:747.8</sub>.p2)
!(0 == asType < integer > (\$heap_{724,1;747,8}.p2))
asType<integer>($heap<sub>724,1:747,8</sub>.p2) <
asType<integer>($heap<sub>724,1:747,8</sub>.M2)
heap_{724,1:749.8} == heap_{724,1:747.8}._replace(p3 \rightarrow asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType < int > (\$heap_{724.1:747.8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType< int>($heap_{724,1;747,8}.b3))))
-asType < integer const > (\$heap_{724,1:749,8}.M3) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;749,8}.\mathrm{p3})
!(0 == asType < integer > (\$heap_{724,1;749,8}.p3))
asType<integer>($heap<sub>724,1:749,8</sub>.p3) <
asType<integer>($heap<sub>724.1:749.8</sub>.M3)
\text{heap}_{724.1;752.8} == \text{heap}_{724.1;749.8}._replace(p1 \rightarrow asType<short)
int>((asType<int>($heap<sub>724.1:749.8</sub>.M1) *
\mathbf{asType} < \mathbf{int} > (\mathbf{static\_cast} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{724,1;749,8}.\mathrm{p1}) < \mathsf{nt}) < \mathsf{nt} > \mathsf{nt} >
(int)(0) + asType < int > (\$heap_{724,1:749.8}.p1))
Proof:
[Take goal term]
[1.0] $\text{heap}_{724.1:752.8}.p2 \leq \text{maxof(int)}
```

```
\rightarrow [simplify]
[1.9] -32768 < -$heap<sub>724,1;752,8</sub>.p2
→ [negate goal and search for contradiction]
[1.10]!(-32768 < -\$heap_{724,1:752.8}.p2)
\rightarrow [simplify]
[1.13] 32767 < heap_{724,1;752,8}.p2
[Assume known post-assertion, class invariant or type constraint for term 1.13]
[72.0] $heap<sub>724.1:752.8</sub>.p2 \leq maxof(short int)
\rightarrow [simplify]
[72.9] \ \hbox{-}32768 < -\$ \mathrm{heap}_{724,1;752,8}.\mathrm{p2}
\rightarrow [from term 1.13, literala < –$heap_{724,1;752,8}.p2 is false whenever -2 <
(32767 + literala)
   Proof of rule precondition:
   [72.9.0] - 2 < (-32768 + 32767)
   \rightarrow [simplify]
   [72.9.2] true
[72.10] false
Proof of verification condition: Type constraint satisfied in implicit
conversion from 'int' to 'short int'
Condition generated at: C:\Escher\Customers\prang\prang.c (69,8)
Condition defined at:
To prove: minof(short int) \le ((asType < int > (\$heap_{724.1:752.8}.M2) *
asType<int>(static_cast<integer>(asType<int>($heap<sub>724.1:752.8</sub>.p2) <
(int)(0) + asType<int>($heap<sub>724,1:752,8</sub>.p2))
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta
heap_{init}.M2 == asType < short int > ((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
```

```
\theta sheap<sub>init</sub>.b2 == asType<short int>((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
heap_{init}.b3 == asType < short int > ((int)63)
\theta
\theta
\theta = asType < short int > ((int)3)
invariant
1(heap<br/>Is \theta_{funcstart\_724,1}
div1 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(\mathbf{asType} {<} \mathbf{integer} {>} (\mathbf{asType} {<} \mathbf{int} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ / \\
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))) = =
asType<integer>(div1.quot)
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(asType < integer > ($heap_{funcstart\_724,1}.p1) < 
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) ==
asType<integer>(div1.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathtt{a1}) \leq
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1})) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p2})) \ / \\
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))) ==
asType<integer>(div2.quot)
(asType < integer > (asType < int > (\$heap_{tuncstart\_724.1}.p2)) \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.rem)
(asType<integer>($heap_{tuncstart\_724,1}.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
```

```
(asType < integer > (\$heap_{funcstart_{-724,1}}.p2) = =
asType<integer>(div2.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a2) \le
asType < integer > (\$heap_{funcstart\_724,1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
(asType<int>(asType<int>($heap_{tuncstart\_724.1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}))~\%
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a3}))) = =
asType<integer>(div3.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3})) =>
(asType < integer > ($heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a3) \le
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})) => !(0 ==
asType<integer>(div3.quot))
!(0 == asTvpe < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
\$heap_{724,1;745,8} == \$heap_{funcstart\_724,1}.\_\textbf{replace}(p1 \rightarrow \textbf{asType} < \textbf{short}
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{tuncstart\_724.1}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1}.\mathbf{quot})) * \mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
-{\bf asType}{<} {\bf integer~const}{>} (\${\rm heap}_{724,1;745,8}.{\rm M1}) <
asType<integer>($heap<sub>724,1:745,8</sub>.p1)
!(0 == asType < integer > (\$heap_{724,1:745.8}.p1))
asType<integer>($heap<sub>724.1:745.8</sub>.p1) <
asType<integer>($heap<sub>724.1:745.8</sub>.M1)
\text{sheap}_{724,1;747,8} == \text{sheap}_{724,1;745,8}.\text{-replace}(p2 \to asType < short)
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724,1;745,8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType< int>($heap_{724,1:745,8}.b2))))
-asType < integer const > (\$heap_{724,1:747.8}.M2) < 
asType<integer>($heap<sub>724.1:747.8</sub>.p2)
```

```
!(0 == asType < integer > (\$heap_{724,1:747.8}.p2))
asType<integer>($heap<sub>724.1:747.8</sub>.p2) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;747,8}.\mathrm{M2})
heap_{724,1;749,8} == heap_{724,1;747,8}.replace(p3 \rightarrow asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType < int > (\$heap_{724.1:747.8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap<sub>724,1:747,8</sub>.b3))))
-asType<integer const>($heap<sub>724,1:749,8</sub>.M3) <
asType<integer>($heap<sub>724,1:749,8</sub>.p3)
!(0 == asType < integer > (\$heap_{724,1;749,8}.p3))
asType<integer>($heap<sub>724,1:749,8</sub>.p3) <
asType<integer>($heap<sub>724,1:749,8</sub>.M3)
\text{heap}_{724.1:752.8} == \text{heap}_{724.1:749.8}._replace(p1 \rightarrow asType<short)
int>((asType<int>($heap<sub>724.1:749.8</sub>.M1) *
asType<int>(static_cast<integer>(asType<int>($heap<sub>724.1:749.8</sub>.p1) <
(int)(0)) + asType < int > (\$heap_{724,1;749,8}.p1)))
Proof:
[Take goal term]
[1.0] minof(short int) \le ((asType < int > (\$heap_{724,1:752.8}.M2) *
asType<int>(static_cast<integer>(asType<int>($heap<sub>724,1:752.8</sub>.p2) <
(int)(0)) + asType < int > ($heap_{724,1:752,8}.p2))
\rightarrow [simplify]
[1.1] -32768 \leq ((asType<int>($heap_{724,1;752,8}.M2) *
asType<int>(static_cast<integer>(asType<int>($heap_{724,1:752,8}.p2) <
(int)(0) + asType<int>($heap<sub>724,1:752,8</sub>.p2))
\rightarrow [const static or extern object]
[1.2] -32768 \le ((asType < int > (\$heap_{init}.M2) *
asType<int>(static_cast<integer>(asType<int>($heap_{724,1:752,8}.p2) <
(int)(0)) + asType < int > ($heap_{724,1;752,8}.p2))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[1.3] -32768 \leq ((asType\leqint>(asType\leqshort int>((int)30307)) *
\mathbf{asType} < \mathbf{int} > (\mathbf{static\_cast} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{724,1;752,8}.\mathrm{p2}) < \mathsf{nt}) < \mathsf{neger} > (\mathsf{neger} > (\mathsf{neger
(int)(0) + asType<int>($heap<sub>724,1:752,8</sub>.p2))
\rightarrow [simplify]
[1.11] -32768 \leq ((30307 * asType<int>(([0 < -$heap<sub>724,1;752,8</sub>.p2]: 1, []: 0)))
+ asType < int > (\$heap_{724,1;752,8}.p2))
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[1.12] -32768 \leq ((30307 * asType<int>(([0 < -$heap_{724,1;752,8}.p2]: 1, [!(0 < -$heap_{724,1;752,8}.p2]: 1)
```

```
-\text{$heap}_{724,1;752,8}.p2): 0))) + asType<int>($heap}_{724,1;752,8}.p2))
\rightarrow [simplify]
\mbox{\it [1.16]} -32768 \leq ((30307 * ([0 < -$heap_{724,1;752,8}.p2]: 1, [-1 < -$hea
\text{sheap}_{724,1;752,8}.\text{p2}: 0) + \mathbf{asType} < \mathbf{int} > (\text{sheap}_{724,1;752,8}.\text{p2}))
\rightarrow [move guard outside expression]
[1.17] -32768 \leq (([0 < -\$heap_{724,1;752,8}.p2]: 1 * 30307, [-1 < -\$heap_{724,1;752,8}.p2])
\rho_{724,1;752,8} = 0 * 30307 + asType < int > (\rho_{724,1;752,8} = 0)
\rightarrow [simplify]
 [1.20] \ -32768 \leq (([0 < -\$heap_{724,1;752,8}.p2]: \ 30307, \ [-1 < \$heap_{724,1;752,8}.p2]: \ 30307, \ [-1] < \Sheap_{724,1;752,8}.p2]: \ 30307, \ [-1]
0) + \text{$heap}_{724,1:752.8}.p2)
\rightarrow [move guard outside expression]
[1.21] -32768 \leq ([0 < -$heap<sub>724,1;752,8</sub>.p2]: 30307 + $heap<sub>724,1;752,8</sub>.p2, [-1 <
heap_{724,1;752,8}.p2: 0 + p_{724,1;752,8}.p2
\rightarrow [simplify]
[1.24] -32769 < ([0 < -$heap<sub>724,1;752,8</sub>.p2]: 30307 + $heap<sub>724,1;752,8</sub>.p2, [-1 <
$heap<sub>724,1:752,8</sub>.p2]: $heap<sub>724,1:752,8</sub>.p2)
\rightarrow [move guard outside expression]
[1.25] ([0 < -$heap<sub>724,1:752,8</sub>.p2]: -32769 < (30307 + $heap<sub>724,1:752,8</sub>.p2), [-1 <
\text{sheap}_{724,1;752,8}.\text{p2}: -32769 < \text{sheap}_{724,1;752,8}.\text{p2}
\rightarrow [simplify]
[1.27] ([0 < -$heap<sub>724,1;752,8</sub>.p2]: -63076 < $heap<sub>724,1;752,8</sub>.p2, [-1 <
\rho_{724,1;752,8}.p2: -32769 < \rho_{724,1;752,8}.p2
\rightarrow [from guard, literala < $heap<sub>724,1;752,8</sub>.p2 is true whenever (-1 + literala) <
-1]
            Proof of rule precondition:
            [1.27.0](-32769 + -1) < -1
            \rightarrow [simplify]
            [1.27.2] true
[1.28] ([0 < -$heap<sub>724.1:752.8</sub>.p2]: -63076 < $heap<sub>724.1:752.8</sub>.p2, [-1 <
$heap<sub>724,1;752,8</sub>.p2]: true)
\rightarrow [negate goal and search for contradiction]
[1.29]!([0 < -\$heap_{724,1;752,8}.p2]: -63076 < \$heap_{724,1;752,8}.p2, [-1 < -63076]: -63076 < \$heap_{724,1;752,8}.p2
$heap<sub>724,1;752,8</sub>.p2]: true)
\rightarrow [move guard outside expression]
[1.30] ([0 < -$heap<sub>724,1;752,8</sub>.p2]: !(-63076 < $heap<sub>724,1;752,8</sub>.p2), [-1 <
$heap<sub>724,1;752,8</sub>.p2|: !true)
```

```
\rightarrow [simplify]
[1.35] (0 < -$heap<sub>724,1:752,8</sub>.p2) \wedge (63075 < -$heap<sub>724,1:752,8</sub>.p2)
[Work on sub-term 2 of conjunction in term 1.35]
[72.0] 63075 < -$heap<sub>724.1:752.8</sub>.p2
[Assume known post-assertion, class invariant or type constraint for term 1.35]
[73.0] minof(short int) \leq $heap<sub>724,1;752,8</sub>.p2
\rightarrow [simplify]
[73.3] -32769 < \text{$heap}_{724.1:752.8}.p2
\rightarrow [from term 72.0, literala < $heap<sub>724,1;752,8</sub>.p2 is false whenever -2 < (63075
+ literala)]
         Proof of rule precondition:
         [73.3.0] - 2 < (-32769 + 63075)
         \rightarrow [simplify]
         [73.3.2] true
[73.4] false
Proof of verification condition: Type constraint satisfied in implicit
conversion from 'int' to 'short int'
Condition generated at: C:\Escher\Customers\prang\prang.c (69,8)
Condition defined at:
To prove: ((asType<int>($heap<sub>724,1;752,8</sub>.M2) *
\mathbf{asType} < \mathbf{int} > (\mathbf{static\_cast} < \mathbf{integer}) < (\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{724,1:752.8}.\mathrm{p2}) < (\$ \mathrm{heap}_{724,1:752.8}.\mathrm{p2})
(int)(0) + asType<int>($heap<sub>724,1:752,8</sub>.p2)) \leq maxof(short int)
Given:
heap_{init}.LIMIT == (int)80
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
heap_{init}.M2 == asType < short int > ((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
```

```
\rho_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType<short int>((int)178)
heap_{init}.b3 == asType < short int > ((int)63)
\theta
\theta
heap_{init}.p3 == asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart_724,1})
div1 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ / \ 
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))) = =
asType<integer>(div1.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p1) = =
asType<integer>(div1.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a1) \le
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}))\ /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heap_{funcstart\_724.1}.p2)) %
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p2) = =
asType<integer>(div2.rem))
```

```
(asType < integer > (\$heap_{funcstart_{-724,1}}.a2) \le
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2})) = > !(0 = =
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1} \cdot \mathbf{p3})) \ / \\
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(asType<integer>(asType<int>($heap_{tuncstart\_724.1}.p3)) %
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.rem)
(asType<integer>($heap_funcstart_724.1.p3) <
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(asType < integer > ($heap_{funcstart\_724.1}.p3) = =
asType<integer>(div3.rem))
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a3}) \leq
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})) => !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
heap_{724,1;745,8} == heap_{funcstart\_724,1}.\_replace(p1 \rightarrow asType < short)
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
-asType<integer const>($heap<sub>724 1.745 8</sub>.M1) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{p1})
!(0 == asType < integer > (\$heap_{724,1:745.8} \cdot p1))
asType<integer>($heap<sub>724,1:745,8</sub>.p1) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{M1})
\rho_{724,1:747.8} == \rho_{724,1:745.8} replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div2.rem))
asType < int > (\$heap_{724,1:745,8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType< int>($heap_{724,1;745,8}.b2))))
-asType < integer\ const > (\$heap_{724,1;747,8}.M2) < 
asType < integer > ($heap_{724,1;747,8}.p2)
!(0 == asType < integer > (\$heap_{724,1;747,8}.p2))
```

```
asType<integer>($heap<sub>724.1:747.8</sub>.p2) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;747,8}.\mathrm{M2})
heap_{724,1:749,8} == heap_{724,1:747,8}.replace(p3 \rightarrow asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType < int > (\$heap_{724.1:747.8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap_{724,1;747,8}.b3))))
 -asType < integer const > (\$heap_{724,1:749.8}.M3) < 
asType<integer>($heap<sub>724.1:749.8</sub>.p3)
!(0 == asType < integer > (\$heap_{724,1:749.8}.p3))
asType<integer>($heap<sub>724.1:749.8</sub>.p3) <
asType < integer > (\$heap_{724,1;749,8}.M3)
\text{sheap}_{724,1;752,8} == \text{sheap}_{724,1;749,8}. \text{replace}(\text{p1} \to \text{asType} < \text{short})
int>((asType<int>($heap<sub>724,1:749,8</sub>.M1) *
\mathbf{asType} < \mathbf{int} > (\mathbf{static\_cast} < \mathbf{integer}) < (\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{724,1:749.8}.\mathrm{p1}) < (\$ \mathrm{heap}_{724,1:749.8}.\mathrm{p1})
(int)(0) + asType < int > ($heap_{724.1:749.8}.p1)))
Proof:
[Take goal term]
[1.0] ((asType<int>($heap<sub>724.1:752.8</sub>.M2) *
asType<int>(static_cast<integer>(asType<int>($heap<sub>724.1:752.8</sub>.p2) <
(\mathbf{int})(0) + \mathbf{asType} < \mathbf{int} > (\$ heap_{724,1;752,8}.p2)) \le \mathbf{maxof}(\mathbf{short\ int})
\rightarrow [const static or extern object]
[1.1] ((asType<int>($heap<sub>init</sub>.M2) *
\mathbf{asType} < \mathbf{int} > (\mathbf{static\_cast} < \mathbf{integer}) < (\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{724,1;752,8}.\mathrm{p2}) < (\$ \mathrm{heap}_{724,1;752,8}.\mathrm{p2})
(int)(0)) + asType < int > (\$heap_{724,1:752.8}.p2)) \le maxof(short int)
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[1.2] ((asType<int>(asType<short int>((int)30307)) *
asType<int>(static_cast<integer>(asType<int>($heap<sub>724.1:752.8</sub>.p2) <
(int)(0) + asType<int>($heap<sub>724.1:752.8</sub>.p2)) \leq maxof(short int)
\rightarrow [simplify]
[1.10] ((30307 * asType<int>(([0 < -$heap_{724,1;752,8}.p2]: 1, []: 0))) +
asType < int > (\$heap_{724,1;752,8}.p2)) \le maxof(short int)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[1.11] ((30307 * asType<int>(([0 < -$heap_{724,1:752,8}.p2]: 1, [!(0 < -$heap_{724,1:752,8}.p2]: 1)
-\text{$heap}_{724,1;752,8}.p2): 0))) + asType<int>($heap}_{724,1;752,8}.p2)) \le \text{9}
maxof(short int)
\rightarrow [simplify]
[1.15] ((30307 * ([0 < -$heap<sub>724,1:752,8</sub>.p2]: 1, [-1 < $heap<sub>724,1:752,8</sub>.p2]: 0)) +
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{724,1;752,8}.\mathrm{p2})) \leq \mathbf{maxof}(\mathbf{short}\ \mathbf{int})
```

```
\rightarrow [move guard outside expression]
[1.16] (([0 < -$heap<sub>724,1:752,8</sub>.p2]: 1 * 30307, [-1 < $heap<sub>724,1:752,8</sub>.p2]: 0 *
30307) + asType < int > (\$heap_{724,1;752,8}.p2)) \le maxof(short int)
\rightarrow [simplify]
[1.19] (([0 < -$heap<sub>724,1:752,8</sub>.p2]: 30307, [-1 < $heap<sub>724,1:752,8</sub>.p2]: 0) +
$heap_{724,1:752,8}.p2) \le maxof(short int)
\rightarrow [move guard outside expression]
[1.20] ([0 < -$heap<sub>724,1:752,8</sub>.p2]: 30307 + $heap<sub>724,1:752,8</sub>.p2, [-1 <
\text{sheap}_{724,1;752,8}.p2: 0 + \text{sheap}_{724,1;752,8}.p2) \leq \max(\text{short int})
\rightarrow [simplify]
[1.23] (-1 + ([0 < -$heap<sub>724,1;752,8</sub>.p2]: 30307 + $heap<sub>724,1;752,8</sub>.p2, [-1 <
heap_{724,1;752,8}.p2: p_{724,1;752,8}.p2: p_{724,1;752,8}.p2:
\rightarrow [move guard outside expression]
[1.24] ([0 < -$heap<sub>724,1;752,8</sub>.p2]: -1 + (30307 + $heap<sub>724,1;752,8</sub>.p2), [-1 <
\text{heap}_{724,1;752,8}.\text{p2}: -1 + \text{heap}_{724,1;752,8}.\text{p2}) < 32767
\rightarrow [simplify]
[1.27] 0 < (32767 + -([0 < -\$heap_{724.1:752.8}.p2]: 30306 + \$heap_{724.1:752.8}.p2]
[-1 < \text{$heap}_{724.1:752.8}.p2]: -1 + \text{$heap}_{724.1:752.8}.p2))
\rightarrow [move guard outside expression]
[1.28] 0 < (32767 + ([0 < -\$heap_{724,1;752,8}.p2]): -(30306 + (32767 + ([0 < -\$heap_{724,1;752,8}.p2])): -(30306 + ([0 < -\$heap_{724,1;752,8}.p2]))]
\rho_{724,1;752,8}, p2), [-1 < \rho_{724,1;752,8}, p2]: -(-1 + \rho_{724,1;752,8}, p2)))
\rightarrow [simplify]
[1.32] \ 0 < (32767 + ([0 < -\$heap_{724,1;752,8}.p2]: -30306 + -\$heap_{724,1;752,8}.p2];
[-1 < \text{$heap}_{724,1;752,8}.p2]: 1 + -\text{$heap}_{724,1;752,8}.p2))
\rightarrow [move guard outside expression]
[1.33]\ 0 < ([0 < -\$heap_{724,1:752,8}.p2]:\ 32767 + (-30306 + -\$heap_{724,1:752,8}.p2),
[-1 < \text{$heap}_{724,1;752,8}.p2]: 32767 + (1 + -\text{$heap}_{724,1;752,8}.p2))
\rightarrow [simplify]
[1.37] \ 0 < ([0 < -\$heap_{724,1;752,8}.p2]: \ 2461 + -\$heap_{724,1;752,8}.p2, \ [-1 < -\$heap_{724,1;752,8}.p2]: \ 2461 + -\$heap_{724,1;752,8}.p2 < [-1 < -\Sheap_{724,1;752,8}.p2]: \ 2461 + -\$heap_{724,1;752,8}.p2 < [-1 < -\Sheap_{724,1;752,8}.p2]: \ 2461 + -\$heap_{724,1;752,8}.p2 < [-1 < -\Sheap_{724,1;752,8}.p2]: \ 2461 + -\Sheap_{724,1;752,8}.p2 < [-1 < -\Sheap_{724,1;
heap_{724,1;752,8}.p2: 32768 + -heap_{724,1;752,8}.p2
\rightarrow [move guard outside expression]
[1.38] ([0 < -$heap<sub>724,1:752,8</sub>.p2]: 0 < (2461 + -$heap<sub>724,1:752,8</sub>.p2), [-1 <
\text{heap}_{724,1:752,8}.p2: 0 < (32768 + -\text{heap}_{724,1:752,8}.p2))
\rightarrow [simplify]
[1.40] ([0 < -$heap<sub>724.1:752.8</sub>.p2]: -2461 < -$heap<sub>724.1:752.8</sub>.p2, [-1 <
\text{sheap}_{724,1;752,8}.\text{p2}: 0 < (32768 + -\text{sheap}_{724,1;752,8}.\text{p2})
```

```
< 0
    Proof of rule precondition:
    [1.40.0](-2461 + -1) < 0
    \rightarrow [simplify]
    [1.40.2] true
[1.41] ([0 < -$heap<sub>724,1:752,8</sub>.p2]: true, [-1 < $heap<sub>724,1:752,8</sub>.p2]: 0 < (32768)
+ - \text{$heap}_{724,1;752,8}.p2))
\rightarrow [simplify]
[1.43] ([0 < -$heap<sub>724,1:752,8</sub>.p2]: true, [-1 < $heap<sub>724,1:752,8</sub>.p2]: -32768 <
-\$heap_{724,1;752,8}.p2)
\rightarrow [negate goal and search for contradiction]
[1.44]!([0 < -\$heap_{724,1;752,8}.p2]: true, [-1 < \$heap_{724,1;752,8}.p2]: -32768 <
-\$heap_{724,1;752,8}.p2)
\rightarrow [move guard outside expression]
[1.45] ([0 < -$heap<sub>724,1;752,8</sub>.p2]: !true, [-1 < $heap<sub>724,1;752,8</sub>.p2]: !(-32768 <
-\$heap_{724,1:752.8}.p2)
\rightarrow [simplify]
[1.51] (-1 < \text{heap}_{724,1:752,8}.p2) \land (32767 < \text{heap}_{724,1:752,8}.p2)
[Work on sub-term 2 of conjunction in term 1.51]
[72.0] 32767 < heap_{724,1;752,8}.p2
[Assume known post-assertion, class invariant or type constraint for term 1.51]
[73.0] $heap<sub>724,1;752,8</sub>.p2 \leq maxof(short int)
\rightarrow [simplify]
[73.9] - 32768 < -\$heap_{724,1:752,8}.p2
\rightarrow [from term 72.0, literala < -$heap<sub>724,1:752,8</sub>.p2 is false whenever -2 <
(32767 + literala)
    Proof of rule precondition:
    [73.9.0] - 2 < (-32768 + 32767)
    \rightarrow [simplify]
    [73.9.2] true
[73.10] false
```

 \rightarrow [from guard, literala < -\$heap_{724,1;752,8}.p2 is true whenever (-1 + literala)

Proof of verification condition: Type constraint satisfied in implicit conversion from 'short int const' to 'int'

```
Condition generated at: C:\Escher\Customers\prang\prang.c (70,27)
Condition defined at:
To prove: minof(int) \leq $heap_{724,1:753.8}.M3
Given:
heap_{init}.LIMIT == (int)80
\theta
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta
heap_{init}.M2 == asType < short int > ((int)30307)
\theta
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
\theta = asType < short int > ((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart\_724,1})
div1 == div(\mathbf{heapIs} \$ heap_{funcstart\_724.1},
asType < int > (\$heap_{funcstart\_724.1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}))\ /
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))) = =
asType<integer>(div1.quot)
(asType < integer > (asType < int > (\$heap_{tuncstart\_724.1}.p1)) \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}))) = =
asType<integer>(div1.rem)
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p1) = =
asType<integer>(div1.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a1}) \leq
```

```
asType < integer > (\$heap_{funcstart-724.1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p2})) \ / \\
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.quot)
(asType<int>(asType<int>($heap_{tuncstart\_724.1}.p2)) %
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}) ==
asType<integer>(div2.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a2) \le
asType < integer > (\$heap_{funcstart\_724,1}.p2)) => !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
asType < int > (\$heap_{funcstart\_724,1}.a3))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724.1}.a3))) = =
asType<integer>(div3.quot)
(asType < int > (asType < int > (\$heap_{tuncstart\_724,1}.p3)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = = 
asType<integer>(div3.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a3) \le
asType < integer > (\$heap_{funcstart\_724.1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
```

```
\$heap_{724,1;745,8} == \$heap_{funcstart\_724,1}.\_\textbf{replace}(p1 \rightarrow \textbf{asType} < \textbf{short}
int>((asType<int>(asType<short int>(div1.rem)) *
\mathbf{asType} \small{<} \mathbf{int} \small{>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{r1})) \\ - (\mathbf{asType} \small{<} \mathbf{int} \small{>} (\mathbf{asType} \small{<} \mathbf{short}
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
-asType < integer const > (\$heap_{724.1:745.8}.M1) < 
asType<integer>($heap<sub>724,1:745,8</sub>.p1)
!(0 == asType < integer > (\$heap_{724,1:745.8} \cdot p1))
asType<integer>($heap<sub>724,1:745,8</sub>.p1) <
asType<integer>($heap<sub>724,1:745,8</sub>.M1)
\rho_{724,1:747.8} == \rho_{724,1:745.8}._replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724.1:745.8}.r2)) - (asType < int > (asType < short)
int > (div2.quot)) * asType < int > (\$heap_{724,1:745,8}.b2))))
-\mathbf{asType}{<}\mathbf{integer\ const}{>}(\$\mathrm{heap}_{724,1;747,8}.\mathrm{M2}) <
asType<integer>($heap<sub>724.1:747.8</sub>.p2)
!(0 == \mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathrm{heap}_{724,1;747,8}.\mathrm{p2}))
asType<integer>($heap<sub>724,1:747,8</sub>.p2) <
asType<integer>($heap<sub>724.1:747.8</sub>.M2)
\text{heap}_{724.1:749.8} == \text{heap}_{724.1:747.8}._replace(p3 \rightarrow asType<short)
int>((asType<int>(asType<short int>(div3.rem)) *
asType < int > (\$heap_{724.1:747.8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap<sub>724.1:747.8</sub>.b3))))
-asType<integer const>($heap<sub>724,1:749,8</sub>.M3) <
asType<integer>($heap<sub>724.1:749.8</sub>.p3)
!(0 == asType < integer > (\$heap_{724\ 1.749\ 8.p3}))
asType<integer>($heap<sub>724,1:749,8</sub>.p3) <
asType<integer>($heap<sub>724,1:749,8</sub>.M3)
heap_{724,1;752,8} == heap_{724,1;749,8}.replace(p1 \rightarrow asType<short
int>((asType<int>($heap<sub>724,1;749,8</sub>.M1) *
asType<int>(static_cast<integer>(asType<int>($heap<sub>724.1:749.8</sub>.p1) <
(int)(0) + asType<int>($heap<sub>724.1:749.8</sub>.p1)))
heap_{724,1:753.8} == heap_{724,1:752.8}.replace(p2 \rightarrow asType<short
int>((asType<int>($heap<sub>724,1:752,8</sub>.M2) *
asType<int>(static_cast<integer>(asType<int>($heap<sub>724,1:752,8</sub>.p2) <
(int)(0) + asType < int > (\$heap_{724,1;752,8}.p2))
Proof:
[Take goal term]
[1.0] minof(int) \leq $heap<sub>724,1;753,8</sub>.M3
```

```
\rightarrow [simplify]
[1.1] -32768 \leq $heap<sub>724.1:753.8</sub>.M3
\rightarrow [const static or extern object]
[1.2] -32768 \le \text{$heap}_{init}.M3
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[1.3] - 32768 \le asType < short int > ((int) 30323)
\rightarrow [simplify]
[1.6] true
Proof of verification condition: Type constraint satisfied in implicit
conversion from 'short int const' to 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (70,27)
Condition defined at:
To prove: heap_{724,1:753.8}.M3 \le maxof(int)
Given:
heap_{init}.LIMIT == (int)80
\theta
\theta_{init}.r1 == asType < short int > ((int)171)
\theta
\theta
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\rho_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
\theta = asType < short int > ((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
\theta == asType<short int>((int)178)
\theta = asType < short int > ((int)63)
\theta
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart_{-724,1}})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
```

```
asType < int > (\$heap_{funcstart\_724,1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ / \\
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}))) = =
asType<integer>(div1.quot)
(asType < int > (asType < int > (\$heap_{funcstart\_724,1}.p1)) \%
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}))) = =
asType<integer>(div1.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p1) = =
asType<integer>(div1.rem))
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}) \leq
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1})) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.quot)
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}))~\%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a2})) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p2) = =
asType<integer>(div2.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a2) \le
asType < integer > (\$heap_{funcstart\_724,1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > ($heap_{funcstart\_724,1}.p3),
asType < int > (\$heap_{funcstart\_724,1}.a3))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724.1}.a3))) = =
```

```
asType<integer>(div3.quot)
(asType<integer>(asType<int>($heap_{tuncstart_724,1}.p3)) %
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.rem)
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart_{-724,1}}.a3)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a3}) \leq
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3})) = > !(0 = =
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
\$heap_{724,1;745,8} == \$heap_{funcstart\_724,1}.\_\mathbf{replace}(p1 \to \mathbf{asType} < \mathbf{short}
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724.1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>(heap_{funcstart\_724,1}.b1)))
-{\bf asType}{<} {\bf integer~const}{>} (\${\rm heap}_{724,1;745,8}.{\rm M1}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{p1})
!(0 == asType < integer > (\$heap_{724,1;745,8}.p1))
asType<integer>($heap<sub>724.1:745.8</sub>.p1) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{M1})
heap_{724,1:747,8} == heap_{724,1:745,8}.replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
\mathbf{asType} < \mathbf{int} > (\$ heap_{724,1:745,8}.r2)) - (\mathbf{asType} < \mathbf{int} > (\mathbf{asType} < \mathbf{short})
int>(div2.quot)) * asType< int>($heap_{724,1;745,8}.b2))))
-asType<integer const>($heap<sub>724.1:747.8</sub>.M2) <
asType<integer>($heap<sub>724.1:747.8</sub>.p2)
!(0 == asType < integer > (\$heap_{724,1:747.8}.p2))
asType<integer>($heap<sub>724.1:747.8</sub>.p2) <
asType<integer>($heap<sub>724.1:747.8</sub>.M2)
heap_{724,1:749,8} == heap_{724,1:747,8}.replace(p3 \rightarrow asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType < int > (\$heap_{724,1:747,8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType< int>($heap_{724,1:747.8}.b3))))
-asType<integer const>($heap<sub>724 1.749 8.</sub>M3) <
asType<integer>($heap<sub>724,1:749,8:p3</sub>)
!(0 == asType < integer > (\$heap_{724,1:749.8}.p3))
asType<integer>($heap<sub>724.1:749.8</sub>.p3) <
```

```
heap_{724,1:752,8} == heap_{724,1:749,8}._replace(p1 \rightarrow asType<short
int>((asType<int>($heap<sub>724,1:749,8</sub>.M1) *
asType<int>(static_cast<integer>(asType<int>($heap_{724.1:749.8}.p1) <
(int)(0) + asType<int>($heap<sub>724.1:749.8</sub>.p1)))
\$heap_{724,1;753,8} == \$heap_{724,1;752,8}.\mathbf{\_replace}(p2 \rightarrow \mathbf{asType} {<} \mathbf{short}
int>((asType<int>($heap<sub>724,1:752,8</sub>.M2) *
asType<int>(static_cast<integer>(asType<int>($heap_{724,1:752,8}.p2) <
(int)(0) + asType<int>($heap<sub>724,1:752,8</sub>.p2)))
Proof:
[Take goal term]
[1.0] $\text{heap}_{724,1;753,8}.M3 \leq \text{maxof(int)}
\rightarrow [const static or extern object]
[1.1] $heap<sub>init</sub>.M3 \leq maxof(int)
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[1.2] asType<short int>((int)30323) \le maxof(int)
\rightarrow [simplify]
[1.6] true
Proof of verification condition: Type constraint satisfied in implicit
conversion from 'short int' to 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (70,17)
Condition defined at:
To prove: minof(int) \le \text{$heap}_{724,1:753.8}.p3
Given:
heap_{init}.LIMIT == (int)80
\theta
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
heap_{init}.M2 == asType < short int > ((int)30307)
\rho_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
```

asType<integer>(\$heap_{724.1:749.8}.M3)

```
\rho_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType<short int>((int)178)
heap_{init}.b3 == asType < short int > ((int)63)
\theta
\theta
heap_{init}.p3 == asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart_724,1})
div1 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ / \ 
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))) = =
asType<integer>(div1.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(asType < integer > ($heap_{funcstart\_724,1}.p1) < 
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p1) = =
asType<integer>(div1.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a1) \le
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}))\ /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heap_{funcstart\_724.1}.p2)) %
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p2) = =
asType<integer>(div2.rem))
```

```
(asType < integer > (\$heap_{funcstart_{-724,1}}.a2) \le
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2})) = > !(0 = =
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1} \cdot \mathbf{p3})) \ / \\
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(asType<integer>(asType<int>($heap_{tuncstart\_724.1}.p3)) %
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.rem)
(asType<integer>($heap_funcstart_724.1.p3) <
asType<integer>($heap_funcstart_724,1.a3)) =>
(asType < integer > ($heap_{funcstart\_724.1}.p3) = =
asType<integer>(div3.rem))
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a3}) \leq
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})) => !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
heap_{724,1;745,8} == heap_{funcstart\_724,1}.\_replace(p1 \rightarrow asType < short)
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
-asType<integer const>($heap<sub>724 1.745 8</sub>.M1) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{p1})
!(0 == asType < integer > (\$heap_{724,1:745.8} \cdot p1))
asType<integer>($heap<sub>724,1:745,8</sub>.p1) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{M1})
\rho_{724,1:747.8} == \rho_{724,1:745.8} replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div2.rem))
asType < int > (\$heap_{724,1:745,8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType< int>($heap_{724,1;745,8}.b2))))
-\mathbf{asType} {<} \mathbf{integer\ const} {>} (\$ \mathbf{heap}_{724,1;747,8}.\mathbf{M2}) <
asType < integer > ($heap_{724,1;747,8}.p2)
!(0 == asType < integer > (\$heap_{724,1;747,8}.p2))
```

```
asType<integer>($heap<sub>724.1:747.8</sub>.p2) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;747,8}.\mathrm{M2})
heap_{724,1:749,8} == heap_{724,1:747,8}.replace(p3 \rightarrow asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType < int > (\$heap_{724.1:747.8}.r3)) - (asType < int > (asType < short)
int > (div3.quot)) * asType < int > ($heap_{724,1;747,8}.b3))))
-asType < integer const > (\$heap_{724,1:749.8}.M3) < 
asType<integer>($heap<sub>724,1:749,8</sub>.p3)
!(0 == asType < integer > (\$heap_{724,1:749.8}.p3))
asType<integer>($heap<sub>724.1:749.8</sub>.p3) <
asType<integer>($heap<sub>724,1:749,8</sub>.M3)
\text{sheap}_{724,1;752,8} == \text{sheap}_{724,1;749,8}. \text{replace}(\text{p1} \to \text{asType} < \text{short})
int>((asType<int>($heap<sub>724,1:749,8</sub>.M1) *
\mathbf{asType} < \mathbf{int} > (\mathbf{static\_cast} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{724,1;749,8}.\mathrm{p1}) <
(int)(0) + asType<int>($heap<sub>724.1:749.8</sub>.p1)))
heap_{724,1;753,8} == heap_{724,1;752,8}.replace(p2 \rightarrow asType<short
int>((asType<int>($heap<sub>724.1:752.8</sub>.M2) *
asType<int>(static_cast<integer>(asType<int>($heap<sub>724,1:752,8</sub>.p2) <
(int)(0)) + asType < int > ($heap_{724,1;752,8}.p2)))
Proof:
[Take goal term]
[1.0] minof(int) \leq $heap<sub>724,1:753,8</sub>.p3
\rightarrow [simplify]
[1.3] -32769 < $heap<sub>724,1:753,8</sub>.p3
\rightarrow [negate goal and search for contradiction]
[1.4]!(-32769 < \text{$heap}_{724,1;753,8}.p3)
\rightarrow [simplify]
[1.6] 32768 < -$heap<sub>724,1;753,8</sub>.p3
[Assume known post-assertion, class invariant or type constraint for term 1.6]
[75.0] minof(short int) \leq $heap<sub>724,1;753,8</sub>.p3
\rightarrow [simplify]
[75.3] - 32769 < \text{heap}_{724.1:753.8}.p3
\rightarrow [from term 1.6, literala < $heap<sub>724.1:753.8</sub>.p3 is false whenever -2 < (32768)
+ literala)]
    Proof of rule precondition:
    [75.3.0] - 2 < (-32769 + 32768)
```

```
[75.3.2] true
[75.4] false
Proof of verification condition: Type constraint satisfied in implicit
conversion from 'short int' to 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (70,17)
Condition defined at:
To prove: percent proves prove proves pr
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
heap_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta = asType < short int > ((int)2)
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
\theta sheap<sub>init</sub>.a2 == asType<short int>((int)176)
\theta
heap_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart_{-724,1}})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(\mathbf{asType} {<} \mathbf{int} {>} (\mathbf{asType} {<} \mathbf{int} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ \%
```

 \rightarrow [simplify]

```
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p1) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p1) = =
asType<integer>(div1.rem))
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
(asType<integer>(asType<int>($heap_{tuncstart\_724.1}.p2)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724.1}.a2))) = =
asType<integer>(div2.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}) ==
asType<integer>(div2.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a2}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
\mathrm{div3} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1},
asType < int > ($heap_{funcstart\_724,1}.p3),
asType < int > (\$heap_{funcstart\_724,1}.a3))
(asType<int>(sheap<sub>funcstart_724.1</sub>.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3})) =>
```

```
(asType < integer > (\$heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a3) \le
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})) => !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
\$heap_{724,1;745,8} == \$heap_{funcstart\_724,1}.\_\textbf{replace}(p1 \rightarrow \textbf{asType} < \textbf{short}
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
-asType < integer const > (\$heap_{724,1:745.8}.M1) < 
asType<integer>($heap<sub>724.1:745.8</sub>.p1)
!(0 == asType < integer > (\$heap_{724,1;745,8}.p1))
asType<integer>($heap<sub>724,1;745,8</sub>.p1) <
asType < integer > (\$heap_{724,1;745,8}.M1)
heap_{724,1:747,8} == heap_{724,1:745,8}.replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724,1:745,8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724,1:745,8</sub>.b2))))
-asType<integer const>($heap<sub>724.1:747.8</sub>.M2) <
\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{724,1;747,8}.\mathrm{p2})
!(0 == asType < integer > (\$heap_{724,1:747.8}.p2))
asType<integer>($heap<sub>724.1:747.8</sub>.p2) <
asType<integer>($heap<sub>724,1:747,8</sub>.M2)
heap_{724,1:749,8} == heap_{724,1:747,8}._replace(p3 \rightarrow asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType < int > (\$heap_{724,1:747,8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType< int>($heap_{724.1:747.8}.b3))))
-asType < integer const > (\$heap_{724,1:749.8}.M3) < 
asType < integer > ($heap_{724,1;749,8}.p3)
!(0 == \mathbf{asType} {<} \mathbf{integer} {>} (\$ heap_{724,1;749,8}.p3))
asType < integer > ($heap_{724,1;749,8}.p3) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;749,8}.\mathrm{M3})
heap_{724,1:752,8} == heap_{724,1:749,8}.replace(p1 \rightarrow asType<short
int>((asType<int>($heap<sub>724,1;749,8</sub>.M1) *
asType<int>(static_cast<integer>(asType<int>($heap_{724,1:749,8}.p1) <
(int)(0) + asType<int>($heap<sub>724,1:749,8</sub>.p1)))
\$ heap_{724,1;753,8} == \$ heap_{724,1;752,8}. \textbf{\_replace} (p2 \rightarrow \textbf{asType} < \textbf{short}
```

```
\mathbf{int}{>}((\mathbf{asType}{<}\mathbf{int}{>}(\$\text{heap}_{724,1;752,8}.\text{M2}) \ *
\mathbf{asType} < \mathbf{int} > (\mathbf{static\_cast} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{724,1;752,8}.\mathrm{p2}) < \mathsf{nt})
(int)(0)) + asType < int > ($heap_{724,1;752,8}.p2)))
Proof:
[Take goal term]
[1.0] $heap<sub>724,1:753,8</sub>.p3 \leq maxof(int)
\rightarrow [simplify]
[1.9] -32768 < -\$heap_{724,1;753,8}.p3
\rightarrow [negate goal and search for contradiction]
[1.10]!(-32768 < -\$heap_{724,1;753,8}.p3)
\rightarrow [simplify]
[1.13] 32767 < $heap<sub>724,1;753,8</sub>.p3
[Assume known post-assertion, class invariant or type constraint for term 1.13]
[75.0] $heap<sub>724,1;753,8</sub>.p3 \leq maxof(short int)
\rightarrow [simplify]
[75.9] -32768 < -\$heap_{724,1;753,8}.p3
\rightarrow [from term 1.13, literala < -$heap<sub>724.1:753.8</sub>.p3 is false whenever -2 <
(32767 + literala)
   Proof of rule precondition:
   [75.9.0] - 2 < (-32768 + 32767)
   \rightarrow [\text{simplify}]
   [75.9.2] true
[75.10] false
Proof of verification condition: Type constraint satisfied in explicit
conversion from 'integer' to 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (70,11)
Condition defined at:
To prove: minof(int) <
static\_cast < integer > (asType < int > (\$heap_{724,1;753,8}.p3) < (int)0)
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
\theta
```

```
heap_{init}.a1 == asType < short int > ((int)177)
\theta = asType < short int > ((int)2)
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
\theta_{init}.a2 == asType<short int>((int)176)
heap_{init}.b2 == asType<short int>((int)35)
\theta = asType < short int > ((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta
\theta
\theta = asType < short int > ((int)3)
invariant
1(heap<br/>Is \rho_{funcstart\_724,1}
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \ \operatorname{\$heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
(asType<integer>(asType<int>($heap_{funcstart\_724,1}.p1)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p1) = =
asType<integer>(div1.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a1) \le
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}),
asType < int > (\$heap_{funcstart\_724,1}.a2))
(asType<integer>(asType<int>($heap_{tuncstart\_724,1}.p2)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
```

```
asType<integer>(div2.quot)
(asType < int > (asType < int > (\$heap_{funcstart\_724,1}.p2)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.rem)
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) <
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{a2})) = >
(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p2) ==
asType<integer>(div2.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a2}) \leq
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2})) = > !(0 = =
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
\label{eq:div3} \text{div3} == \text{div}(\mathbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1},
\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}),
asType < int > (\$heap_{funcstart\_724.1}.a3))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) \%
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a3}))) = =
asType<integer>(div3.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a3) \le
asType < integer > (\$heap_{funcstart\_724,1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
\$heap_{724,1;745,8} == \$heap_{funcstart\_724,1}.\_\mathbf{replace}(p1 \rightarrow \mathbf{asType} < \mathbf{short}
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType<int>($heap_{funcstart\_724,1}.b1)))
-asType<integer const>($heap_{724,1:745,8}.M1) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{p1})
!(0 == asType < integer > (\$heap_{724,1;745,8}.p1))
asType<integer>($heap<sub>724.1:745.8</sub>.p1) <
asType<integer>($heap<sub>724.1:745.8</sub>.M1)
```

```
heap_{724,1;747,8} == heap_{724,1;745,8}.replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724,1:745,8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType< int>($heap_{724,1;745.8}.b2))))
-asType<integer const>($heap<sub>724.1:747.8</sub>.M2) <
asType<integer>($heap<sub>724.1:747.8</sub>.p2)
!(0 == asType < integer > (\$heap_{724,1:747,8}.p2))
asType<integer>($heap<sub>724,1:747,8</sub>.p2) <
asType<integer>($heap<sub>724,1:747,8</sub>.M2)
\$heap_{724,1;749,8} == \$heap_{724,1;747,8}. \textbf{\_replace}(p3 \rightarrow \textbf{asType} {<} \textbf{short}
int>((asType<int>(asType<short int>(div3.rem)) *
asType < int > (\$heap_{724.1:747.8}.r3)) - (asType < int > (asType < short)
int > (div3.quot)) * asType < int > (\$heap_{724,1:747,8}.b3))))
-{\bf asType}{<} {\bf integer~const}{>}(\${\rm heap}_{724,1;749,8}.{\rm M3}) <
asType<integer>($heap<sub>724.1:749.8</sub>.p3)
!(0 == asType < integer > (\$heap_{724,1;749,8}.p3))
\mathbf{asType}{<}\mathbf{integer}{>}(\$ heap_{724,1;749,8}.p3) <
asType<integer>($heap<sub>724.1:749.8</sub>.M3)
\text{heap}_{724.1;752.8} == \text{heap}_{724.1;749.8}._replace(p1 \rightarrow asType<short)
int>((asType< int>(\$heap_{724,1;749,8}.M1) *
asType<int>(static_cast<integer>(asType<int>($heap_{724.1:749.8}.p1) <
(int)(0) + asType < int > (\$heap_{724,1:749.8}.p1))
\$heap_{724,1;753,8} == \$heap_{724,1;752,8}.\mathbf{replace}(p2 \rightarrow \mathbf{asType} {<} \mathbf{short}
int>((asType<int>($heap<sub>724,1;752,8</sub>.M2) *
asType<int>(static_cast<integer>(asType<int>($heap_{724,1:752,8}.p2) <
(int)(0)) + asType < int > (\$heap_{724,1;752,8}.p2)))
Proof:
[Take goal term]
[1.0]  minof(int) \leq static_cast<integer>(asType<int>($heap<sub>724.1:753.8</sub>.p3)
< (int)0)
\rightarrow [simplify]
[1.6] -32768 \le ([0 < -\$heap_{724,1;753,8}.p3]: 1, []: 0)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[1.7] - 32768 \le ([0 < -\$heap_{724,1:753,8}.p3]: 1, [!(0 < -\$heap_{724,1:753,8}.p3)]: 0)
\rightarrow [simplify]
[1.12] - 32769 < ([0 < -\$heap_{724,1;753,8}.p3]: 1, [-1 < \$heap_{724,1;753,8}.p3]: 0)
\rightarrow [move guard outside expression]
```

```
[1.13] ([0 < -$heap<sub>724,1:753,8</sub>.p3]: -32769 < 1, [-1 < $heap<sub>724,1:753,8</sub>.p3]: -32769
< 0)
\rightarrow [simplify]
[1.15] ([0 < -$heap<sub>724,1;753,8</sub>.p3]: true, [-1 < $heap<sub>724,1;753,8</sub>.p3]: true)
\rightarrow [all guards have equal guarded terms]
[1.16] true
Proof of verification condition: Type constraint satisfied in explicit
conversion from 'integer' to 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (70,11)
Condition defined at:
To prove: static_cast<integer>(asType<int>($heap<sub>724.1:753.8</sub>.p3) <
(int)0) \le maxof(int)
Given:
heap_{init}.LIMIT == (int)80
\theta
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
heap_{init}.M2 == asType < short int > ((int)30307)
\rho_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
heap_{init}.b2 == asType < short int > ((int)35)
\theta sheap<sub>init</sub>.M3 == asType<short int>((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
\theta == asType<short int>((int)178)
\theta = asType < short int > ((int)63)
\theta
\theta
heap_{init}.p3 == asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart_{-724,1}})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \ \operatorname{\$heap}_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
```

```
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ / \\
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}))) = =
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{div1}.\mathbf{quot})
(asType<int>(asType<int>($heap_{funcstart\_724,1}.p1)) %
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) ==
asType<integer>(div1.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a1) \le
asType < integer > (\$heap_{funcstart\_724,1}.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart_{-724.1}},
\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2})) \ / \\
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))) ==
asType<integer>(div2.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724.1}.p2)) \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.rem)
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2})) =>
(asType < integer > ($heap_{funcstart\_724,1}.p2) ==
asType<integer>(div2.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a2}) \leq
\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
asType < int > (\$heap_{funcstart\_724,1}.a3))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p3})) \ / \\
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3})) \%
```

```
asType < integer > (asType < int > (\$heap_{funcstart_{-724,1}}.a3))) = =
asType<integer>(div3.rem)
(asType<integer>($heap_{tuncstart\_724,1}.p3) <
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(asType < integer > (\$heap_{funcstart_{-724,1}}.p3) = =
asType<integer>(div3.rem))
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a3}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
$heap_{724,1;745,8} == $heap_{funcstart\_724,1}.\_replace(p1 \rightarrow asType < short)
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
-asType < integer\ const > (\$heap_{724,1;745,8}.M1) < 
asType < integer > ($heap_{724,1;745,8}.p1)
!(0 == asType < integer > (\$heap_{724,1:745,8}.p1))
asType<integer>($heap<sub>724,1:745,8</sub>.p1) <
asType<integer>($heap<sub>724,1:745,8</sub>.M1)
\rho_{724,1:747.8} == \rho_{724,1:745.8}._replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724.1:745.8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
-\mathbf{asType}{<}\mathbf{integer\ const}{>}(\$\mathrm{heap}_{724,1;747,8}.\mathrm{M2}) <
\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{724,1;747,8}.\mathrm{p2})
!(0 == asType < integer > (\$heap_{724,1:747.8}.p2))
asType<integer>($heap<sub>724.1:747.8</sub>.p2) <
asType<integer>($heap<sub>724.1:747.8</sub>.M2)
\text{sheap}_{724,1:749.8} == \text{sheap}_{724,1:747.8}._replace(p3 \rightarrow asType<short
int>((asType<int>(asType<short int>(div3.rem))
\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{724,1;747,8}.\mathrm{r3})) - (\mathbf{asType} < \mathbf{int} > (\mathbf{asType} < \mathbf{short}))
int>(div3.quot)) * asType<int>($heap<sub>724.1:747.8</sub>.b3))))
-asType<integer const>($heap_{724,1:749,8}.M3) <
asType<integer>($heap<sub>724.1:749.8</sub>.p3)
!(0 == asType < integer > (\$heap_{724.1:749.8}.p3))
asType<integer>($heap<sub>724,1:749,8</sub>.p3) <
asType<integer>($heap<sub>724,1;749,8</sub>.M3)
heap_{724,1;752,8} == heap_{724,1;749,8}.replace(p1 \rightarrow asType<short
```

```
int>((asType< int>(\$heap_{724,1;749,8}.M1) *
asType<int>(static_cast<integer>(asType<int>($heap_{724,1:749,8}.p1) <
(int)(0)) + asType < int > (\$heap_{724,1;749,8}.p1)))
\$ heap_{724,1;753,8} == \$ heap_{724,1;752,8}. \textbf{\_replace} (p2 \rightarrow \textbf{asType} < \textbf{short}
int>((asType<int>($heap<sub>724.1:752.8</sub>.M2) *
asType<int>(static_cast<integer>(asType<int>($heap<sub>724.1:752.8</sub>.p2) <
(int)(0) + asType<int>($heap<sub>724,1;752,8</sub>.p2)))
Proof:
[Take goal term]
[1.0] static_cast<integer>(asType<int>($heap_{724.1:753.8}.p3) < (int)0) \leq
maxof(int)
\rightarrow [simplify]
[1.5] ([0 < -\$heap_{724,1:753.8}.p3]: 1, []: 0) \le maxof(int)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[1.6] ([0 < -$heap<sub>724.1:753.8</sub>.p3]: 1, [!(0 < -$heap<sub>724.1:753.8</sub>.p3)]: 0) \leq
maxof(int)
\rightarrow [simplify]
[1.11] (-1 + ([0 < -$heap<sub>724,1;753,8</sub>.p3]: 1, [-1 < $heap<sub>724,1;753,8</sub>.p3]: 0)) <
32767
\rightarrow [move guard outside expression]
[1.12] ([0 < -$heap<sub>724,1;753,8</sub>.p3]: -1 + 1, [-1 < $heap<sub>724,1;753,8</sub>.p3]: -1 + 0) <
32767
\rightarrow [simplify]
[1.15] 0 < (32767 + -([0 < -\$heap_{724,1:753.8}.p3]): 0, [-1 < \$heap_{724,1:753.8}.p3]:
-1))
\rightarrow [move guard outside expression]
[1.16] 0 < (32767 + ([0 < -\$heap_{724,1:753.8}.p3]: -0, [-1 < \$heap_{724,1:753.8}.p3]:
--1))
\rightarrow [simplify]
 [1.18] \ 0 < (32767 + ([0 < -\$heap_{724,1;753,8}.p3]: \ 0, \ [-1 < \$heap_{724,1;753,8}.p3]: 
\rightarrow [move guard outside expression]
[1.19] 0 < ([0 < -\$heap_{724,1;753,8}.p3]: 0 + 32767, [-1 < \$heap_{724,1;753,8}.p3]: 1
+32767
\rightarrow [simplify]
[1.21] 0 < ([0 < -\$heap_{724,1;753,8}.p3]: 32767, [-1 < \$heap_{724,1;753,8}.p3]: 32768)
```

```
\rightarrow [move guard outside expression]
[1.22] ([0 < -$heap<sub>724.1:753.8</sub>.p3]: 0 < 32767, [-1 < $heap<sub>724.1:753.8</sub>.p3]: 0 <
32768)
\rightarrow [simplify]
[1.24] ([0 < -$heap<sub>724,1:753,8</sub>.p3]: true, [-1 < $heap<sub>724,1:753,8</sub>.p3]: true)
\rightarrow [all guards have equal guarded terms]
[1.25] true
Proof of verification condition: Arithmetic result of operator '*' is within
limit of type 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (70,25)
Condition defined at:
To prove: minof(int) \le (asType < int > (\$heap_{724,1:753.8}.M3) *
\mathbf{asType} < \mathbf{int} > (\mathbf{static\_cast} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{724,1;753,8}.\mathrm{p3}) < \mathsf{nt}) < \mathsf{nt} > \mathsf{nt} >
(\mathbf{int})(0)
Given:
heap_{init}.LIMIT == (int)80
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta = asType < short int > ((int)2)
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
heap_{init}.b2 == asType<short int>((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
heap_{init}.b3 == asType < short int > ((int)63)
\theta
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart\_724,1})
\mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1},
```

```
asType < int > (\$heap_{funcstart\_724,1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ / \\
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}))) = =
asType<integer>(div1.quot)
(asType < int > (asType < int > (\$heap_{funcstart\_724,1}.p1)) \%
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}))) = =
asType<integer>(div1.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p1) = =
asType<integer>(div1.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathtt{a1}) \leq
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1})) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.quot)
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}))~\%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a2})) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p2) = =
asType<integer>(div2.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a2) \le
asType < integer > (\$heap_{funcstart\_724,1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724.1}.a3))) = =
```

```
asType<integer>(div3.quot)
(asType<integer>(asType<int>($heap_{tuncstart_724,1}.p3)) %
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.rem)
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart_{-724,1}}.a3)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a3}) \leq
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3})) = > !(0 = =
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
\$heap_{724,1;745,8} == \$heap_{funcstart\_724,1}.\_\mathbf{replace}(p1 \to \mathbf{asType} < \mathbf{short}
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>(heap_{funcstart\_724,1}.b1)))
-{\bf asType}{<} {\bf integer~const}{>} (\${\rm heap}_{724,1;745,8}.{\rm M1}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{p1})
!(0 == asType < integer > (\$heap_{724,1;745,8}.p1))
asType<integer>($heap<sub>724.1:745.8</sub>.p1) <
asType<integer>($heap<sub>724.1:745.8</sub>.M1)
heap_{724,1:747,8} == heap_{724,1:745,8}.replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
\mathbf{asType} < \mathbf{int} > (\$ heap_{724,1:745,8}.r2)) - (\mathbf{asType} < \mathbf{int} > (\mathbf{asType} < \mathbf{short})
int>(div2.quot)) * asType< int>($heap_{724,1;745,8}.b2))))
-asType<integer const>($heap<sub>724.1:747.8</sub>.M2) <
asType<integer>($heap<sub>724.1:747.8</sub>.p2)
!(0 == asType < integer > (\$heap_{724,1:747.8}.p2))
asType<integer>($heap<sub>724.1:747.8</sub>.p2) <
asType<integer>($heap<sub>724.1:747.8</sub>.M2)
heap_{724,1:749,8} == heap_{724,1:747,8}.replace(p3 \rightarrow asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{724,1;747,8}.\mathrm{r3})) - (\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{short}
int>(div3.quot)) * asType< int>($heap_{724,1:747.8}.b3))))
-asType<integer const>($heap<sub>724 1.749 8.</sub>M3) <
asType<integer>($heap<sub>724,1:749,8:p3</sub>)
!(0 == asType < integer > (\$heap_{724,1:749.8}.p3))
asType<integer>($heap<sub>724.1:749.8</sub>.p3) <
```

```
asType<integer>($heap<sub>724.1:749.8</sub>.M3)
\text{heap}_{724.1:752.8} == \text{heap}_{724.1:749.8}._replace(p1 \rightarrow asType<short)
int>((asType<int>($heap<sub>724,1:749,8</sub>.M1) *
asType<int>(static_cast<integer>(asType<int>($heap_{724.1:749.8}.p1) <
(int)(0) + asType<int>($heap<sub>724.1:749.8</sub>.p1)))
heap_{724,1:753.8} == heap_{724,1:752.8}._replace(p2 \rightarrow asType<short
int>((asType<int>($heap<sub>724,1:752,8</sub>.M2) *
asType<int>(static_cast<integer>(asType<int>($heap_{724,1:752,8}.p2) <
(int)(0)) + asType < int > ($heap_{724,1;752,8}.p2)))
Proof:
[Take goal term]
[1.0]  minof(int) \leq (asType < int > (\$heap_{724,1;753,8}.M3) *
asType<int>(static_cast<integer>(asType<int>($heap_{724,1:753,8}.p3) <
(int)0)))
\rightarrow [simplify]
[1.1] -32768 \leq (asType<int>($heap<sub>724,1;753,8</sub>.M3) *
\mathbf{asType} < \mathbf{int} > (\mathbf{static\_cast} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{724,1;753,8}.\mathrm{p3}) < \mathsf{nt})
(\mathbf{int})(0)
\rightarrow [const static or extern object]
[1.2] -32768 \le (asType < int > (\$heap_{init}.M3) *
\mathbf{asType} < \mathbf{int} > (\mathbf{static\_cast} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{724,1:753.8}.\mathrm{p3}) < \mathsf{nt})
(int)0)))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[1.3] -32768 \leq (asType\leqint>(asType\leqshort int>((int)30323)) *
asType<int>(static_cast<integer>(asType<int>($heap<sub>724,1:753,8</sub>.p3) <
(int)0)))
\rightarrow [simplify]
[1.11] -32768 \leq (30323 * asType<int>(([0 < -$heap<sub>724,1:753,8</sub>.p3]: 1, []: 0)))
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[1.12] -32768 \leq (30323 * asType<int>(([0 < -$heap<sub>724,1;753,8</sub>.p3]: 1, [!(0 <
-\$heap_{724,1;753,8}.p3)]: 0)))
\rightarrow [simplify]
\lceil 1.16 \rceil-32768 \leq (30323 * ([0 < -$heap_{724,1;753,8}.p3]: 1, [-1 <
heap_{724,1:753,8}.p3: 0)
\rightarrow [move guard outside expression]
[1.17] -32768 \leq ([0 < -$heap<sub>724.1:753.8</sub>.p3]: 1 * 30323, [-1 <
heap_{724,1:753.8}.p3: 0 * 30323)
```

```
\rightarrow [simplify]
[1.21] -32769 < ([0 < -\$heap_{724,1:753,8}.p3]: 30323, [-1 < \$heap_{724,1:753,8}.p3]: 0)
\rightarrow [move guard outside expression]
[1.22] ([0 < -$heap<sub>724.1:753.8</sub>.p3]: -32769 < 30323, [-1 < $heap<sub>724.1:753.8</sub>.p3]:
-32769 < 0
\rightarrow [simplify]
[1.24] ([0 < -$heap<sub>724,1:753,8</sub>.p3]: true, [-1 < $heap<sub>724,1:753,8</sub>.p3]: true)
\rightarrow [all guards have equal guarded terms]
[1.25] true
Proof of verification condition: Arithmetic result of operator '*' is within
limit of type 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (70,25)
Condition defined at:
To prove: (asType<int>($heap<sub>724,1;753,8</sub>.M3) *
\mathbf{asType} < \mathbf{int} > (\mathbf{static\_cast} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{724,1;753,8}.\mathrm{p3}) < \mathsf{nt}) < \mathsf{nt} > \mathsf{nt} >
(int)(0)) \le maxof(int)
Given:
heap_{init}.LIMIT == (int)80
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta = asType < short int > ((int)2)
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
heap_{init}.b2 == asType < short int > ((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
```

```
invariant1(heapIs heap_{funcstart_{-724.1}})
div1 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) \%
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}))) = =
asType<integer>(div1.rem)
(asType<integer>($heap_{funcstart\_724.1}.p1) <
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a1})) = >
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) = =
asType<integer>(div1.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a1}) \leq
asType < integer > (\$heap_{funcstart\_724.1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
(asType<int>(asType<int>($heap_{tuncstart}, 724.1.p2)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))) ==
asType<integer>(div2.rem)
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) ==
asType<integer>(div2.rem))
(asType < integer > (\$heap_{funcstart\_724.1}.a2) \le
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})) => !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
```

```
(\mathbf{asType} {<} \mathbf{integer} {>} (\mathbf{asType} {<} \mathbf{int} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3})) \ / \\
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(asType<int>(asType<int>($heap_{funcstart\_724,1}.p3)) %
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
(asType < integer > (\$heap_{funcstart_{724,1}}.a3) \le
asType < integer > (\$heap_{funcstart\_724,1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1.quot})) \ * \ \mathbf{asType}{<} \mathbf{int}{>} (\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
-asType<integer const>($heap_{724,1:745,8}.M1) <
asType<integer>($heap<sub>724.1:745.8</sub>.p1)
!(0 == asType < integer > (\$heap_{724,1:745.8}.p1))
asType<integer>($heap<sub>724.1:745.8</sub>.p1) <
asType<integer>($heap<sub>724,1:745,8</sub>.M1)
heap_{724,1;747,8} == heap_{724,1;745,8}._replace(p2 \rightarrow asType<short)
int>((asType<int>(asType<short int>(div2.rem)) *
\mathbf{asType} < \mathbf{int} > (\$ heap_{724,1;745,8}.r2)) - (\mathbf{asType} < \mathbf{int} > (\mathbf{asType} < \mathbf{short})
int>(div2.quot)) * asType< int>($heap_{724,1;745,8}.b2))))
-asType < integer const > (\$heap_{724,1:747,8}.M2) < 
asType<integer>($heap<sub>724,1:747,8</sub>.p2)
!(0 == \mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathrm{heap}_{724,1;747,8}.\mathrm{p2}))
asType < integer > ($heap_{724,1;747,8}.p2) < 
asType<integer>($heap<sub>724,1:747,8</sub>.M2)
\text{Sheap}_{724,1;749,8} == \text{Sheap}_{724,1;747,8}.\text{replace}(p3 \to asType < short)
int>((asType<int>(asType<short int>(div3.rem)) *
asType < int > (\$heap_{724,1;747,8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType< int>($heap_{724,1;747,8}.b3))))
-asType<integer const>($heap<sub>724.1:749.8</sub>.M3) <
asType<integer>($heap<sub>724.1:749.8</sub>.p3)
```

```
!(0 == asType < integer > (\$heap_{724,1:749.8}.p3))
asType<integer>($heap<sub>724.1:749.8</sub>.p3) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;749,8}.\mathrm{M3})
heap_{724,1;752,8} == heap_{724,1;749,8}.replace(p1 \rightarrow asType<short
int>((asType< int>(\$heap_{724,1;749,8}.M1) *
asType<int>(static_cast<integer>(asType<int>($heap_{724.1:749.8}.p1) <
(int)(0) + asType < int > (\$heap_{724,1:749,8}.p1))
heap_{724,1:753.8} == heap_{724,1:752.8}.replace(p2 \rightarrow asType<short
\mathbf{int}{>}((\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{724,1;752,8}.\mathrm{M2})~^*
asType<int>(static_cast<integer>(asType<int>($heap<sub>724.1:752.8</sub>.p2) <
(int)(0) + asType<int>($heap<sub>724.1:752.8</sub>.p2)))
Proof:
[Take goal term]
[1.0] (asType<int>($heap<sub>724.1.753.8.</sub>M3) *
asType<int>(static_cast<integer>(asType<int>($heap_{724.1:753.8}.p3) <
(int)(0)) \le maxof(int)
\rightarrow [const static or extern object]
[1.1] (asType<int>($heap<sub>init</sub>.M3) *
asType<int>(static_cast<integer>(asType<int>($heap<sub>724.1:753.8</sub>.p3) <
(int)(0)) \le maxof(int)
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[1.2] (asType<int>(asType<short int>((int)30323)) *
asType<int>(static_cast<integer>(asType<int>($heap_{724.1:753.8}.p3) <
(int)(0)) \le maxof(int)
\rightarrow [simplify]
[1.10] (30323 * asType<int>(([0 < -$heap<sub>724.1:753.8</sub>.p3]: 1, []: 0))) \leq
maxof(int)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[1.11] (30323 * asType<int>(([0 < -$heap<sub>724,1:753,8</sub>.p3]: 1, [!(0 <
-\$heap_{724,1;753,8}.p3)] \colon 0))) \le \mathbf{maxof}(\mathbf{int})
\rightarrow [simplify]
[1.15] (30323 * ([0 < -$heap<sub>724,1:753,8</sub>.p3]: 1, [-1 < $heap<sub>724,1:753,8</sub>.p3]: 0)) \leq
maxof(int)
\rightarrow [move guard outside expression]
[1.16] ([0 < -$heap<sub>724,1;753,8</sub>.p3]: 1 * 30323, [-1 < $heap<sub>724,1;753,8</sub>.p3]: 0 *
30323) \leq \mathbf{maxof(int)}
\rightarrow [simplify]
```

```
[1.20] (-1 + ([0 < -\$heap_{724,1;753,8}.p3]: 30323, [-1 < \$heap_{724,1;753,8}.p3]: 0)) < -1.20]
32767
\rightarrow [move guard outside expression]
 [1.21] \; ([0 < -\$heap_{724,1;753,8}.p3]: \; -1 \; + \; 30323, \; [-1 < \$heap_{724,1;753,8}.p3]: \; -1 \; + \; 30323, \; [-1 < \$heap_{724,1;753,8}.p3]: \; -1 \; + \; 30323, \; [-1 < \$heap_{724,1;753,8}.p3]: \; -1 \; + \; 30323, \; [-1 < \$heap_{724,1;753,8}.p3]: \; -1 \; + \; 30323, \; [-1 < \$heap_{724,1;753,8}.p3]: \; -1 \; + \; 30323, \; [-1 < \$heap_{724,1;753,8}.p3]: \; -1 \; + \; 30323, \; [-1 < \$heap_{724,1;753,8}.p3]: \; -1 \; + \; 30323, \; [-1 < \$heap_{724,1;753,8}.p3]: \; -1 \; + \; 30323, \; [-1 < \$heap_{724,1;753,8}.p3]: \; -1 \; + \; 30323, \; [-1 < \$heap_{724,1;753,8}.p3]: \; -1 \; + \; 30323, \; [-1 < \$heap_{724,1;753,8}.p3]: \; -1 \; + \; 30323, \; [-1 < \$heap_{724,1;753,8}.p3]: \; -1 \; + \; 30323, \; [-1 < \$heap_{724,1;753,8}.p3]: \; -1 \; + \; 30323, \; [-1 < \$heap_{724,1;753,8}.p3]: \; -1 \; + \; 30323, \; [-1 < \Sheap_{724,1;753,8}.p3]: \; -1 \; + \; 30323, \; [-1 < \Sheap_{724,1;753,8}.p3]: \; -1 \; + \; 30323, \; [-1 < \Sheap_{724,1;753,8}.p3]: \; -1 \; + \; 30323, \; [-1 < \Sheap_{724,1;753,8}.p3]: \; -1 \; + \; 30323, \; [-1 < \Sheap_{724,1;753,8}.p3]: \; -1 \; + \; 30323, \; [-1 < \Sheap_{724,1;753,8}.p3]: \; -1 \; + \; 30323, \; [-1 < \Sheap_{724,1;753,8}.p3]: \; -1 \; + \; 30323, \; [-1 < \Sheap_{724,1;753,8}.p3]: \; -1 \; + \; 30323, \; [-1 < \Sheap_{724,1;753,8}.p3]: \; -1 \; + \; 30323, \; [-1 < \Sheap_{724,1;753,8}.p3]: \; -1 \; + \; 30323, \; [-1 < \Sheap_{724,1;753,8}.p3]: \; -1 \; + \; 30323, \; [-1 < \Sheap_{724,1;753,8}.p3]: \; -1 \; + \; 30323, \; [-1 < \Sheap_{724,1;753,8}.p3]: \; -1 \; + \; 30323, \; [-1 < \Sheap_{724,1;753,8}.p3]: \; -1 \; + \; 30323, \; [-1 < \Sheap_{724,1;753,8}.p3]: \; -1 \; + \; 30323, \; [-1 < \Sheap_{724,1;753,8}.p3]: \; -1 \; + \; 30323, \; [-1 < \Sheap_{724,1;753,8}.p3]: \; -1 \; + \; 30323, \; [-1 < \Sheap_{724,1;753,8}.p3]: \; -1 \; + \; 30323, \; [-1 < \Sheap_{724,1;753,8}.p3]: \; -1 \; + \; 30323, \; [-1 < \Sheap_{724,1;753,8}.p3]: \; -1 \; + \; 30323, \; [-1 < \Sheap_{724,1;753,8}.p3]: \; -1 \; + \; 30323, \; [-1 < \Sheap_{724,1;753,8}.p3]: \; -1 \; + \; 30323, \; [-1 < \Sheap_{724,1;753,8}.p3]: \; -1 \; + \; 30323, \; [-1 < \Sheap_{724,1;753,8}.p3]: \; -1 \; + \; 30323, \; [-1 < \Sheap_{724,1;753,8}.p3]: \; -1 \; + \; 30
0) < 32767
 \rightarrow [simplify]
  [1.24] \ 0 < (32767 + -([0 < -\$heap_{724,1;753,8}.p3]: \ 30322, \ [-1 < -\hbarheap_{724,1;753,8}.p3]: \ 30322, \
heap_{724,1;753,8}.p3: -1))
 \rightarrow [move guard outside expression]
 [1.25] 0 < (32767 + ([0 < -\$heap_{724.1:753.8}.p3]: -30322, [-1 < -\$heap_{724.1:753.8}.p3]: -30322, [-1 < -\$heap_{724.1:753.8}.p3]
heap_{724,1;753,8}.p3: --1)
\rightarrow [simplify]
 [1.27] 0 < (32767 + ([0 < -\$heap_{724,1;753,8}.p3]: -30322, [-1 < -\Sheap_{724,1;753,8}.p3]: -30322, [-1 < -\Sheap_{724,1;75
heap_{724,1;753,8}.p3: 1)
\rightarrow [move guard outside expression]
 [1.28] 0 < ([0 < -$heap<sub>724,1;753,8</sub>.p3]: -30322 + 32767, [-1 <
heap_{724,1;753,8}.p3: 1 + 32767)
 \rightarrow [simplify]
[1.30] \ 0 < ([0 < -\$heap_{724,1;753,8}.p3]: 2445, [-1 < \$heap_{724,1;753,8}.p3]: 32768)
\rightarrow [move guard outside expression]
[1.31] ([0 < -$heap<sub>724,1:753,8</sub>.p3]: 0 < 2445, [-1 < $heap<sub>724,1:753,8</sub>.p3]: 0 <
32768)
\rightarrow [simplify]
[1.33] ([0 < -$heap<sub>724,1;753,8</sub>.p3]: true, [-1 < $heap<sub>724,1;753,8</sub>.p3]: true)
\rightarrow [all guards have equal guarded terms]
[1.34] true
Proof of verification condition: Type constraint satisfied in implicit
conversion from 'short int' to 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (70,5)
Condition defined at:
To prove: minof(int) \le \text{$heap}_{724,1;753,8}.p3
 Given:
heap_{init}.LIMIT == (int)80
```

 $heap_{init}.M1 == asType < short int > ((int)30269)$

```
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
heap_{init}.M2 == asType < short int > ((int)30307)
\theta_{init}.r2 == asType<short int>((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs $heap_{tuncstart_724.1})
div1 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ / \\
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(\mathbf{asType} {<} \mathbf{integer} {>} (\mathbf{asType} {<} \mathbf{int} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1})) =>
(asType < integer > ($heap_{funcstart\_724.1}.p1) = =
asType<integer>(div1.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathtt{a1}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p1)) => !(0 ==
asType < integer > (div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
```

```
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}))\ /
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.quot)
(asType<int>(asType<int>($heap_{funcstart\_724,1}.p2)) %
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p2) = =
asType<integer>(div2.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a2) \le
asType < integer > (\$heap_{funcstart\_724,1}.p2)) => !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart_{-724.1}},
\mathbf{asType} < \mathbf{int} > (\$ heap_{funcstart\_724,1}.p3),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3})) \ / \\
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a3}))) = =
asType<integer>(div3.quot)
(asType<integer>(asType<int>($heap_{tuncstart\_724.1}.p3)) %
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a3}))) = =
asType<integer>(div3.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a3})) = >
(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a3}) \leq
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3})) => !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
-asType < integer const > (\$heap_{724,1:745.8}.M1) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{p1})
!(0 == asType < integer > (\$heap_{724,1;745,8}.p1))
```

```
asType<integer>($heap<sub>724.1:745.8</sub>.p1) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{M1})
heap_{724,1:747,8} == heap_{724,1:745,8}.replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724.1:745.8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType< int>($heap_{724,1;745,8}.b2))))
-asType < integer const > (\$heap_{724,1:747,8}.M2) < 
asType<integer>($heap<sub>724,1:747,8</sub>.p2)
!(0 == asType < integer > (\$heap_{724,1:747,8}.p2))
asType<integer>($heap<sub>724.1:747.8</sub>.p2) <
asType<integer>($heap<sub>724.1:747.8</sub>.M2)
\text{Sheap}_{724,1;749,8} == \text{Sheap}_{724,1;747,8}.\text{replace}(p3 \to asType < short)
int>((asType<int>(asType<short int>(div3.rem)) *
asType < int > (\$heap_{724,1:747,8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap<sub>724.1:747.8</sub>.b3))))
-asType<integer const>($heap<sub>724,1;749,8</sub>.M3) <
asType < integer > ($heap_{724,1;749,8}.p3)
!(0 == asType < integer > (\$heap_{724,1;749,8}.p3))
asType<integer>($heap<sub>724.1:749.8</sub>.p3) <
asType<integer>($heap<sub>724.1:749.8</sub>.M3)
\text{sheap}_{724,1;752,8} == \text{sheap}_{724,1;749,8}. \text{replace}(\text{p1} \to \text{asType} < \text{short})
int>((asType<int>($heap<sub>724,1:749,8</sub>.M1) *
asType<int>(static_cast<integer>(asType<int>($heap_{724,1:749,8}.p1) <
(int)(0) + asType<int>($heap<sub>724,1:749,8</sub>.p1)))
\text{$heap}_{724,1;753,8} == \text{$heap}_{724,1;752,8}.\mathbf{replace}(p2 \to \mathbf{asType} < \mathbf{short})
int>((asType< int>(\$heap_{724,1;752,8}.M2) *
asType<int>(static_cast<integer>(asType<int>($heap_{724.1:752.8}.p2) <
(int)(0) + asType<int>($heap_{724.1:752.8}.p2)))
Proof:
[Take goal term]
[1.0] minof(int) \leq $heap<sub>724,1;753,8</sub>.p3
\rightarrow [simplify]
[1.3] -32769 < heap_{724,1;753,8}.p3
\rightarrow [negate goal and search for contradiction]
[1.4]!(-32769 < \text{$heap}_{724,1;753,8}.p3)
\rightarrow [simplify]
[1.6] 32768 < -$heap<sub>724.1:753.8</sub>.p3
```

```
[Assume known post-assertion, class invariant or type constraint for term 1.6]
[75.0] minof(short int) \leq $heap<sub>724,1;753,8</sub>.p3
\rightarrow [simplify]
[75.3] -32769 < page = 32769 < page = 32769
\rightarrow [from term 1.6, literala < $heap<sub>724,1;753,8</sub>.p3 is false whenever -2 < (32768)
+ literala)]
   Proof of rule precondition:
   [75.3.0] - 2 < (-32769 + 32768)
   \rightarrow [simplify]
   [75.3.2] true
[75.4] false
Proof of verification condition: Type constraint satisfied in implicit
conversion from 'short int' to 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (70,5)
Condition defined at:
To prove: heap_{724,1;753,8}.p3 \le maxof(int)
Given:
heap_{init}.LIMIT == (int)80
\theta
\label{eq:short_int} $$ $ = asType < short int > ((int)171) $$
\theta
\theta
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
```

```
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart_{-724,1}})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ / \\
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))) = =
asType<integer>(div1.quot)
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}))) = =
asType<integer>(div1.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p1) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) = =
asType<integer>(div1.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathtt{a1}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart_{-724.1}},
asType < int > (\$heap_{funcstart\_724.1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
(asType<integer>(asType<int>($heap_{funcstart\_724,1}.p2)) /
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType < integer > (div2.quot)
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}))~\%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.rem)
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}) ==
asType<integer>(div2.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a2) \le
asType < integer > (\$heap_{funcstart\_724,1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart_{-724.1}},
asType < int > (\$heap_{funcstart\_724,1}.p3),
```

```
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
(asType<integer>(asType<int>($heap_{tuncstart_724,1}.p3)) /
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))) = =
asType<integer>(div3.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.rem)
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) ==
asType<integer>(div3.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a3) \le
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3})) = > !(0 = =
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1.quot})) * \mathbf{asType}{<} \mathbf{int}{>} (\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
-asType<integer const>($heap<sub>724.1:745.8</sub>.M1) <
asType<integer>($heap<sub>724,1:745,8</sub>.p1)
!(0 == asType < integer > (\$heap_{724,1:745.8}.p1))
asType < integer > (\$heap_{724,1;745,8}.p1) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{M1})
heap_{724,1;747,8} == heap_{724,1;745,8}.replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724.1:745.8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType< int>($heap_{724,1:745,8}.b2))))
-asType < integer const > (\$heap_{724,1:747.8}.M2) < 
asType<integer>($heap<sub>724,1:747,8</sub>.p2)
!(0 == asType < integer > (\$heap_{724,1:747.8}.p2))
asType<integer>($heap<sub>724,1:747,8</sub>.p2) <
asType<integer>($heap<sub>724,1:747,8</sub>.M2)
\text{heap}_{724.1:749.8} == \text{heap}_{724.1:747.8}._replace(p3 \rightarrow asType<short)
int>((asType<int>(asType<short int>(div3.rem))
\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{724,1;747,8}.\mathrm{r3})) - (\mathbf{asType} < \mathbf{int} > (\mathbf{asType} < \mathbf{short}))
int>(div3.quot)) * asType<int>($heap<sub>724.1:747.8</sub>.b3))))
-asType<integer const>($heap<sub>724,1:749,8</sub>.M3) <
```

```
asType<integer>($heap<sub>724.1:749.8</sub>.p3)
!(0 == asType < integer > (\$heap_{724,1:749.8}, p3))
asType<integer>($heap<sub>724,1;749,8</sub>.p3) <
asType<integer>($heap<sub>724,1;749,8</sub>.M3)
\text{$heap}_{724,1;752,8} == \text{$heap}_{724,1;749,8}.\_\textbf{replace}(\text{p1} \to \textbf{asType} < \textbf{short}
int>((asType<int>($heap<sub>724,1:749.8</sub>.M1) *
\mathbf{asType} < \mathbf{int} > (\mathbf{static\_cast} < \mathbf{integer}) < (\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{724,1:749.8}.\mathrm{p1}) < (\$ \mathrm{heap}_{724,1:749.8}.\mathrm{p1})
(int)(0)) + asType < int > (\$heap_{724,1;749,8}.p1)))
\$heap_{724,1;753,8} == \$heap_{724,1;752,8}.\mathbf{replace}(p2 \rightarrow \mathbf{asType} < \mathbf{short}
int>((asType<int>($heap<sub>724.1:752.8</sub>.M2) *
asType<int>(static_cast<integer>(asType<int>($heap_{724.1:752.8}.p2) <
(int)(0)) + asType<int>($heap<sub>724.1:752.8</sub>.p2)))
Proof:
[Take goal term]
[1.0] $heap<sub>724,1:753,8</sub>.p3 \leq maxof(int)
\rightarrow [simplify]
[1.9] -32768 < -\$heap_{724,1:753.8}.p3
\rightarrow [negate goal and search for contradiction]
[1.10]!(-32768 < -\$heap_{724.1:753.8}.p3)
\rightarrow [simplify]
\textit{[1.13]}\ 32767 < \$ heap_{724,1;753,8}.p3
[Assume known post-assertion, class invariant or type constraint for term 1.13]
[75.0] $heap<sub>724,1:753,8</sub>.p3 \leq maxof(short int)
\rightarrow [simplify]
[75.9] - 32768 < -\$heap_{724,1;753,8}.p3
\rightarrow [from term 1.13, literala < -$heap<sub>724.1:753.8</sub>.p3 is false whenever -2 <
(32767 + literala)
          Proof of rule precondition:
          [75.9.0] - 2 < (-32768 + 32767)
          \rightarrow [simplify]
          [75.9.2] true
[75.10] false
```

Proof of verification condition: Type constraint satisfied in implicit conversion from 'int' to 'short int'

```
Condition generated at: C:\Escher\Customers\prang\prang.c (70,8)
Condition defined at:
To prove: minof(short int) \leq ((asType<int>($heap<sub>724.1:753.8</sub>.M3) *
\mathbf{asType} < \mathbf{int} > (\mathbf{static\_cast} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{724,1;753,8}.\mathrm{p3}) < \mathsf{nt}) < \mathsf{nt} > \mathsf{nt} >
(int)(0)) + asType < int > ($heap_{724,1;753,8}.p3))
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
\theta
heap_{init}.a1 == asType < short int > ((int)177)
\theta
heap_{init}.M2 == asType < short int > ((int)30307)
heap_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
heap_{init}.b2 == asType<short int>((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType < short int > ((int)170)
\theta = asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta
\theta
heap_{init}.p3 == asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart\_724,1})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \ \operatorname{\$heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(asType<integer>(asType<int>($heap_{funcstart\_724.1}.p1)) /
asType<int>($heap_{tuncstart_724,1}.a1))) ==
asType<integer>(div1.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}) <
\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{a1})) = >
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) = =
asType<integer>(div1.rem))
```

```
(asType < integer > (\$heap_{funcstart_{-724,1}}.a1) \le
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2})) \ / \ 
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724.1}.p2)) \%
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p2) = =
asType<integer>(div2.rem))
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}),
asType < int > (\$heap_{funcstart\_724,1}.a3))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}))~\%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))) ==
asType<integer>(div3.rem)
(asType<integer>($heap_funcstart_724.1.p3) <
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a3})) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a3) \le
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})) => !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
```

```
asType<integer>(div3.quot))
$heap_{724,1;745,8} == $heap_{funcstart\_724,1}.\_replace(p1 \rightarrow asType < short)
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType<int>($heap_{funcstart\_724,1}.b1)))
-asType < integer\ const > (\$heap_{724,1;745,8}.M1) < 1
asType<integer>($heap<sub>724,1:745,8</sub>.p1)
!(0 == asType < integer > (\$heap_{724,1;745,8}.p1))
asType<integer>($heap<sub>724.1:745.8</sub>.p1) <
asType<integer>($heap<sub>724.1:745.8</sub>.M1)
$heap_{724,1;747,8} == $heap_{724,1;745,8}.replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724,1:745,8}.r2)) - (asType < int > (asType < short)
\mathbf{int}{>}(\text{div2.quot})) \ * \ \mathbf{asType}{<} \mathbf{int}{>} (\$\text{heap}_{724,1;745,8}.\text{b2}))))
-asType < integer\ const > (\$heap_{724,1;747,8}.M2) < 
asType<integer>($heap<sub>724.1:747.8</sub>.p2)
!(0 == \mathbf{asType} < \mathbf{integer} > (\$ heap_{724,1;747,8}.p2))
asType<integer>($heap<sub>724,1;747,8</sub>.p2) <
asType<integer>($heap<sub>724.1:747.8</sub>.M2)
\text{heap}_{724,1:749.8} == \text{heap}_{724,1:747.8}._replace(p3 \rightarrow asType<short)
int>((asType<int>(asType<short int>(div3.rem))
asType < int > (\$heap_{724,1:747,8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap<sub>724,1:747,8</sub>.b3))))
-asType<integer const>($heap<sub>724.1:749.8</sub>.M3) <
asType<integer>($heap<sub>724.1:749.8</sub>.p3)
!(0 == asType < integer > (\$heap_{724,1:749.8}.p3))
asType<integer>($heap<sub>724.1:749.8</sub>.p3) <
asType<integer>($heap<sub>724,1;749,8</sub>.M3)
heap_{724,1:752,8} == heap_{724,1:749,8}.replace(p1 \rightarrow asType<short
int>((asType< int>(\$heap_{724,1;749,8}.M1) *
asType<int>(static_cast<integer>(asType<int>($heap<sub>724.1:749.8</sub>.p1) <
(int)(0)) + asType < int > (\$heap_{724,1;749,8}.p1)))
\text{$heap}_{724,1;753,8} == \text{$heap}_{724,1;752,8}.\_\textbf{replace}(p2 \to \textbf{asType} < \textbf{short}
int>((asType< int>(\$heap_{724,1;752,8}.M2) *
asType<int>(static_cast<integer>(asType<int>($heap<sub>724.1:752.8</sub>.p2) <
(int)(0)) + asType < int > ($heap_{724,1;752,8}.p2)))
Proof:
```

[Take goal term]

```
[1.0] minof(short int) \leq ((asType<int>($heap<sub>724.1:753.8</sub>.M3) *
\mathbf{asType} < \mathbf{int} > (\mathbf{static\_cast} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{724,1;753,8}.\mathrm{p3}) < \mathsf{mather})
(int)(0) + asType<int>($heap<sub>724,1:753,8</sub>.p3))
\rightarrow [simplify]
[1.1] -32768 \leq ((asType<int>($heap<sub>724,1;753,8</sub>.M3) *
asType<int>(static_cast<integer>(asType<int>($heap<sub>724.1:753.8</sub>.p3) <
(int)(0)) + asType < int > (\$heap_{724,1;753,8}.p3))
\rightarrow [const static or extern object]
[1.2] -32768 \le ((asType < int > (\$heap_{init}.M3) *
asType<int>(static_cast<integer>(asType<int>($heap_{724.1:753.8}.p3) <
(int)(0) + asType<int>($heap<sub>724.1:753.8</sub>.p3))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[1.3] -32768 \leq ((asType\leqint>(asType\leqshort int>((int)30323)) *
asType<int>(static_cast<integer>(asType<int>($heap<sub>724.1:753.8</sub>.p3) <
(int)(0) + asType<int>($heap<sub>724,1;753,8</sub>.p3))
\rightarrow [simplify]
[1.11] -32768 \leq ((30323 * asType<int>(([0 < -$heap<sub>724,1;753,8</sub>.p3]: 1, []: 0)))
+ asType < int > ($heap_{724,1;753,8}.p3))
→ [explicitly assert falsehood of skipped guards in subsequent guards]
 [1.12] \ \hbox{--}32768 \le ((30323 \ \hbox{* asType} < \mathbf{int} > (([0 < -\$ \mathrm{heap}_{724,1;753,8}.\mathrm{p3}] : \ 1, \ [!(0 < -\$ \mathrm{heap}_{7
-\text{$heap}_{724,1;753,8}.\text{p3}): 0))) + asType<int>($heap}_{724,1;753,8}.\text{p3}))
\rightarrow [simplify]
 \lceil 1.16 \rceil \text{ -32768} \leq ((30323 * ([0 < -\$ \text{heap}_{724,1;753,8}.\text{p3}]: 1, [-1 <
\text{sheap}_{724,1;753,8}.\text{p3}: 0) + \mathbf{asType} < \mathbf{int} > (\text{sheap}_{724,1;753,8}.\text{p3}))
\rightarrow [move guard outside expression]
[1.17] -32768 \leq (([0 < -$heap<sub>724,1:753,8</sub>.p3]: 1 * 30323, [-1 <
\rho_{724,1:753,8} = 0 * 30323 + asType < int > (\rho_{724,1:753,8} = 0)
\rightarrow [simplify]
[1.20] -32768 \leq (([0 < -$heap<sub>724,1:753,8</sub>.p3]: 30323, [-1 < $heap<sub>724,1:753,8</sub>.p3]:
0) + \text{$heap}_{724,1;753,8}.p3)
\rightarrow [move guard outside expression]
[1.21] -32768 \leq ([0 < -$heap<sub>724,1:753,8</sub>.p3]: 30323 + $heap<sub>724,1:753,8</sub>.p3, [-1 <
heap_{724,1;753,8}.p3: 0 + p_{724,1;753,8}.p3
\rightarrow [simplify]
[1.24] -32769 < ([0 < -$heap<sub>724,1;753,8</sub>.p3]: 30323 + $heap<sub>724,1;753,8</sub>.p3, [-1 < -$parallel | 1.24] | 1.24]
heap_{724,1;753,8}.p3: p_{724,1;753,8}.p3
\rightarrow [move guard outside expression]
```

```
[1.25] ([0 < -$heap<sub>724,1;753,8</sub>.p3]: -32769 < (30323 + $heap<sub>724,1;753,8</sub>.p3), [-1 <
\rho_{724,1;753,8.p3}: -32769 < \rho_{724,1;753,8.p3}
\rightarrow [simplify]
[1.27] ([0 < -$heap<sub>724,1;753,8</sub>.p3]: -63092 < $heap<sub>724,1;753,8</sub>.p3, [-1 <
heap_{724,1;753,8}.p3: -32769 < heap_{724,1;753,8}.p3
\rightarrow [from guard, literala < $heap_{724,1:753.8}.p3 is true whenever (-1 + literala) <
        Proof of rule precondition:
        [1.27.0](-32769 + -1) < -1
        \rightarrow [simplify]
        [1.27.2] true
[1.28] ([0 < -$heap<sub>724,1;753,8</sub>.p3]: -63092 < $heap<sub>724,1;753,8</sub>.p3, [-1 <
$heap<sub>724,1:753,8</sub>.p3]: true)
\rightarrow [negate goal and search for contradiction]
\hbox{$[1.29]$ !([0<-$heap_{724,1;753,8}.p3]: -63092<$heap_{724,1;753,8}.p3, [-1<-$heap_{724,1;753,8}.p3]: -63092<$heap_{724,1;753,8}.p3, [-1<-$heap_{724,1;753,8}.p3]: -63092<$heap_{724,1;753,8}.p3, [-1<-$heap_{724,1;753,8}.p3]: -63092<$heap_{724,1;753,8}.p3, [-1<-$heap_{724,1;753,8}.p3]: -63092<$heap_{724,1;753,8}.p3, [-1<-$heap_{724,1;753,8}.p3]: -63092<$heap_{724,1;753,8}.p3, [-1<-$heap_{724,1;753,8}.p3]: -63092<$heap_{724,1;753,8}.p3]: -63092
$heap<sub>724,1:753,8</sub>.p3]: true)
\rightarrow [move guard outside expression]
[1.30] ([0 < -$heap<sub>724,1;753,8</sub>.p3]: !(-63092 < $heap<sub>724,1;753,8</sub>.p3), [-1 <
$heap<sub>724,1:753,8</sub>.p3]: !true)
\rightarrow [simplify]
[1.35] (0 < -$heap<sub>724,1;753,8</sub>.p3) \wedge (63091 < -$heap<sub>724,1;753,8</sub>.p3)
[Work on sub-term 2 of conjunction in term 1.35]
[75.0] 63091 < -$heap<sub>724,1;753,8</sub>.p3
[Assume known post-assertion, class invariant or type constraint for term 1.35]
[76.0] minof(short int) \leq $heap<sub>724,1;753,8</sub>.p3
\rightarrow [simplify]
[76.3] -32769 < page = 32769 < page = 32769
\rightarrow [from term 75.0, literala < $heap<sub>724,1;753,8</sub>.p3 is false whenever -2 < (63091)
+ literala)]
        Proof of rule precondition:
        [76.3.0] - 2 < (-32769 + 63091)
        \rightarrow [simplify]
        [76.3.2] true
[76.4] false
```

```
Proof of verification condition: Type constraint satisfied in implicit
conversion from 'int' to 'short int'
Condition generated at: C:\Escher\Customers\prang\prang.c (70,8)
Condition defined at:
To prove: ((asType<int>($heap<sub>724,1:753,8</sub>.M3) *
asType<int>(static_cast<integer>(asType<int>($heap_{724.1:753.8}.p3) <
(int)(0) + asType<int>($heap<sub>724,1:753,8</sub>.p3)) \leq maxof(short int)
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
\theta_{init}.a1 == asType<short int>((int)177)
\theta = asType < short int > ((int)2)
heap_{init}.M2 == asType < short int > ((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
\theta
\theta == asType<short int>((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs $heap_{tuncstart_724.1})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1})) \ / \\
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(\mathbf{asType} {<} \mathbf{int} {>} (\mathbf{asType} {<} \mathbf{int} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}) <
```

```
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a1})) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) ==
asType<integer>(div1.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a1}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p1)) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart_{-724,1}}.a2))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.quot)
(asType<int>(asType<int>($heap_{tuncstart\_724.1}.p2)) %
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p2) = =
asType<integer>(div2.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.a2) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724.1}.p3),
asType < int > (\$heap_{funcstart\_724,1}.a3))
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3})) \ / \\
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathtt{a3}))) ==
asType<integer>(div3.quot)
(asType<integer>(asType<int>($heap_{tuncstart\_724.1}.p3)) %
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a3}))) = =
asType<integer>(div3.rem)
(asType<integer>($heap_funcstart_724,1.p3) <
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a3})) = >
(asType < integer > ($heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a3}) \leq
```

```
asType < integer > (\$heap_{funcstart-724.1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724.1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
-asType<integer const>($heap<sub>724,1:745,8</sub>.M1) <
asType<integer>($heap<sub>724.1:745.8</sub>.p1)
!(0 == asType < integer > (\$heap_{724,1;745,8}.p1))
asType < integer > (\$heap_{724,1;745,8}.p1) <
asType<integer>($heap<sub>724,1:745,8</sub>.M1)
\text{heap}_{724.1:747.8} == \text{heap}_{724.1:745.8}._replace(p2 \rightarrow asType<short)
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724,1;745,8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType< int>($heap_{724,1;745,8}.b2))))
-asType<integer const>($heap<sub>724.1:747.8</sub>.M2) <
asType<integer>($heap<sub>724.1:747.8</sub>.p2)
!(0 == asType < integer > (\$heap_{724,1;747,8}.p2))
{\bf asType}{<} {\bf integer}{>} (\$ {\rm heap}_{724,1;747,8}.{\rm p2}) <
asType<integer>($heap<sub>724,1:747,8</sub>.M2)
heap_{724,1:749.8} == heap_{724,1:747.8}._replace(p3 \rightarrow asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType < int > (\$heap_{724,1.747,8.}r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType< int>($heap_{724,1;747,8}.b3))))
-asType < integer const > (\$heap_{724,1:749,8}.M3) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;749,8}.\mathrm{p3})
!(0 == asType < integer > (\$heap_{724,1:749.8}.p3))
asType<integer>($heap<sub>724,1:749,8</sub>.p3) <
asType<integer>($heap<sub>724.1:749.8</sub>.M3)
\text{heap}_{724.1;752.8} == \text{heap}_{724.1;749.8}._replace(p1 \rightarrow asType<short)
int>((asType<int>($heap<sub>724.1:749.8</sub>.M1) *
\mathbf{asType} < \mathbf{int} > (\mathbf{static\_cast} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{724,1;749,8}.\mathrm{p1}) < \mathsf{nt}) < \mathsf{nt} > \mathsf{nt} >
(int)(0) + asType < int > ($heap_{724.1:749.8}.p1))
heap_{724,1:753.8} == heap_{724,1:752.8}.replace(p2 \rightarrow asType<short
int>((asType<int>($heap<sub>724,1;752,8</sub>.M2) *
asType<int>(static_cast<integer>(asType<int>($heap<sub>724,1:752,8</sub>.p2) <
(int)(0)) + asType < int > ($heap_{724,1;752,8}.p2)))
```

Proof:

```
[Take goal term]
[1.0] ((asType<int>($heap<sub>724.1:753.8</sub>.M3) *
\mathbf{asType} < \mathbf{int} > (\mathbf{static\_cast} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{724,1;753,8}.\mathrm{p3}) < \mathsf{nt}) < \mathsf{nt} > \mathsf{nt} >
(int)(0)) + asType < int > (\$heap_{724,1;753,8}.p3)) \le maxof(short int)
\rightarrow [const static or extern object]
[1.1] ((asType<int>($heap_{init}.M3) *
asType<int>(static_cast<integer>(asType<int>($heap_{724.1:753.8}.p3) <
(int)(0) + asType<int>(heap_{724,1;753,8}.p3)) \leq maxof(short int)
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[1.2] ((asType<int>(asType<short int>((int)30323)) *
asType<int>(static_cast<integer>(asType<int>($heap_{724.1:753.8}.p3) <
(int)(0) + asType<int>($heap<sub>724.1:753.8</sub>.p3)) \leq maxof(short int)
\rightarrow [simplify]
[1.10] ((30323 * asType<int>(([0 < -$heap_{724.1:753.8}.p3]: 1, []: 0))) +
asType < int > (\$heap_{724,1;753,8}.p3)) \le maxof(short int)
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[1.11] ((30323 * asType<int>(([0 < -$heap_{724,1:753.8}.p3]: 1, [!(0 < -$heap_{724,1:753.8}.p3]: 1)
-\text{$heap}_{724,1:753,8}.p3)]: 0))) + asType<int>($heap}_{724,1:753,8}.p3)) \le \text{9}
maxof(short int)
\rightarrow [simplify]
[1.15] \left( (30323*([0<-\$heap_{724,1;753,8}.p3]: 1, [-1<\$heap_{724,1;753,8}.p3]: 0) \right) + \\
asType < int > (\$heap_{724,1:753,8}.p3)) \le maxof(short int)
\rightarrow [move guard outside expression]
[1.16] (([0 < -$heap<sub>724,1:753,8</sub>.p3]: 1 * 30323, [-1 < $heap<sub>724,1:753,8</sub>.p3]: 0 *
30323) + asType < int > (\$heap_{724,1:753,8}.p3)) \le maxof(short int)
\rightarrow [simplify]
[1.19] (([0 < -$heap<sub>724,1;753,8</sub>.p3]: 30323, [-1 < $heap<sub>724,1;753,8</sub>.p3]: 0) +
$heap_{724,1:753,8}.p3) \le maxof(short int)
\rightarrow [move guard outside expression]
[1.20] ([0 < -$heap<sub>724.1:753.8</sub>.p3]: 30323 + $heap<sub>724.1:753.8</sub>.p3, [-1 <
\text{sheap}_{724,1;753,8}.\text{p3}: 0 + \text{sheap}_{724,1;753,8}.\text{p3} \leq \text{maxof}(\text{short int})
\rightarrow [simplify]
[1.23] (-1 + ([0 < -$heap<sub>724,1;753,8</sub>.p3]: 30323 + $heap<sub>724,1;753,8</sub>.p3, [-1 <
heap_{724,1;753,8}.p3: page 24,1;753,8.p3: page 24,1;753,8.p3:
\rightarrow [move guard outside expression]
```

```
[1.24] ([0 < -$heap<sub>724,1:753,8</sub>.p3]: -1 + (30323 + $heap<sub>724,1:753,8</sub>.p3), [-1 <
heap_{724,1;753,8}.p3: -1 + p_{724,1;753,8}.p3 < 32767
\rightarrow [simplify]
[1.27] \ 0 < (32767 + -([0 < -\$heap_{724,1;753,8}.p3]: \ 30322 + \$heap_{724,1;753,8}.p3,
[-1 < \text{$heap}_{724,1;753,8}.p3]: -1 + \text{$heap}_{724,1;753,8}.p3))
\rightarrow [move guard outside expression]
[1.28] 0 < (32767 + ([0 < -\$heap_{724,1;753,8}.p3]: -(30322 + )]
\text{Sheap}_{724,1;753,8}.\text{p3}, [-1 < \text{Sheap}_{724,1;753,8}.\text{p3}]: -(-1 + \text{Sheap}_{724,1;753,8}.\text{p3}))
\rightarrow [simplify]
[1.32]\ 0 < (32767 + ([0 < -\$heap_{724,1;753,8}.p3]: -30322 + -\$heap_{724,1;753,8}.p3]
[-1 < \text{$heap}_{724,1;753,8}.p3]: 1 + -\text{$heap}_{724,1;753,8}.p3))
\rightarrow [move guard outside expression]
[1.33]\ 0 < ([0 < -\$heap_{724,1:753,8}.p3]:\ 32767 + (-30322 + -\$heap_{724,1:753,8}.p3),
[-1 < \text{$heap}_{724,1;753,8}.p3]: 32767 + (1 + -\text{$heap}_{724,1;753,8}.p3))
\rightarrow [simplify]
[1.37] 0 < ([0 < -$heap<sub>724,1;753,8</sub>.p3]: 2445 + -$heap<sub>724,1;753,8</sub>.p3, [-1 <
heap_{724,1;753,8}.p3: 32768 + -heap_{724,1;753,8}.p3
\rightarrow [move guard outside expression]
[1.38] ([0 < -$heap<sub>724,1:753,8</sub>.p3]: 0 < (2445 + -$heap<sub>724,1:753,8</sub>.p3), [-1 <
\text{sheap}_{724,1;753,8}.\text{p3}: 0 < (32768 + -\text{sheap}_{724,1;753,8}.\text{p3})
\rightarrow [simplify]
[1.40] ([0 < -$heap<sub>724,1;753,8</sub>.p3]: -2445 < -$heap<sub>724,1;753,8</sub>.p3, [-1 <
\text{heap}_{724,1;753,8}.\text{p3}: 0 < (32768 + -\text{heap}_{724,1;753,8}.\text{p3}))
\rightarrow [from guard, literala < -$heap<sub>724,1;753,8</sub>.p3 is true whenever (-1 + literala)
< 0
    Proof of rule precondition:
    [1.40.0](-2445 + -1) < 0
    \rightarrow [simplify]
    [1.40.2] true
[1.41] ([0 < -\$heap_{724,1;753,8}.p3]: \ \mathbf{true}, \ [-1 < \$heap_{724,1;753,8}.p3]: \ 0 < (32768)
+ - \text{$heap}_{724,1;753,8}.p3)
\rightarrow [simplify]
 [1.43] \; ([0 < -\$heap_{724,1;753,8}.p3]: \; \mathbf{true}, \; [\text{-}1 < \$heap_{724,1;753,8}.p3]: \; \text{-}32768 < 
-\$heap_{724,1;753,8}.p3
\rightarrow [negate goal and search for contradiction]
[1.44]!([0 < -\$heap_{724,1;753,8}.p3]: true, [-1 < \$heap_{724,1;753,8}.p3]: -32768 <
```

```
-\$heap_{724,1;753,8}.p3
\rightarrow [move guard outside expression]
[1.45] ([0 < -$heap<sub>724,1;753,8</sub>.p3]: !true, [-1 < $heap<sub>724,1;753,8</sub>.p3]: !(-32768 <
-\$heap_{724,1;753,8}.p3)
\rightarrow [simplify]
[1.51] (-1 < \text{$heap}_{724,1;753,8}.p3) \land (32767 < \text{$heap}_{724,1;753,8}.p3)
[Work on sub-term 2 of conjunction in term 1.51]
[75.0] 32767 < heap_{724,1;753,8}.p3
[Assume known post-assertion, class invariant or type constraint for term 1.51]
[76.0] $heap<sub>724,1:753.8</sub>.p3 \leq maxof(short int)
\rightarrow [simplify]
[76.9] -32768 < -\$heap_{724,1;753,8}.p3
\rightarrow [from term 75.0, literala < -$heap<sub>724,1;753,8</sub>.p3 is false whenever -2 <
(32767 + literala)
   Proof of rule precondition:
   [76.9.0] - 2 < (-32768 + 32767)
   \rightarrow [simplify]
   [76.9.2] true
[76.10] false
Proof of verification condition: Assertion valid
Condition generated at: C:\Escher\Customers\prang\prang.c (76,12)
To prove: invariant1(heapIs heap_{funcend\_724,1})
Given:
heap_{init}.LIMIT == (int)80
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta
heap_{init}.M2 == asType < short int > ((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta sheap<sub>init</sub>.b2 == asType<short int>((int)35)
```

```
heap_{init}.M3 == asType < short int > ((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
heap_{init}.b3 == asType < short int > ((int)63)
\theta
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs $heap_{tuncstart_724.1})
div1 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}),
asType < int > (\$heap_{funcstart_{-724,1}}.a1))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) /
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}))) = =
asType<integer>(div1.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p1) < 
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) ==
asType<integer>(div1.rem))
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724.1}.a2))) = =
asType<integer>(div2.quot)
(asType < integer > (asType < int > (\$heap_{tuncstart\_724,1}.p2)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a2})) = >
(asType < integer > (\$heap_{funcstart_{-724.1}}.p2) = =
```

```
asType<integer>(div2.rem))
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
(asType<int>(asType<int>($heap_{tuncstart\_724.1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724.1}.a3))) = =
asType<integer>(div3.quot)
(asType<int>(asType<int>($heap_{funcstart\_724,1}.p3)) %
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.rem)
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{a3})) = >
(asType < integer > ($heap_{funcstart\_724,1}.p3) = =
asType < integer > (div3.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a3}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724.1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{tuncstart\_724.1}.b1))))
-\mathbf{asType}{<}\mathbf{integer}\ \mathbf{const}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{M1}) <
asType<integer>($heap<sub>724,1:745,8</sub>.p1)
!(0 == asType < integer > (\$heap_{724,1;745,8}.p1))
asType < integer > (\$heap_{724,1;745,8}.p1) <
asType<integer>($heap<sub>724,1:745,8</sub>.M1)
heap_{724,1:747,8} == heap_{724,1:745,8}.replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724,1;745,8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType< int>($heap_{724,1;745,8}.b2))))
-asType<integer const>($heap<sub>724.1:747.8</sub>.M2) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;747,8}.\mathrm{p2})
```

```
!(0 == asType < integer > (\$heap_{724,1:747.8}.p2))
asType<integer>($heap<sub>724.1:747.8</sub>.p2) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;747,8}.\mathrm{M2})
heap_{724,1;749,8} == heap_{724,1;747,8}.replace(p3 \rightarrow asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType < int > (\$heap_{724.1:747.8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap<sub>724,1:747,8</sub>.b3))))
-asType<integer const>($heap<sub>724,1:749,8</sub>.M3) <
asType<integer>($heap<sub>724,1:749,8</sub>.p3)
!(0 == asType < integer > (\$heap_{724,1;749,8}.p3))
asType<integer>($heap<sub>724,1:749,8</sub>.p3) <
asType<integer>($heap<sub>724,1:749,8</sub>.M3)
\text{heap}_{724.1;752.8} == \text{heap}_{724.1;749.8}._replace(p1 \rightarrow asType<short)
int>((asType<int>($heap<sub>724.1:749.8</sub>.M1) *
\mathbf{asType} < \mathbf{int} > (\mathbf{static\_cast} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{724,1;749,8}.\mathrm{p1}) < \mathsf{p1}) < \mathsf{p2} < \mathsf{p2} < \mathsf{p3} < \mathsf{p3} < \mathsf{p4} < \mathsf{p3} < \mathsf{p4} <
(int)(0)) + asType < int > (\$heap_{724,1;749,8}.p1)))
heap_{724,1:753.8} == heap_{724,1:752.8}.replace(p2 \rightarrow asType<short
int>((asType<int>($heap<sub>724.1:752.8</sub>.M2) *
\mathbf{asType} < \mathbf{int} > (\mathbf{static\_cast} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{724,1:752.8}.\mathrm{p2}) < \mathsf{nt}) < \mathsf{neget} > \mathsf{
(int)(0) + asType<int>($heap<sub>724,1:752,8</sub>.p2)))
\rho_{funcend\_724,1} == \rho_{func
int>((asType<int>($heap<sub>724.1:753.8</sub>.M3) *
asType<int>(static_cast<integer>(asType<int>($heap<sub>724,1:753,8.</sub>p3) <
(int)(0) + asType<int>($heap<sub>724,1:753,8</sub>.p3)))
Proof:
[Take goal term]
[1.0] invariant1(heapIs heap_{funcend\_724,1})
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
[1.1] (((((0 < asType < integer > ($heap_{funcend\_724.1}.p1)) &&
(asType<integer>($heap_funcend_724,1.p1) <
asType<integer>($heap<sub>funcend_724,1</sub>.M1))) && (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathtt{heap}_{funcend\_724,1}.\mathtt{p2})))\ \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcend\_724,1}.\mathrm{p2}) <
asType<integer>($heap<sub>funcend_724,1</sub>.M2))) && (0 <
asType < integer > (\$heap_{funcend\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcend\_724,1}.\mathrm{p3}) <
asType < integer > (\$heap_{funcend\_724,1}.M3))
\rightarrow [simplify]
[1.3] (((((0 < $heap_{funcend\_724,1}.p1) && ($heap_{funcend\_724,1}.p1 <
```

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asType<integer>(\theta_{1}) && (0 <
\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcend\_724,1}.p2))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathtt{heap}_{funcend\_724,1}.\mathtt{p2}) <
asType < integer > (\$heap_{funcend\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcend\_724,1}.p3))) \&\&
(asType<integer>($heap_funcend_724,1.p3) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcend\_724,1}.\mathrm{M3}))
\rightarrow [const static or extern object]
[1.4] (((((0 < \theta_{1.4}) ((((0 < \theta_{1.4}) (\text{$\text{$}}) (\tex
asType<integer>($heap<sub>init</sub>.M1))) && (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathtt{heap}_{funcend\_724,1}.\mathtt{p2})))\ \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcend\_724,1}.\mathsf{p2}) <
asType<integer>($heap<sub>funcend_724,1</sub>.M2))) && (0 <
\mathbf{asType} < \mathbf{integer} > (\$ \mathtt{heap}_{funcend\_724,1}.\mathtt{p3}))) \ \&\& \\
(asType < integer > (\$heap_{funcend\_724,1}.p3) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcend\_724,1}.\mathrm{M3}))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[1.5] (((((0 < \frac{1.5}{1.5}) ((((0 < \frac{1.5}{1.5}) && (\frac{1.5}{1.5}) && (\frac{1.5}{1.5})
asType<integer>(asType<short int>((int)30269)))) && (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathtt{heap}_{funcend\_724,1}.\mathtt{p2})))\ \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcend\_724,1}.\mathrm{p2}) <
asType<integer>(\theta_{13}) && (0 <
asType < integer > (\$heap_{funcend\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcend\_724,1}.p3) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcend\_724,1}.\mathrm{M3}))
\rightarrow [simplify]
[1.16] \; ((((-30269 < -\$ heap_{funcend\_724,1}.p1) \; \wedge \; (0 < \$ heap_{funcend\_724,1}.p2) \; \wedge \; (0 < \$ heap_{funcend\_724,1}.p2) \; \wedge \; (0 < \$ heap_
 < $heap<sub>funcend_724,1.</sub>p2)) && ($heap<sub>funcend_724,1.</sub>p2 <
asType < integer > (\$heap_{funcend\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcend\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcend\_724,1}.\mathsf{p3}) <
asType<integer>($heap_{funcend\_724.1}.M3))
\rightarrow [const static or extern object]
[1.17] ((((-30269 < -$heap_{funcend_724.1}.p1) \land (0 < $heap_{funcend_724.1}.p1) \land (0
< $heap_{funcend\_724,1}.p2)) && ($heap_{funcend\_724,1}.p2 <
asType < integer > (\$heap_{init}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcend\_724,1}.p3))) \&\&
(asType < integer > (\$heap_{funcend\_724.1}.p3) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcend\_724,1}.\mathrm{M3}))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[1.18] ((((-30269 < -\$heap_{funcend\_724,1}.p1) \land (0 < \$heap_{funcend\_724,1}.p1) \land (0 < \$heap_{funcend\_724,1}.p1))))
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< $heap<sub>funcend_724,1.</sub>p2)) && ($heap<sub>funcend_724,1.</sub>p2 <
asType<integer>(asType<short int>((int)30307)))) && (0 <
\mathbf{asType} \small{<} \mathbf{integer} \small{>} (\$ \mathtt{heap}_{funcend\_724,1}.\mathtt{p3}))) \ \&\& \\
(asType < integer > (\$heap_{funcend\_724,1}.p3) < 
asType < integer > (\$heap_{funcend\_724,1}.M3))
\rightarrow [simplify]
[1.30] ((-30307 < -$heap_{funcend\_724,1}.p2) \land (-30269 < -$heap_{funcend\_724,1}.p1)
\land (0 < \text{\$heap}_{funcend\_724,1}.\text{p1}) \land (0 < \text{\$heap}_{funcend\_724,1}.\text{p2}) \land (0 < \text{\$heap}_{funcend\_724,1}.\text{p2})
heap_{funcend_{724,1}.p3} & (heap_{funcend_{724,1}.p3} <
asType<integer>($heap_{funcend,724.1}.M3))
\rightarrow [const static or extern object]
[1.31] ((-30307 < -$heap_{funcend\_724,1}.p2) \land (-30269 < -$heap_{funcend\_724,1}.p1)
\land (0 < \text{\$heap}_{funcend\_724,1}.\text{p1}) \land (0 < \text{\$heap}_{funcend\_724,1}.\text{p2}) \land (0 < \text{\$heap}_{funcend\_724,1}.\text{p2})
\rho_{funcend\_724,1.p3}) && (\rho_{funcend\_724,1.p3}
asType < integer > (\$heap_{init}.M3))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[1.32] ((-30307 < -$heap_{funcend\_724,1}.p2) \land (-30269 < -$heap_{funcend\_724,1}.p1)
\land (0 < \text{\$heap}_{funcend\_724,1}.\text{p1}) \land (0 < \text{\$heap}_{funcend\_724,1}.\text{p2}) \land (0 < \text{\$heap}_{funcend\_724,1}.\text{p2})
heap_{funcend_{724,1}.p3}) && (heap_{funcend_{724,1}.p3})
asType<integer>(asType<short int>((int)30323)))
\rightarrow [simplify]
[1.40] (-30323 < -$heap<sub>funcend_724.1.p3</sub>) \wedge (-30307 < -$heap<sub>funcend_724.1.p2</sub>)
 \land (-30269 < -\$ heap_{funcend\_724,1}.p1) \land (0 < \$ heap_{funcend\_724,1}.p2) \land (0 < \$ heap_{funcend\_724,1}.p
\text{Sheap}_{funcend_{724,1}.p2} \land (0 < \text{Sheap}_{funcend_{724,1}.p3})
\rightarrow [negate goal and search for contradiction]
[1.41]!(-30323 < -\$heap_{funcend\_724,1}.p3) \lor !(-30307 < -\$heap_{funcend\_724,1}.p2)
 \lor !(-30269 < -\$ heap_{funcend\_724,1}.p1) \lor !(0 < \$ heap_{funcend\_724,1}.p1) \lor !(0 <
\text{Sheap}_{funcend_{-724,1}.p2}) \vee !(0 < \text{Sheap}_{funcend_{-724,1}.p3})
\rightarrow [simplify]
[1.56] (30322 < $\text{heap}_{funcend\_724,1}.p3) \quad (30306 < $\text{heap}_{funcend\_724,1}.p2) \quad \qua
(30268 < \text{$heap_{funcend\_724,1}.p1}) \lor (-1 < -\text{$heap_{funcend\_724,1}.p1}) \lor (-1 < -\text{$heap_{funcend\_724,1}.p1})
 -\$heap_{funcend\_724,1}.p2) \lor (-1 < -\$heap_{funcend\_724,1}.p3)
[Take given term]
[11.0] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
\rightarrow [simplify]
[11.1] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
```

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\rightarrow [const static or extern object]
[11.2] \operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
asType < int > (\$heap_{init}.a1))
\rightarrow [expand definition of constant 'a1' at prang.c (16,20)]
[11.3] \ \mathrm{div1} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
asType<int>(asType<short int>((int)177)))
\rightarrow [simplify]
[11.6] div1 == div(heapIs $heap<sub>funcstart_724,1</sub>, $heap<sub>funcstart_724,1</sub>.p1, 177)
[Take given term]
[27.0] div2 == div(heapIs $heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
\rightarrow [simplify]
[27.1]~{\rm div2} == {\rm div}(\mathbf{heapIs}~\$ \mathrm{heap}_{funcstart\_724,1},\,\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2},
asType < int > (\$heap_{funcstart\_724,1}.a2))
\rightarrow [const static or extern object]
[27.2] div2 == div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2,
asType < int > (\$heap_{init}.a2))
\rightarrow [expand definition of constant 'a2' at prang.c (21,20)]
[27.3] \operatorname{div2} == \operatorname{div}(\mathbf{heapIs} \operatorname{\$heap}_{funcstart\_724,1}, \operatorname{\$heap}_{funcstart\_724,1}.p2,
asType<int>(asType<short int>((int)176)))
\rightarrow [simplify]
[27.6] \text{ div2} == \text{div}(\mathbf{heapIs} \$ heap_{funcstart\_724,1}, \$ heap_{funcstart\_724,1}.p2, 176)
[Take given term]
[43.0] div3 == div(heapIs $heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
\rightarrow [simplify]
[43.1] \ \mathrm{div3} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
\rightarrow [const static or extern object]
[43.2] \ \mathrm{div3} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3},
asType < int > (\$heap_{init}.a3))
\rightarrow [expand definition of constant 'a3' at prang.c (26,20)]
[43.3] div3 == div(heapIs $heap_{tuncstart\_724.1}, $heap_{tuncstart\_724.1}.p3,
asType<int>(asType<short int>((int)178)))
```

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\rightarrow [simplify]
[43.6] \ \mathrm{div3} == \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}, \ 178)
[Take given term]
[59.0] heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1.quot})) \ * \ \mathbf{asType}{<} \mathbf{int}{>} (\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177
[59.1] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}) * asType < int > (\text{Sheap}_{funcstart\_724,1}.\text{r1})) -
(asType<int>(asType<short int>(div1.quot)) *
\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
\rightarrow [simplify]
[59.3] \rho_{1745,8} == \rho_{1745,8} == \rho_{1745,8} == \rho_{1745,8}._replace(p1 \rightarrow \rho_{1745,8} == \rho_{1745,8}
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType < int > (\$heap_{tuncstart\_724.1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
\rightarrow [const static or extern object]
[59.4] \rho_{1745,8} == \rho_{1745,8} == \rho_{1745,8} == \rho_{1745,8}._replace(p1 \rightarrow \rho_{1745,8} == \rho_{1745,8}
\mathbf{int}{>}((\mathrm{div}(\mathbf{heapIs}\ \$\mathrm{heap}_{funcstart\_724,1},\ \$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},\ 177).\mathrm{rem}\ *
asType < int > (\$heap_{init}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
\rightarrow [expand definition of constant 'r1' at prang.c (15,20)]
[59.5] \rho_{1745,8} == \rho_{1745,8} == \rho_{1745,8} == \rho_{1745,8}._replace(p1 \rightarrow \rho_{1745,8} == \rho_{1745,8}
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem *
asType<int>(asType<short int>((int)171))) -
(asType<int>(asType<short int>(div1.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [simplify]
[59.8] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
\mathbf{int} > ((\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, \ 177).\operatorname{rem} \ * \ 171)
- (asType<int>(asType<short int>(div1.quot)) *
asType < int > (\$heap_{funcstart\_724,1}.b1))))
\rightarrow [from term 11.6, div1 is equal to div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177
[59.9] heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).rem)
```

```
- (asType<int>(asType<short int>(div(heapIs $heap_{tuncstart\_724.1},
heap_{funcstart_{-724,1}.p1, 177}.quot) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [simplify]
[59.11] \theta_{13} = \theta_
int>((171 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b1}))))
\rightarrow [const static or extern object]
[59.12] heap_{724,1;745,8} == heap_{funcstart\_724,1}. replace(p1 \rightarrow asType<short
int>((171 * div(heapIs \$heap_{tuncstart\_724.1}, \$heap_{tuncstart\_724.1}, p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType < int > (\$heap_{init}.b1)))
\rightarrow [expand definition of constant 'b1' at prang.c (17,20)]
[59.13] heap_{724,1;745,8} == heap_{funcstart\_724,1}. replace(p1 \rightarrow asType<short
int>((171 * div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)
- (\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} *
asType<int>(asType<short int>((int)2))))
\rightarrow [simplify]
[59.19] $heap<sub>724,1;745,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724.1}, \ \text{\$heap}_{funcstart\_724.1}, 177).rem)))
[Take given term]
[60.0] -asType<integer const>($heap_{724,1;745,8}.M1) <
asType<integer>($heap<sub>724,1.745,8.</sub>p1)
\rightarrow [from term 59.19, $heap<sub>724,1:745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs p_{funcstart\_724,1})
heap_{funcstart_{-724,1}.p1, 177).rem}
[60.1] -asType<integer const>($heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).rem))).M1) <
asType<integer>($heap<sub>724.1:745.8</sub>.p1)
\rightarrow [const member of object with modified fields]
[60.2] -asType<integer const>(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2})(parton{1}{2}
asType<integer>($heap<sub>724,1:745,8</sub>.p1)
\rightarrow [const static or extern object]
[60.3] -asType<integer const>($heap<sub>init</sub>.M1) <
asType<integer>($heap<sub>724,1:745,8</sub>.p1)
```

```
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[60.4] -asType<integer const>(asType<short int>((int)30269)) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{p1})
\rightarrow [simplify]
[60.8] -30269 < asType<integer>($heap_{724,1;745,8}.p1)
\rightarrow [from term 59.19, $heap<sub>724,1;745,8</sub> is equal to
\text{Sheap}_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart\_724.1.p1}, 177).quot + (171 * div(heapIs $heap_{funcstart\_724.1}, 177).quot) + (171 * div(heapIs $heap_{funcstart\_724.1}, 17
heap_{funcstart_{-724,1}}.p1, 177).rem)
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).rem))).p1)
\rightarrow [simplify]
[60.11] -30269 < ((-2 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1,
177).quot) + (171 * div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p1,
177).rem))
[Take given term]
[61.0]!(0 == asType < integer > (\$heap_{724,1:745,8}.p1))
\rightarrow [from term 59.19, $heap<sub>724,1;745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724,1}),
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1},p1,177,rem}
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).rem))).p1))
\rightarrow [simplify]
[61.3]!(0 == ((-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1,
177).quot) + (171 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).rem)))
[Take given term]
[62.0] asType<integer>($heap_{724.1:745.8}.p1) <
asType<integer>($heap<sub>724.1:745.8</sub>.M1)
\rightarrow [from term 59.19, $heap<sub>724,1:745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724,1}),
heap_{funcstart_{-724,1},p1,177}, quot) + (171 * div(heapIs p_{funcstart_{-724,1},p1,177})
heap_{funcstart_{724,1}.p1, 177).rem}
| [62.1] as
Type<integer>($heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
```

```
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p1, \ 177).rem))).p1) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{M1})
\rightarrow [simplify]
[62.3] ((-2 * div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, -1),
177).quot) + (171 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
(177).rem) < asType < integer > (\$heap_{724.1:745.8}.M1)
\rightarrow [from term 59.19, $heap<sub>724,1:745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724,1}),
heap_{funcstart_{-724,1},p1, 177}, quot) + (171 * div(heapIs p_{funcstart_{-724,1},p1, 177}).
heap_{funcstart_{-724,1}}.p1, 177).rem)
[62.4] ((-2 * div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}.p1,
177).quot) + (171 * div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, 1,
177).rem)) < asType<integer>($heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}. p1, \ 177). \operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).rem))).M1)
→ [const member of object with modified fields]
[62.5] ((-2 * div(heapIs \theta_{funcstart-724,1}, \theta_{funcstart-724,1}.p1,
177).quot) + (171 * div(heapIs \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, p1,
177).rem)) < \mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.M1)
\rightarrow [const static or extern object]
\textit{[62.6]} \ ((\text{-2 * div}(\textbf{heapIs }\$ \text{heap}_{funcstart\_724,1},\,\$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).quot) + (171 * div(heapIs heapIs = f_{uncstart_{-724,1}}, heap_{funcstart_{-724,1}}.p1,
(177).rem) < asType < integer > (\$heap_{init}.M1)
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[62.7] ((-2 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1,
177).quot) + (171 * div(heapIs heapIs = f_{uncstart_{-724,1}}, heap_{funcstart_{-724,1}}.p1,
177).rem)) < asType<integer>(asType<short int>((int)30269))
\rightarrow [simplify]
[62.17] -30269 < ((-171 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177).quot)
[Take given term]
[63.0] $\text{heap}_{724,1;747,8} == $\text{heap}_{724,1;745,8}._\text{replace}(p2 \rightarrow \text{asType} < \text{short}
int>((asType<int>(asType<short\ int>(div2.rem))*
asType < int > (\$heap_{724.1:745.8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType< int>($heap_{724,1;745,8}.b2))))
\rightarrow [from term 59.19, $heap<sub>724,1:745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724,1}),
heap_{funcstart_{724,1},p1, 177}, quot) + (171 * div(heapIs heap_{funcstart_{724,1},p1, 177})
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```
heap_{funcstart_{-724,1}.p1, 177).rem}
[63.1] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724,1;745,8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{funcstart\_724,1},
$heap_{tuncstart_{724,1}}.p2, 176)]
[63.2] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \text{$heap}_{funcstart\_724.1}, \ \text{$heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short
\mathbf{int}{>}((\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{short}\ \mathbf{int}{>}(\mathbf{div}(\mathbf{heapIs}\ \$\mathbf{heap}_{funcstart\_724,1},
\text{sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem}) * asType < int > (\text{sheap}_{724,1;745,8}.\text{r2})) -
(asType<int>(asType<short int>(div2.quot)) *
asType < int > (\$heap_{724,1;745,8}.b2))))
\rightarrow [simplify]
[63.4] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\mathrm{div}(\mathbf{heapIs}\ \$\mathrm{heap}_{funcstart\_724,1},\ \$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},\ 177).\mathrm{quot}) + (171\ *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((\operatorname{div}(\mathbf{heapIs}))))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem *
asType < int > (\$heap_{724,1:745,8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724,1:745,8</sub>.b2))))
\rightarrow [from term 59.19, $heap<sub>724,1;745,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow (-2 * div(heapIs heap_{funcstart\_724,1}),
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177).rem)
[63.5] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
(177).rem))._replace(p2 \rightarrow asType<short int>((div(heapIs)))._replace(p2 \rightarrow asType
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}.p2, 176).rem *
asType<int>($heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 * div(heapIs
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1},p1, 177}.quot + (171 * div(heapIs))
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, 177).rem))).r2)) -
(asType<int>(asType<short int>(div2.quot)) *
\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{724,1;745,8}.\mathrm{b2}))))
→ [const member of object with modified fields]
[63.6] $heap<sub>724,1:747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
```

```
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
\text{Sheap}_{funcstart_{-724,1}}, \text{Sheap}_{funcstart_{-724,1}}.p2, 176).rem *
asType < int > (\$heap_{funcstart\_724,1}.r2)) - (asType < int > (asType < short)
int > (div2.quot)) * asType < int > (\$heap_{724,1:745,8}.b2))))
\rightarrow [const static or extern object]
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((\operatorname{div}(\mathbf{heapIs}))))
\rho_{funcstart\_724,1}, \rho_{funcstart\_724,1.p2, 176}.rem *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{init}.\mathbf{r2})) - (\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{short}
int > (div2.quot)) * asType < int > (\$heap_{724,1:745,8}.b2))))
\rightarrow [expand definition of constant 'r2' at prang.c (20,20)]
[63.8] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem))).replace(p2 \rightarrow asType < short int > ((div(heapIs)))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem} *
asType<int>(asType<short int>((int)172))) -
(asType<int>(asType<short int>(div2.quot)) *
asType < int > (\$heap_{724,1;745,8}.b2))))
\rightarrow [simplify]
[63.11] \text{heap}_{724,1;747,8} == \text{heap}_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs}\ \$ \mathrm{heap}_{funcstart\_724,1},\ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p1},
177).rem)))._replace(p2 \rightarrow asType<short int>((div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}.p2, 176).rem * 172) -
(asType<int>(asType<short int>(div2.quot)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{b2}))))
\rightarrow [from term 27.6, div2 is equal to div(heapIs $heap_{funcstart_724,1},
heap_{funcstart_{-724,1}}.p2, 176
[63.12] $\text{heap}_{724.1:747.8} == $\text{heap}_{funcstart_724.1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem) -
(asType<int>(asType<short int>(div(heapIs $heap_{funcstart\_724,1},
\text{sheap}_{funcstart\_724,1.p2, 176}.\text{quot}) * asType < int > (\text{sheap}_{724,1:745,8}.\text{b2}))))
\rightarrow [simplify]
```

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[63.14] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\label{eq:div_heap} \text{div}(\textbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2, 176).rem) - \theta_{funcstart\_724,1}.p2, 176).rem) - \theta_{funcstart\_724,1}
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}.p2, 176).quot*
asType<int>($heap<sub>724,1:745,8</sub>.b2))))
\rightarrow [from term 59.19, $heap<sub>724,1;745,8</sub> is equal to
heap_{funcstart\_724.1}._replace(p1 \rightarrow (-2 * div(heapIs \$heap_{funcstart\_724.1}, -24.1))
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177).rem)
[63.15] \rho_{724,1;747,8} == \rho_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}.p2, 176).quot *
asType < int > (\$heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * div(heapIs)))))))
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).rem))).b2))))
\rightarrow [const member of object with modified fields]
[63.16] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}. \operatorname{pl},
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{b2}))))
\rightarrow [const static or extern object]
[63.17] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._{\mathbf{replace}}(p2 \rightarrow \mathbf{asType} < \mathbf{short\ int} > ((172 * div(\mathbf{heapIs}))))
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2, 176).rem) - (div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}.p2, 176).quot *
asType < int > (\$heap_{init}.b2)))
\rightarrow [expand definition of constant 'b2' at prang.c (22,20)]
[63.18] heap_{724,1;747,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow asType<short int>((172 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem}) - (\text{div}(\text{heapIs})
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heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}.p2, 176).quot *
asType<int>(asType<short int>((int)35)))))
\rightarrow [simplify]
[63.24] $heap<sub>724,1;747,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p2, 176).rem}
[Take given term]
[64.0] -asType<integer const>($heap_{724,1;747,8}.M2) <
asType<integer>($heap<sub>724,1.747,8.</sub>p2)
\rightarrow [from term 63.24, $heap<sub>724,1;747,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1},p1,177}, quot) + (171 * div(heapIs p_{funcstart_{724,1},p1,177}).
\rho_{funcstart\_724,1}.p1, 177).rem))._replace\rho_{funcstart\_724,1}.p1, 177).rem)
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p_{funcstart_{724,1}}, p_{funcstart_{724,1}}, p_{funcstart_{724,1}}
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p2, 176).rem)
| [64.1] -asType<integer const>($heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
div(\mathbf{heapIs} \ \text{$heap}_{funcstart\_724,1}, \ \text{$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart} \ 724.1, \ \$ \operatorname{heap}_{funcstart} \ 724.1.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724,1},
\rho_{tuncstart_{-724,1},p2, 176} = 176, quot) + (172 * div(heapIs \rho_{tuncstart_{-724,1},p2} = 176).
heap_{funcstart_{724,1},p2, 176,rem})).M2) <
asType<integer>($heap<sub>724,1:747,8</sub>.p2)
\rightarrow [const member of object with modified fields]
[64.3] -asType<integer const>(parton{1}{2}) (parton{1}{2}) (parton
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;747,8}.\mathrm{p2})
\rightarrow [const static or extern object]
[64.4] -asType<integer const>(\theta) (\theta) (\theta)
asType<integer>($heap<sub>724,1:747,8</sub>.p2)
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[64.5] -asType<integer const>(asType<short int>((int)30307)) <
asType<integer>($heap<sub>724.1:747.8.p2</sub>)
\rightarrow [simplify]
[64.9] -30307 < asType < integer > ($heap_{724,1;747,8}.p2)
\rightarrow [from term 63.24, $heap<sub>724,1:747,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1},
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heap_{funcstart\_724.1}.p1, 177).rem))._replace(p2 \rightarrow (-35 * div(heapIs)))._
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p2, 176).rem)
\textit{[64.10] -30307} < \textbf{asType} < \textbf{integer} > (\$ \text{heap}_{funcstart\_724,1}. \_\textbf{replace} (\text{p1} \rightarrow ((-2.15 \text{ most}) + (-2.15 \text{ most})))))
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1, 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p2, 176}.rem)).p2
\rightarrow [simplify]
[64.12] -30307 < ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724.1}.p2, 176).rem}
[Take given term]
[65.0]!(0 == asType < integer > (\$heap_{724 \ 1.747 \ 8.p2}))
\rightarrow [from term 63.24, $heap<sub>724,1;747,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs *heap_{funcstart\_724,1},
\operatorname{Sheap}_{funcstart\_724,1}.p1, 177).\operatorname{quot} + (171 * \operatorname{div}(\mathbf{heapIs} \operatorname{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1}.p1, 177).rem))._replace(\rho_{funcstart\_724,1}.p1, 177).rem))
heap_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 2, 176).rem
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\theta_{funcstart\_724,1}.p2, 176.quot) + (172 * div(heapIs \theta_{funcstart\_724,1},
heap_{funcstart_{724,1}.p2, 176).rem})).p2)
\rightarrow [simplify]
\textit{[65.3] !} (0 == ((-35 * \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p2},
176).quot) + (172 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2,
176).rem)))
[Take given term]
[66.0] asType<integer>($heap_{724.1:747.8}.p2) <
asType<integer>($heap<sub>724.1:747.8</sub>.M2)
\rightarrow [from term 63.24, $heap<sub>724,1;747,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs p_{funcstart\_724,1})
heap_{funcstart\_724,1}.p1, 177).rem))._replace(p2 \rightarrow (-35 * div(heapIs)))._
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).quot) + (172 * div(\textbf{heapIs})
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, p2, 176).rem)
```

```
[66.1] asType<integer>(p1 \rightarrow ((-2 * p_{funcstart}) + (-2 * p_{funcstart}))
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{724,1}.p2, 176).rem})).p2) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;747,8}.\mathrm{M2})
\rightarrow [simplify]
[66.3] ((-35 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p2,
176).quot) + (172 * \text{div}(\textbf{heapIs} \$ \text{heap}_{funcstart}, 724.1, \$ \text{heap}_{funcstart}, 724.1.p2,
(176).rem) < asType < integer > (\$heap_{724,1;747,8}.M2)
\rightarrow [from term 63.24, $heap_{724,1;747,8}$ is equal to
heap_{funcstart\_724.1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724.1},
heap_{funcstart\_724.1.p1}, 177).quot + (171 * div(heapIs $heap_{funcstart\_724.1}, 177).quot) + (171 * div(heapIs $heap_{funcstart\_724.1}, 17
heap_{funcstart\_724.1}.p1, 177).rem)._replace(p2 \rightarrow (-35 * div(heapIs)))._replace
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, p2, 176).rem
[66.4] ((-35 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2,
176).quot) + (172 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2,
176).rem)) < asType<integer>(p1 \rightarrow ((-2 * place))
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\label{eq:div_heapIs} \text{$heap}_{funcstart\_724,1}, \\ \text{$heap}_{funcstart\_724,1}. \\ \text{$pl},
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{tuncstart_724.1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{724,1}.p2, 176).rem})).M2)
\rightarrow [const member of object with modified fields]
[66.6] \ ((-35 * \mathrm{div}(\mathbf{heapIs} \$ \mathrm{heap}_{funcstart\_724,1}, \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2},
176).quot) + (172 * div(heapIs \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}
(176).rem) < asType < integer > (\$heap_{funcstart\_724.1}.M2)
\rightarrow [const static or extern object]
[66.7] ((-35 * div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, p_{funcstart_{-724,1}})
176).quot) + (172 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2,
(176).rem) < asType < integer > (\$heap_{init}.M2)
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[66.8] ((-35 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p2,
176).quot) + (172 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2,
(176).rem < asType < integer > (asType < short int > ((int) 30307))
\rightarrow [simplify]
\label{eq:final_loss} \textit{[66.18] -30307} < ((-172 * div(\textbf{heapIs} \$heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem} + (35 * \text{div}(\text{heapIs} \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1},p2}, 176).quot)
```

```
[Take given term]
[67.0] $\text{heap}_{724,1:749,8} == $\text{heap}_{724,1:747,8}._\text{replace}(p3 \to \text{asType} < \text{short}
int>((asType<int>(asType<short int>(div3.rem)) *
asType < int > (\$heap_{724.1:747.8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap<sub>724.1:747.8</sub>.b3))))
\rightarrow [from term 63.24, $heap<sub>724.1:747.8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1},p1, 177}, quot) + (171 * div(heapIs heap_{funcstart_{724,1},p1, 177})
\theta_{funcstart\_724,1}.p1, 177).rem))._replace(p2 \rightarrow (-35 * div(\mathbf{heapIs})))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
\$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p2, 176).rem))]
[67.1] \theta == 
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{tuncstart_{724,1},p2,176,rem})._replace(p3 \rightarrow asType<short
int>((asType<int>(asType<short int>(div3.rem))
asType < int > (\$heap_{724.1:747.8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap<sub>724,1:747,8</sub>.b3))))
\rightarrow [from term 43.6, div3 is equal to div(heapIs $heap_{funcstart_724,1},
heap_{funcstart_{724,1}}.p3, 178
[67.2] $\text{heap}_{724,1;749,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{tuncstart\ 724.1}, p2, 176).rem)))._replace(p3 \rightarrow asType<short
int>((asType < int > (asType < short int > (div(heapIs $heap_{funcstart\_724,1}, 
\text{sheap}_{funcstart\_724,1.p3}, 178).rem) * asType<int>(\text{sheap}_{724,1:747,8.r3})) -
(asType<int>(asType<short int>(div3.quot)) *
asType < int > (\$heap_{724,1;747,8}.b3))))
\rightarrow [simplify]
[67.4] heap_{724,1;749,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs} \text{Sheap}_{funcstart\_724,1},
\$ heap_{funcstart\_724,1}.p2,\,176).rem))).\_\textbf{replace}(p3 \rightarrow \textbf{asType} < \textbf{short}
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem *
asType < int > (\$heap_{724.1:747.8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap<sub>724.1:747.8</sub>.b3))))
```

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\rightarrow [from term 63.24, $heap<sub>724.1:747.8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs p_{funcstart\_724,1}),
heap_{funcstart_{724,1},p1, 177}, quot) + (171 * div(heapIs heap_{funcstart_{724,1},p1, 177})
heap_{funcstart\_724,1}.p1, 177).rem)._replace(p2 \rightarrow (-35 * div(heapIs)))._
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p2, 176).rem)
[67.5] heap_{724,1;749,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{uncstart_724.1.p2, 176}.rem)._replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724.1}, \$heap_{funcstart\_724.1}.p3, 178).rem *
asType < int > (\$heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * div(heapIs)))))))
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1},p1, 177}.quot) + (171 * div(heapIs)
\rho_{tuncstart_{724,1}}, \rho_{tuncstart_{724,1}}, \rho_{tuncstart_{724,1}}, \rho_{tuncstart_{724,1}}, \rho_{tuncstart_{724,1}}, \rho_{tuncstart_{724,1}}
* div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, p2, 176).quot) + (172 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p2}, \ 176).\operatorname{rem}))).\operatorname{r3})) \ -
(asType<int>(asType<short int>(div3.quot)) *
asType<int>($heap<sub>724,1:747,8</sub>.b3))))
→ [const member of object with modified fields]
[67.7] $\text{heap}_{724,1;749,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724,1},
\text{Sheap}_{funcstart\_724.1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724.1},
\theta_{funcstart\_724,1.p2, 176).rem}))._replace(p3 \rightarrow asType<short
int>((div(heapIs $heap_{funcstart_{-724,1}}, $heap_{funcstart_{-724,1}}.p3, 178).rem *
\mathbf{asType} \hspace{-0.1em}<\hspace{-0.1em} \mathbf{int} \hspace{-0.1em}> \hspace{-0.1em} (\$ heap_{funcstart\_724,1}.r3)) - (\mathbf{asType} \hspace{-0.1em}<\hspace{-0.1em} \mathbf{int} \hspace{-0.1em}> \hspace{-0.1em} (\mathbf{asType} \hspace{-0.1em}<\hspace{-0.1em} \mathbf{short})
int>(div3.quot)) * asType< int>($heap_{724.1:747.8}.b3))))
\rightarrow [const static or extern object]
[67.8] heap_{724,1;749,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ ^*
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\theta_{funcstart\_724.1}.p2, 176).quot) + (172 * div(heapIs \theta_{funcstart\_724.1},
\rho_{tuncstart\_724.1.p2, 176}.rem))._replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem *
asType < int > (\$heap_{init}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType< int>($heap_{724.1:747.8}.b3))))
\rightarrow [expand definition of constant 'r3' at prang.c (25,20)]
[67.9] $\text{heap}_{724,1;749,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \rightarrow ((-2 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
```

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\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{funcstart\_724,1}.p2, 176).rem))._replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem *
asType < int > (asType < short int > ((int)170))) -
(asType<int>(asType<short int>(div3.quot)) *
asType<int>($heap<sub>724.1:747.8</sub>.b3))))
\rightarrow [simplify]
[67.12] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\label{eq:div_heap} \text{div}(\textbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart_{-724,1},p2,176}.rem))._replace(p3 \rightarrow asType<short
int>((div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem * 170)
- (asType<int>(asType<short int>(div3.quot)) *
asType<int>($heap<sub>724.1:747.8</sub>.b3))))
\rightarrow [from term 43.6, div3 is equal to div(heapIs $heap_{funcstart_724,1},
heap_{funcstart_{724,1}}.p3, 178
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{uncstart\_724,1.p2, 176).rem}))._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart\_724.1}, heap_{funcstart\_724.1}, n_{funcstart\_724.1}, n_{funcstart\_724.1}
(asType<int>(asType<short int>(div(heapIs $heap_{tuncstart\_724.1},
\text{sheap}_{funcstart\_724,1.p3}, 178).\text{quot}) * asType < int > (\text{sheap}_{724,1;747,8.b3})))
\rightarrow [simplify]
[67.15] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\theta_{funcstart\_724,1}.p2, 176.quot) + (172 * div(heapIs \theta_{funcstart\_724,1},
\rho_{tuncstart=724.1.p2, 176}.rem)._replace(p3 \rightarrow asType<short int>((170
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) –
(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} *
asType < int > (\$heap_{724,1;747,8}.b3))))
\rightarrow [from term 63.24, $heap<sub>724.1:747.8</sub> is equal to
\text{Sheap}_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1}), the sheap funcstart\_724,1).
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).rem))).\_replace(p2 \rightarrow (-35 * div(heapIs))).
```

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heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 2, 176).rem
[67.16] $heap<sub>724,1;749,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{uncstart\_724,1.p2, 176).rem}))._replace(p3 \rightarrow asType<short int>((170
* \operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p3, \ 178).rem) -
(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} *
asType < int > (\$heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * div(heapIs)))))))
\text{Sheap}_{funcstart\_724.1}, \text{Sheap}_{funcstart\_724.1}, \text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs}))
\rho_{uncstart_{-724,1}}, \rho_{uncstart_{-724,1},p1, 177}.rem))._replace(p2 \rightarrow ((-35)
* div(\mathbf{heapIs} \ \$ heap_{funcstart\_724,1}, \ \$ heap_{funcstart\_724,1}.p2, \ 176).quot) + (172 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p2}, \ 176).\operatorname{rem}))).\operatorname{b3}))))
\rightarrow [const member of object with modified fields]
[67.18] heap_{724,1;749,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{uncstart_724,1}.p2, 176).rem))._replace(p3 \rightarrow asType<short int>((170
* \operatorname{div}(\mathbf{heapIs} \ \text{$heap}_{funcstart\_724,1}, \ \text{$heap}_{funcstart\_724,1}.p3, \ 178).rem) -
(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} *
asType < int > (\$heap_{funcstart\_724,1}.b3))))
\rightarrow [const static or extern object]
[67.19] $\text{heap}_{724,1:749.8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\label{eq:div_heap} \text{div}(\textbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart_{-724,1},p2,176,rem})._replace(p3 \rightarrow asType<short int>((170
* \operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p3, \ 178).rem) -
(div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).quot *
asType < int > (\$heap_{init}.b3))))
\rightarrow [expand definition of constant 'b3' at prang.c (27,20)]
[67.20] heap_{724,1;749,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724.1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724.1},
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem) –
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(\text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} *
asType<int>(asType<short int>((int)63))))
\rightarrow [simplify]
[67.26] heap_{724,1;749,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724.1}, \ \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2, 176}.rem)._replace(p3 \rightarrow ((-63 * div(heapIs
\text{Sheap}_{funcstart\ 724.1}, \text{Sheap}_{funcstart\ 724.1}, \text{p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs}))
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 178).rem))
[Take given term]
[68.0] -asType<integer const>($heap_{724,1:749,8}.M3) <
asType<integer>($heap<sub>724,1:749,8</sub>.p3)
\rightarrow [from term 67.26, $heap<sub>724.1:749.8</sub> is equal to
heap_{funcstart\_724.1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724.1},
heap_{funcstart_{724,1},p1, 177}, quot) + (171 * div(heapIs p_{funcstart_{724,1},p1, 177}), quot)
heap_{funcstart\_724,1}.p1, 177).rem))).\_replace(p2 \rightarrow ((-35 * div(heapIs))).\_replace(p2 \rightarrow ((-35 * div(heapIs)))))._replace(p2 \rightarrow ((-35 * div(heapIs)))))
\$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(\textbf{heapIs}))
\rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).quot) + (170 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).rem))]
[68.1] -asType<integer const>($heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2, 176}.rem)._replace(p3 \rightarrow ((-63 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs}))
\rho_{funcstart_{724,1}}, \rho_{funcstart_{724,1}}, \rho_{funcstart_{724,1}}, \rho_{funcstart_{724,1}}, \rho_{funcstart_{724,1}}, \rho_{funcstart_{724,1}}
asType<integer>($heap<sub>724.1:749.8</sub>.p3)
\rightarrow [const member of object with modified fields]
[68.4] -asType<integer const>($heap_tuncstart_724.1.M3) <
asType<integer>($heap<sub>724,1;749,8</sub>.p3)
\rightarrow [const static or extern object]
[68.5] -asType<integer const>(\text{$heap}_{init}.M3) <
asType<integer>($heap<sub>724,1:749,8</sub>.p3)
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[68.6] -asType<integer const>(asType<short int>((int)30323)) <
asType<integer>($heap<sub>724,1:749,8</sub>.p3)
```

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\rightarrow [simplify]
[68.10] -30323 < asType<integer>($heap<sub>724,1:749.8</sub>.p3)
\rightarrow [from term 67.26, $heap<sub>724.1:749.8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs *heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1}, 177).quot) + (171 * div(heapIs $heap_{funcstart\_724,1}, 17
\rho_{funcstart\_724.1}.p1, 177).rem))).\_replace(p2 \rightarrow ((-35 * div(heapIs))).\_replace(p2 \rightarrow ((-35 * div(heapIs))))._replace(p2 \rightarrow ((-35 * div(heapIs))))._replace(p2 \rightarrow ((-35 * div(heapIs)))))._replace(p2 \rightarrow ((-35 * div(heapIs))))._replace(p2 \rightarrow ((-35 * div(heapIs)))))._replace(p2 \rightarrow ((-35 * div(heapIs)))))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).quot) + (170 *
\operatorname{div}(\mathbf{heapIs} \ \$ heap_{funcstart\_724,1}, \ \$ heap_{funcstart\_724,1}.p3, \ 178).rem))]
\textit{[68.11] -30323} < \textbf{asType} < \textbf{integer} > (\$ \text{heap}_{funcstart\_724,1}. \texttt{\_replace}(\text{p1} \rightarrow ((-2.1)^{-1})^{-1}))
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1, 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724.1}, \ \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{tuncstart_724.1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{tuncstart\_724.1.p2, 176}.rem)._replace(p3 \rightarrow ((-63 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p3, 178).quot) + (170 * div(heapIs
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, 178).rem)).p3)
\rightarrow [simplify]
[68.13] -30323 < ((-63 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p3}, 178).quot) + (170 * div(heapIs \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p3, 178}.rem)
[Take given term]
[69.0]!(0 == asType < integer > ($heap_{724,1;749,8}.p3))
\rightarrow [from term 67.26, $heap<sub>724,1:749,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.p1, 177).quot) + (171 * div(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{1.5}(p_1, p_1, p_2, p_3, p_4, p_5)._replace(p_2 \rightarrow ((-35 * div(\mathbf{heapIs})))._replace(p_3, p_4, p_4, p_5)
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
$heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p2, 176).rem))).\_replace(p3 \rightarrow (-63 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).quot) + (170 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p3, \ 178).\operatorname{rem}))]
[69.1] !(0 == asType<integer>(p1 \rightarrow ((-2 * p1.5)))
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart\_724,1.p2, 176).rem})).\_replace(p3 \rightarrow ((-63 * div(heapIs))).\_replace(p3 \rightarrow ((-63 * div(heapIs)))).\_replace(p3 \rightarrow ((-63 * div(heapIs)))))
\text{Sheap}_{funcstart\ 724.1}, \text{Sheap}_{funcstart\ 724.1}, \text{p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs}))
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, 178).rem)).p3)
\rightarrow [simplify]
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[69.3]!(0 == ((-63 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3,
178).quot) + (170 * div(heapIs heapIs = f_{uncstart_{724,1}}, heap_{funcstart_{724,1}}, g_{uncstart_{724,1}}
178).rem)))
[Take given term]
[70.0] asType<integer>($heap_{724,1;749,8}.p3) <
asType<integer>($heap<sub>724.1:749.8</sub>.M3)
\rightarrow [from term 67.26, $heap<sub>724,1;749,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1},p1, 177}, quot) + (171 * div(heapIs p_{funcstart_{-724,1},p1, 177}).
heap_{funcstart\_724,1}.p1, 177).rem))._replace(p2 \rightarrow ((-35 * div(heapIs)))._
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem)))._replace(p3 \rightarrow (-63 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724.1}, \ \$heap_{funcstart\_724.1}.p3, \ 178).quot) + (170 *
\operatorname{div}(\mathbf{heapIs} \ \$ heap_{funcstart\_724.1}, \ \$ heap_{funcstart\_724.1}.p3, \ 178).rem))]
[70.1] asType<integer>(p1 \rightarrow ((-2 * p_{funcstart\_724,1}.\_replace))
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart_{724,1},p2,176}, quot) + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart_{724,1}})
\rho_{tuncstart_{-724,1},p2, 176,rem})._replace(p3 \rightarrow ((-63 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p3, 178).quot) + (170 * div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p3, 178).rem))).p3) <
asType<integer>($heap<sub>724.1:749.8</sub>.M3)
\rightarrow [simplify]
[70.3] ((-63 * div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1},p3},
178).quot) + (170 * div(heapIs \theta_{funcstart_{-724,1}}, \theta_{funcstart_{-724,1}}, \theta_{funcstart_{-724,1}},
(178).rem) < asType < integer > ($heap_{724,1;749,8}.M3)
\rightarrow [from term 67.26, $heap_{724,1;749,8}$ is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs heap_{funcstart\_724,1}),
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1}, 177).quot) + (171 * div(heapIs $heap_{funcstart\_724,1}, 17
\rho_{funcstart\_724,1}.p1, 177).rem))._replace\rho_{funcstart\_724,1}.p1, 177).rem))._replace
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}, p2, p3, p3, p4, p3, p4, 
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).quot) + (170 \ *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).rem))]
\label{eq:condition} \textit{[70.4]} \ ((-63 \ ^* \ \mathrm{div}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcstart\_724,1}, \ \$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p3},
178).quot) + (170 * div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p3,
178).rem)) < asType<integer>($heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
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\rho_{tuncstart\_724.1.p2, 176).rem})._replace(p3 \rightarrow ((-63 * div(heapIs)
\$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).quot) + (170 * div(\textbf{heapIs}))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p3, 178).rem))).M3)
→ [const member of object with modified fields]
[70.7] ((-63 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3,
178).quot) + (170 * div(heapIs heapIs = f_{uncstart_{-724,1}}, heap_{funcstart_{-724,1}}.p3,
178).rem)) < \mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.M3)
\rightarrow [const static or extern object]
\label{eq:constant_724,1} \mbox{$[70.8]$ ((-63 * div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ ]$}
178).quot) + (170 * div(heapIs heapIs = f_{uncstart_{-724,1}}, heap_{funcstart_{-724,1}}.p3,
(178).rem) < asType < integer > (\$heap_{init}.M3)
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[70.9] ((-63 * div(heapIs heap_{funcstart\_724.1}, heap_{funcstart\_724.1}.p3,
178).quot) + (170 * div(heapIs heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, g_3,
(178).rem) < asType < integer > (asType < short int > ((int) 30323))
\rightarrow [simplify]
[70.19] -30323 < ((-170 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{rem} + (63 * \text{div}(\text{heapIs} \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{724,1}}.p3, 178).quot)
[Take given term]
[71.0] $\text{heap}_{724,1:752,8} == $\text{heap}_{724,1:749,8}._\text{replace}(p1 \to \text{asType} < \text{short}
int>((asType<int>($heap<sub>724,1;749,8</sub>.M1) *
asType<int>(static_cast<integer>(asType<int>($heap_{724.1:749.8}.p1) <
(int)(0)) + asType < int > (\$heap_{724,1;749,8}.p1)))
\rightarrow [from term 67.26, $heap<sub>724,1:749,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs p_{funcstart\_724,1}),
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs p_{funcstart\_724,1})
heap_{funcstart\_724,1}.p1, 177).rem))).\_replace(p2 \rightarrow ((-35 * div(heapIs))).\_replace(p2 \rightarrow ((-35 * div(heapIs)))))._replace(p2 \rightarrow ((-35 * div(heapIs)))))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}.p2, 176).rem))).replace(p3 \rightarrow (-63 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).quot) + (170 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).rem))]
[71.2] $\text{heap}_{724.1:752.8} == $\text{heap}_{funcstart_724.1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem}))._replace(p3 \rightarrow ((-63 * div(heapIs)
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p3, 178).quot) + (170 * div(heapIs
\$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem))).\_\mathbf{replace}(p1 \rightarrow
asType<short int>((asType<int>($heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2
```

```
* div(\mathbf{heapIs} \ \$ heap_{funcstart\_724,1}, \ \$ heap_{funcstart\_724,1}.p1, \ 177).quot) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{funcstart\_724,1}.p2, 176).rem))).\_replace(p3 \rightarrow ((-63 * div(heapIs)))._replace(p3 \rightarrow ((-63 * div(heapIs))))._replace(p3 \rightarrow ((-63 * div(heapIs))))._replace(p3 \rightarrow ((-63 * div(heapIs)))))._replace(p3 \rightarrow ((-63 * div(heapIs)))))._replace(p3 \rightarrow ((-63 * div(heapIs)))))._replace(p3 \rightarrow ((-63 * div(heapIs)))))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p3, 178).quot) + (170 * div(heapIs)
\rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, 178).rem))).M1) *
\mathbf{asType} < \mathbf{int} > (\mathbf{static\_cast} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{724,1;749,8}.\mathrm{p1}) < \mathsf{nt}) < \mathsf{nt} > \mathsf{nt} >
(int)(0) + asType<int>($heap<sub>724.1:749.8</sub>.p1)))
\rightarrow [const member of object with modified fields]
[71.5] heap_{724,1;752,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2, 176}.rem)._replace(p3 \rightarrow ((-63 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}. p3, 178).quot) + (170 * div(heapIs)
\rho_{funcstart_724.1}, \rho_{funcstart_724.1}, \rho_{funcstart_724.1}, \rho_{funcstart_724.1}, \rho_{funcstart_724.1}, \rho_{funcstart_724.1}
asType<short int>((asType<int>($heap_{tuncstart\_724.1}.M1) *
asType<int>(static_cast<integer>(asType<int>($heap_{724.1:749.8}.p1) <
(int)(0) + asType<int>($heap<sub>724.1:749.8</sub>.p1)))
\rightarrow [const static or extern object]
[71.6] heap_{724,1:752,8} == heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * 
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724.1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724.1},
\theta_{uncstart\_724,1}.p2, 176).rem))).\_replace(p3 \rightarrow ((-63 * div(heapIs)))._replace(p3 \rightarrow ((-63 * div(heapIs))))._replace(p3 \rightarrow ((-63 * div(heapIs))))._replace(p3 \rightarrow ((-63 * div(heapIs)))))._replace(p3 \rightarrow ((-63 * div(heapIs))))._replace(p3 \rightarrow ((-63 * div(heapIs)))))._replace(p3 \rightarrow ((-63 * div(heapIs)))))._replace(p3 \rightarrow ((-63 * div(heapIs)))))._replace(p3 \rightarrow ((-63 * div(heapIs))))))._replace(p3 \rightarrow ((-63 * div(heapIs)))))._replace(p3 \rightarrow ((-63 * div(heapIs)))))._replace(p3 \rightarrow ((-63 * div(heapIs))))))._replace(p3 \rightarrow ((-63 * div(heapIs))))))))._replace(p3 \rightarrow ((-63 * div(heapIs))))))
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p3, 178).quot) + (170 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p3, 178).rem))).\_replace(p1 \rightarrow
asType<short int>((asType<int>($heap_{init}.M1) *
\mathbf{asType} < \mathbf{int} > (\mathbf{static\_cast} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{724,1:749.8}.\mathrm{p1}) < \mathsf{nt}) < \mathsf{nt} > \mathsf{nt} >
(int)(0) + asType < int > (\$heap_{724,1:749,8}.p1))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[71.7] heap_{724,1;752,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2, 176}.rem)._replace(p3 \rightarrow ((-63 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p3, 178).quot) + (170 * div(heapIs)
\rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}
asType<short int>((asType<int>(asType<short int>((int)30269)) *
```

```
asType<int>(static_cast<integer>(asType<int>($heap<sub>724,1.749,8.</sub>p1) <
(int)(0) + asType < int > ($heap_{724,1;749,8}.p1))
\rightarrow [simplify]
[71.10] \text{sheap}_{724,1;752,8} == \text{sheap}_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2, 176}.rem)._replace(p3 \rightarrow ((-63 * div(heapIs
\text{Sheap}_{funcstart\ 724.1}, \text{Sheap}_{funcstart\ 724.1}.p3, 178).quot) + (170 * div(heapIs)
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p3, 178).rem)))._replace(p1 \rightarrow
asType < short int > ((30269 *
asType<int>(static_cast<integer>(asType<int>($heap<sub>724,1:749,8</sub>.p1) <
(int)(0) + asType<int>($heap<sub>724,1:749,8</sub>.p1)))
\rightarrow [from term 67.26, $heap<sub>724 1.749 8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1},p1, 177}, quot) + (171 * div(heapIs p_{funcstart_{724,1},p1, 177}), quot)
heap_{funcstart\_724,1}.p1, 177).rem))).\_replace(p2 \rightarrow ((-35 * div(heapIs))).\_replace(p2 \rightarrow ((-35 * div(heapIs)))))._replace(p2 \rightarrow ((-35 * div(heapIs)))))
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p_2, 176).quot + (172 * div(heapIs))
\rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).quot) + (170 \ *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).rem))]
[71.11] heap_{724,1;752,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724.1}, p2, 176).quot) + (172 * div(heapIs \text{Sheap}_{funcstart\_724.1},
\theta_{uncstart\_724,1}.p2, 176).rem))).\_replace(p3 \rightarrow ((-63 * div(heapIs)))._replace(p3 \rightarrow ((-63 * div(heapIs))))._replace(p3 \rightarrow ((-63 * div(heapIs))))._replace(p3 \rightarrow ((-63 * div(heapIs)))))._replace(p3 \rightarrow ((-63 * div(heapIs))))._replace(p3 \rightarrow ((-63 * div(heapIs)))))._replace(p3 \rightarrow ((-63 * div(heapIs)))))._replace(p3 \rightarrow ((-63 * div(heapIs)))))._replace(p3 \rightarrow ((-63 * div(heapIs))))))._replace(p3 \rightarrow ((-63 * div(heapIs)))))._replace(p3 \rightarrow ((-63 * div(heapIs)))))._replace(p3 \rightarrow ((-63 * div(heapIs))))))._replace(p3 \rightarrow ((-63 * div(heapIs))))))))._replace(p3 \rightarrow ((-63 * div(heapIs))))))
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}. p3, 178).quot) + (170 * div(heapIs
\rho_{funcstart_{724,1}}, \rho_{funcstart_{724,1},p3,178}.rem))._replace(p1 \rightarrow
asType<short int>((30269 *
\mathbf{asType} < \mathbf{int} > (\mathbf{static\_cast} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \operatorname{heap}_{funcstart\_724,1}. \bot \mathbf{replace} (\operatorname{p1})))
\rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).quot) +
(171 * \text{div}(\textbf{heapIs } \$\text{heap}_{funcstart\_724,1}, \$\text{heap}_{funcstart\_724,1}.\text{p1},
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem}))._replace(p3 \rightarrow ((-63 * div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p3, 178).quot) + (170 * div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p3, 178).rem))).p1) < (int)0))) +
asType<int>($heap<sub>724,1:749,8</sub>.p1)))
\rightarrow [simplify]
[71.23] heap_{724,1;752,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
div(\mathbf{heapIs} \ \text{$heap}_{funcstart\_724,1}, \ \text{$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
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\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2}, 176).quot) + (172 * div(heapIs \rho_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem}))._replace(p3 \rightarrow ((-63 * div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p3, 178).quot) + (170 * div(heapIs)
\$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, \ 178).rem))).\_\mathbf{replace}(p1 \rightarrow
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1, 177).rem) + (2 * div(heapIs
\frac{\text{sheap}_{funcstart_{724,1}}, \text{sheap}_{funcstart_{724,1},p1, 177}.\text{quot})}{1, []: 0))} +
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{724,1;749,8}.\mathrm{p1})))
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[71.24] \rho_{724,1;752,8} == \rho_{124,1;752,8} == \rho_{124,1}.
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2, 176}.rem))._replace(p3 \rightarrow ((-63 * div(heapIs
\text{Sheap}_{funcstart\_724.1}, \text{Sheap}_{funcstart\_724.1}.p3, 178).quot) + (170 * div(heapIs)
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p3, 178).rem))._replace(p1 \rightarrow
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).quot): 1, [!(0 < ((-171 * 
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1, 177).rem) + (2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot})))|: \ 0))) \ +
asType < int > (\$heap_{724.1:749.8}.p1)))
\rightarrow [simplify]
[71.29] heap_{724,1;752,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}. \operatorname{pl},
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724.1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs} \text{Sheap}_{funcstart\_724,1},
\theta_{funcstart\_724,1.p2, 176}.rem))._replace(p3 \rightarrow ((-63 * div(heapIs
\$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).quot) + (170 * div(\mathbf{heapIs})
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p3, 178).rem)))._replace(p1 \rightarrow
asType < short int > ((30269 * asType < int > (([0 < ((-171 * div(heapIs))))))))))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1, 177).rem) + (2 * div(heapIs)
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, \ 177).\operatorname{rem}) + (-2 \ *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}))]: 0))) +
asType<int>($heap<sub>724,1:749,8</sub>.p1)))
\rightarrow [from term 61.3, -1 < ((-2 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).rem) is true if and only if 0 < ((-2 * div(\mathbf{heapIs})))
```

```
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1, 177).quot) + (171 * div(heapIs)
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1},p1, 177}.rem)
[71.30] \rho_{724,1;752,8} == \rho_{13,6} - \rho_{13,6} - \rho_{13,6} = \rho_{13,6} = \rho_{13,6} - \rho_{13,6} = \rho_{1
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{uncstart\_724,1}.p2, 176).rem))).\_replace(p3 \rightarrow ((-63 * div(heapIs)))._replace(p3 \rightarrow ((-63 * div(heapIs))))._replace(p3 \rightarrow ((-63 * div(heapIs))))._replace(p3 \rightarrow ((-63 * div(heapIs))))._replace(p3 \rightarrow ((-63 * div(heapIs))))._replace(p3 \rightarrow ((-63 * div(heapIs)))))._replace(p3 \rightarrow ((-63 * div(heapIs)))))._replace(p3 \rightarrow ((-63 * div(heapIs))))._replace(p3 \rightarrow ((-63 * div(heapIs)))))._replace(p3 \rightarrow ((-63 * div(heapIs)))))))))._replace(p3 \rightarrow ((-63 * div(heapIs))))))
\text{Sheap}_{funcstart\_724.1}, \text{Sheap}_{funcstart\_724.1}.p3, 178).quot) + (170 * div(heapIs)
\$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem))).\_\textbf{replace}(p1 \rightarrow
asType<short int>((30269 * asType<int>(([0 < ((-171 * \mathrm{div}(\mathbf{heapIs})
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1},p1, 177}.rem) + (2 * div(heapIs)
\rho_{funcstart_{-724,1}}, \rho_{funcstart_{-724,1}}, 177).quot): 1, [0 < ((-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (-2 * 10^{-5}) + (
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
div(\mathbf{heapIs} \ \text{$heap}_{funcstart\_724,1}, \ \text{$heap}_{funcstart\_724,1}.p1, \ 177).rem))]: \ 0))) +
\mathbf{asType}{<}\mathbf{int}{>}(\${heap}_{724,1;749,8}.p1)))
\rightarrow [simplify]
[71.31] heap_{724,1;752,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}. p1, \ 177). \operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{funcstart\_724,1.p2, 176}.rem))._replace(p3 \rightarrow ((-63 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p3, 178).quot) + (170 * div(heapIs)
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p3, 178).rem))).replace(p1 \rightarrow
asType<short int>((30269 * ([0 < ((-171 * div(heapIs $heap_{funcstart\_724.1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart_{-724,1},p1, 177,quot}): 1, \rho_{funcstart_{-724,1},p1, 177,quot}: 1, \rho_{funcstart_{-724,1},p1, 177,quot}:
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p1, 177).quot) + (171 * div(heapIs
\frac{\text{sheap}_{funcstart_{724.1}}, \text{sheap}_{funcstart_{724.1}, p1, 177).rem}}{177).rem}
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{724,1;749,8}.\mathrm{p1})))
\rightarrow [move guard outside expression]
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724.1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).quot) + (172 * div(heapIs \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1}.p2, 176).rem))._replace(p3 \rightarrow ((-63 * div(heapIs
\text{Sheap}_{funcstart\_724.1}, \text{Sheap}_{funcstart\_724.1}.p3, 178).quot) + (170 * div(heapIs)
\rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}
asType<short int>(([0 < ((-171 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1},p1, 177,quot}): 1 * 30269, [0 < ((-2 * div(heapIs))]
```

```
\frac{\text{sheap}_{funcstart\_724,1}, \text{sheap}_{funcstart\_724,1}.p1, 177).rem)}{\text{rem}} = 0 * 30269} +
asType < int > (\$heap_{724,1;749,8}.p1)))
\rightarrow [simplify]
[71.34] $\text{heap}_{724,1;752,8} == \text{$heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart\_724,1.p2, 176).rem})).\_replace(p3 \rightarrow ((-63 * div(heapIs))).\_replace(p3 \rightarrow ((-63 * div(heapIs)))).\_replace(p3 \rightarrow ((-63 * div(heapIs)))))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).quot) + (170 * div(heapIs
\rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}
asType<short int>(([0 < ((-171 * div(heapIs $heap_{funcstart\_724.1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\frac{\text{heap}_{funcstart\_724,1.p1, 177}.\text{quot}}{177}: 30269, [0 < ((-2 * \text{div}(\mathbf{heapIs}))]
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs}))
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 177).rem): 0) +
asType<int>($heap<sub>724.1:749.8</sub>.p1)))
\rightarrow [from term 67.26, $heap<sub>724,1:749.8</sub> is equal to
\text{Sheap}_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(\textbf{heapIs } \$heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1}, 177).quot) + (171 * div(heapIs $heap_{funcstart\_724,1}, 17
heap_{funcstart\_724,1}.p1, 177).rem))._replace(p2 \rightarrow ((-35 * div(heapIs)))._
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem)))._replace(p3 \rightarrow (-63 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).quot) + (170 *
\operatorname{div}(\mathbf{heapIs} \ \$ heap_{funcstart\_724,1}, \ \$ heap_{funcstart\_724,1}.p3, \ 178).rem))]
[71.35] $\text{heap}_{724,1;752,8} == \text{$heap}_{funcstart\_724,1}._\text{$replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}. \operatorname{pl},
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{tuncstart_724.1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs} \text{Sheap}_{funcstart\_724,1},
\theta_{funcstart\_724,1.p2, 176}.rem))._replace(p3 \rightarrow ((-63 * div(heapIs
\$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).quot) + (170 * div(\mathbf{heapIs})
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p3, 178).rem))).\_replace(p1 \rightarrow
asType<short int>(([0 < ((-171 * div(heapIs $heap_{tuncstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart_{724,1},p1,177,quot}): 30269, \rho_{funcstart_{724,1},p1,177,quot}: 30269, \rho_{funcstart_{724,1},p1,177,quot}:
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs}))
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, 177).rem))]: 0) +
asType<int>($heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 * div(heapIs
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1, 177).quot) + (171 * div(heapIs)
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
* div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, p2, 176).quot) + (172 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p2,
```

 $\theta_{funcstart_724,1}$, $\theta_{funcstart_724,1}$, $\theta_{funcstart_724,1}$, $\theta_{funcstart_724,1}$, $\theta_{funcstart_724,1}$

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176).rem)))._replace(p3 \rightarrow ((-63 * div(heapIs $heap_{funcstart_724.1},
\text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{724,1}.p3, 178.rem})).p1))
\rightarrow [simplify]
[71.40] $\text{heap}_{724,1;752,8} == $\text{heap}_{funcstart\_724,1}._\text{replace}(p1 \to ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart\_724,1.p2, 176).rem})).\_replace(p3 \rightarrow ((-63 * div(heapIs))).\_replace(p3 \rightarrow ((-63 * div(heapIs)))).\_replace(p3 \rightarrow ((-63 * div(heapIs)))))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).quot) + (170 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p3, 178).rem))).\_replace(p1 \rightarrow
asType<short int>((-2 * div(heapIs $heap_{funcstart\_724.1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + ([0 < ((-171 * div(\mathbf{heapIs}))]))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}) + (2 * \text{div}(\text{heapIs}))
\rho_{funcstart_{724,1}}, \rho_{funcstart_{724,1},1}, 177).quot)): 30269, [0 < ((-2 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724.1}, \ \$heap_{funcstart\_724.1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).rem))]: 0)))
\rightarrow [move guard outside expression]
[71.41] heap_{724,1;752,8} == heap_{funcstart_{724,1}}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{uncstart\_724,1}.p2, 176).rem))).\_replace(p3 \rightarrow ((-63 * div(heapIs)))._replace(p3 \rightarrow ((-63 * div(heapIs))))._replace(p3 \rightarrow ((-63 * div(heapIs))))._replace(p3 \rightarrow ((-63 * div(heapIs))))._replace(p3 \rightarrow ((-63 * div(heapIs))))._replace(p3 \rightarrow ((-63 * div(heapIs)))))._replace(p3 \rightarrow ((-63 * div(heapIs))))._replace(p3 \rightarrow ((-63 * div(heapIs))))._replace(p3 \rightarrow ((-63 * div(heapIs)))))._replace(p3 \rightarrow ((-63 * div(heapIs)))))._replace(p3 \rightarrow ((-63 * div(heapIs)))))._replace(p3 \rightarrow ((-63 * div(heapIs)))))._replace(p3 \rightarrow ((-63 * div(heapIs))))))._replace(p3 \rightarrow ((-63 * div(heapIs)))))._replace(p3 \rightarrow ((-63 * div(heapIs)))))))))._replace(p3 \rightarrow ((-63 * div(heapIs)))))._replace(p3 \rightarrow ((-63 * div(heapIs)))))))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs}))
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p3, 178).rem))).\_replace(p1 \rightarrow
asType<short int>(([0 < ((-171 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724.1.p1, 177}.\text{rem}) + (2 * \text{div}(\text{heapIs} \text{Sheap}_{funcstart\_724.1,})
heap_{funcstart_{724,1},p1, 177,quot}): 30269 + (-2 * div(heapIs)
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1},p1, 177}.quot + (171 * div(heapIs))
\$heap_{funcstart\_724,1},\,\$heap_{funcstart\_724,1}.p1,\,177).rem),\,[0<((-2\,*\,\mathrm{div}(\mathbf{heapIs}
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1, 177).quot) + (171 * div(heapIs
\{\text{heap}_{funcstart\_724,1}, \text{heap}_{funcstart\_724,1}.\text{p1}, 177\}.\text{rem}\}]: 0 + (-2 * \text{div}(\text{heapIs}))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs}))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).rem))))
\rightarrow [simplify]
[71.43] heap_{724,1;752,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
```

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\rho_{tuncstart\_724.1.p2, 176).rem})._replace(p3 \rightarrow ((-63 * div(heapIs)
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).quot) + (170 * div(heapIs)
\$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem))). \_\textbf{replace}(p1 \rightarrow ([0 < 
((-171 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem) +
(2 * \text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}))]:
30269 + (-2 * div(\textbf{heapIs } \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1,
177).quot) + (171 * div(heapIs heapIs = f_{uncstart_{-724,1}}, heap_{funcstart_{-724,1}}.p1,
177).rem), [0 < ((-2 * \text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.p1,
177).quot) + (171 * div(heapIs heapIs = f_{uncstart_{-724,1}}, heap_{funcstart_{-724,1}}.p1,
177).rem))]: (-2 * div(heapIs \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, p1,
177).quot) + (171 * div(heapIs \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}
177).rem)))
\rightarrow [move guard outside expression]
\label{eq:fine_start_724,1} \mbox{$[71.45]$ ([0 < ((-171 * div(\mathbf{heapIs} \ \$ heap_{funcstart\_724,1}, \ \$ heap_{funcstart\_724,1}.p1, \ }) ) ) ) }
177).rem) + (2 * \text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1},
177).quot))]: heap_{724,1;752,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724.1}, \ \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs \rho_{tart\_724,1},
\text{Sheap}_{funcstart\_724.1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724.1},
\rho_{tuncstart\_724.1.p2, 176}.rem)._replace(p3 \rightarrow ((-63 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs}))
\$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem))).\_\mathbf{replace}(p1 \rightarrow (30269))
+ (-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).quot) +
(171 * div(\mathbf{heapIs} \$heap_{funcstart\_724.1}, \$heap_{funcstart\_724.1}.p1, 177).rem))), [0]
< ((-2 * div(\mathbf{heapIs } \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).quot) +
(171 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart\_724,1}, \text{\$heap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}))]:
heap_{724,1;752,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs)
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1},p1, 177}.quot) + (171 * div(heapIs)
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
* div(heapIs heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 176).quot) + (172 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p2,
176).rem)))._replace(p3 \rightarrow ((-63 * div(heapIs $heap_{funcstart_724,1},
heap_{funcstart\_724,1.p3}, 178).quot) + (170 * div(heapIs heap_{funcstart\_724,1},
\theta_{funcstart\_724,1.p3}, 178).rem)._replace(p1 \rightarrow ((-2 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs}))
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, 177).rem)))
[Take given term]
[72.0] $\text{heap}_{724,1:753,8} == $\text{heap}_{724,1:752,8}._\text{replace}(p2 \to \text{asType} < \text{short}
int>((asType<int>($heap<sub>724,1;752,8</sub>.M2) *
asType<int>(static_cast<integer>(asType<int>($heap_{724.1:752.8}.p2) <
(int)(0)) + asType < int > (\$heap_{724,1;752,8}.p2)))
\rightarrow [const static or extern object]
```

```
[72.1] heap_{724,1;753,8} == heap_{724,1;752,8} replace(p2 \rightarrow asType<short
int>((asType<int>(\$heap_{init}.M2) *
asType<int>(static_cast<integer>(asType<int>($heap_{724,1:752,8}.p2) <
(int)(0) + asType<int>($heap<sub>724,1:752,8</sub>.p2)))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[72.2] $\text{heap}_{724,1:753.8} == $\text{heap}_{724,1:752.8}._\text{replace}(p2 \to \text{asType} < \text{short}
int>((asType<int>(asType<short int>((int)30307)) *
asType<int>(static_cast<integer>(asType<int>($heap<sub>724.1:752.8</sub>.p2) <
(int)(0) + asType < int > ($heap_{724,1:752.8}.p2)))
\rightarrow [simplify]
[72.10] $\text{heap}_{724.1:753.8} == \text{$heap}_{724.1:752.8}.$\text{-replace}(p2 \to asType < short)
int>((30307 * asType < int>(([0 < -\$heap_{724.1:752.8}.p2]: 1, []: 0))) +
asType<int>($heap<sub>724.1:752.8</sub>.p2)))
→ [explicitly assert falsehood of skipped guards in subsequent guards]
[72.11] $\text{heap}_{724,1;753,8} == \text{$heap}_{724,1;752,8}._\text{$replace}(p2 \to asType < short)$
int>((30307 * asType < int>)(([0 < -\$heap_{724,1;752,8}.p2]: 1, [!(0 < -\$heap_{724,1;752,8}.p2]: 1))
-\text{$heap}_{724,1;752,8}.p2)]: 0))) + asType<int>($heap}_{724,1;752,8}.p2)))
\rightarrow [simplify]
[72.15] $\text{heap}_{724,1;753,8} == $\text{heap}_{724,1;752,8}.$\text{replace}(p2 \rightarrow asType < short)
int > ((30307 * ([0 < -\$heap_{724,1;752,8}.p2]: 1, [-1 < \$heap_{724,1;752,8}.p2]: 0)) +
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{724,1;752,8}.\mathrm{p2})))
\rightarrow [move guard outside expression]
[72.16] \; \$ heap_{724,1;753,8} == \$ heap_{724,1;752,8}. \textbf{\_replace} (p2 \to \mathbf{asType} < \mathbf{short})
int>(([0 < -\$heap_{724,1:752.8}.p2]: 1 * 30307, [-1 < \$heap_{724,1:752.8}.p2]: 0 *
30307) + asType < int > (\$heap_{724,1:752.8}.p2)))
\rightarrow [simplify]
[72.19] $\text{heap}_{724,1;753,8} == \text{$heap}_{724,1;752,8}.$\text{$replace}(p2 \to asType < short)$
int>(([0 < -\$heap_{724,1;752,8}.p2]: 30307, [-1 < \$heap_{724,1;752,8}.p2]: 0) +
heap_{724,1;752,8}.p2)
\rightarrow [move guard outside expression]
[72.20] $\text{heap}_{724,1;753,8} == \text{$heap}_{724,1;752,8}.$_{replace}(p2 \to asType < short)
int>(([0 < -\$heap_{724,1;752,8}.p2]: 30307 + \$heap_{724,1;752,8}.p2, [-1 < -\$heap_{724,1;752,8}.p2])
\label{eq:heap_724,1;752,8.p2} \$ heap_{724,1;752,8}.p2)))
\rightarrow [simplify]
[72.22] $\text{heap}_{724,1;753,8} == \text{$heap}_{724,1;752,8}._\text{replace}(p2 \to ([0 <
-\$heap_{724,1:752,8}.p2]: 30307 + \$heap_{724,1:752,8}.p2, [-1 < \$heap_{724,1:752,8}.p2]:
$heap<sub>724.1:752.8</sub>.p2))
\rightarrow [move guard outside expression]
```

```
\rho_{724,1;752,8}._replace(p2 \rightarrow (30307 + \rho_{724,1;752,8}.p2)), [-1 <
\$heap_{724,1;752,8}.p2] \colon \$heap_{724,1;753,8} == \$heap_{724,1;752,8}. \textbf{\_replace}(p2 \to p2) + (p2 \to p
heap_{724,1;752,8}.p2)
[Take given term]
[75.0] \text{sheap}_{funcend\_724,1} == \text{sheap}_{724,1;753,8}. \text{replace}(p3 \rightarrow \text{asType} < \text{short})
int>((asType<int>($heap<sub>724,1:753,8</sub>.M3) '
asType<int>(static_cast<integer>(asType<int>($heap_{724,1:753,8}.p3) <
(int)(0)) + asType < int > ($heap_{724,1;753,8}.p3)))
\rightarrow [const static or extern object]
[75.1] heap_{funcend\_724.1} == heap_{724.1:753.8}._replace(p3 \rightarrow asType<short
int>((asType<int>($heap<sub>init</sub>.M3) *
asType<int>(static_cast<integer>(asType<int>($heap_{724,1:753,8}.p3) <
(int)(0)) + asType < int > (\$heap_{724,1:753,8}.p3)))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[75.2] \theta_{175.2} = \theta_{175.2}
int>((asType<int>(asType<short int>((int)30323)) *
asType<int>(static_cast<integer>(asType<int>($heap<sub>724,1:753,8</sub>.p3) <
(int)(0) + asType < int > ($heap_{724,1:753,8}.p3))
\rightarrow [simplify]
[75.10] $\text{heap}_{funcend_724,1} == \text{$heap}_{724,1;753,8}._\text{replace}(p3 \to \text{asType} < \text{short}
int>((30323 * asType < int>)(([0 < -\$heap_{724.1:753.8}.p3]: 1, []: 0))) +
asType<int>($heap<sub>724,1;753,8</sub>.p3)))
\rightarrow [explicitly assert falsehood of skipped guards in subsequent guards]
[75.11] \text{sheap}_{funcend\_724,1} == \text{sheap}_{724,1;753,8}._replace(p3 \rightarrow asType<short
int>((30323 * asType < int>(([0 < -\$heap_{724,1;753,8}.p3]: 1, [!(0 < -\$heap_{724,1;753,8}.p3]: 1, [
-\text{$heap}_{724,1;753,8}.p3)]: 0))) + asType<int>($heap}_{724,1;753,8}.p3)))
\rightarrow [simplify]
[75.15] heap_{funcend\_724,1} == heap_{724,1;753,8}_replace(p3 \rightarrow asType<short
int>((30323 * ([0 < -\$heap_{724.1:753.8}.p3]: 1, [-1 < \$heap_{724.1:753.8}.p3]: 0)) +
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{724,1;753,8}.\mathrm{p3})))
\rightarrow [move guard outside expression]
[75.16] \text{heap}_{funcend\_724,1} == \text{heap}_{724,1;753,8}._replace(p3 \rightarrow asType<short
int>(([0<-\$heap_{724,1;753,8}.p3]: 1*30323, [-1<\$heap_{724,1;753,8}.p3]: 0*
30323) + asType < int > ($heap_{724,1;753,8}.p3)))
\rightarrow [simplify]
[75.19] heap_{funcend\_724.1} == heap_{724.1:753.8}._replace(p3 \rightarrow asType<short
int>(([0 < -\$heap_{724,1:753,8}.p3]: 30323, [-1 < \$heap_{724,1:753,8}.p3]: 0) +
$heap<sub>724.1:753.8</sub>.p3))
```

[72.24] ([0 < -\$heap_{724.1:752.8}.p2]: \$heap_{724.1:753.8} ==

```
\rightarrow [move guard outside expression]
[75.20] \text{heap}_{funcend\_724,1} == \text{heap}_{724,1;753,8}._replace(p3 \rightarrow asType<short
int>(([0 < -\$heap_{724,1;753,8}.p3]: 30323 + \$heap_{724,1;753,8}.p3, [-1 < -\$heap_{724,1;753,8}.p3])
heap_{724,1;753,8}.p3: 0 + p_{724,1;753,8}.p3))
\rightarrow [simplify]
[75.22] heap_{funcend\_724,1} == heap_{724,1;753,8}._replace(p3 \rightarrow ([0 <
-\$heap_{724,1:753,8}.p3]: 30323 + \$heap_{724,1:753,8}.p3, [-1 < \$heap_{724,1:753,8}.p3]:
heap_{724,1:753,8}.p3)
\rightarrow [move guard outside expression]
[75.24] ([0 < -$heap<sub>724,1;753,8</sub>.p3]: $heap<sub>funcend_724,1</sub> ==
\text{heap}_{724,1:753.8}._replace(p3 \rightarrow (30323 + \text{heap}_{724,1:753.8}.p3)), [-1 <
[heap_{724,1;753,8}.p3]: [heap_{funcend\_724,1} == [heap_{724,1;753,8}.\_replace(p3 \rightarrow
heap_{724,1:753,8}.p3)
[Branch on disjunction or conditional in term 75.24]
[78.0] (\text{$heap}_{funcend\_724,1} == \text{$heap}_{724,1;753,8}._replace(p3 \rightarrow (30323 +
\{\text{heap}_{724,1;753,8}.p3)\} \lor \{\text{heap}_{funcend\_724,1} == \{\text{heap}_{724,1;753,8}.\_\mathbf{replace}(p3 \rightarrow p3)\}
\text{Sheap}_{724,1:753,8}.\text{p3})) \lor (-1 < \text{Sheap}_{724,1:753,8}.\text{p3})
[Branch on disjunction or conditional in term 75.24]
[79.0] (0 < -\$heap_{724,1:753,8}.p3) \lor (\$heap_{funcend\_724,1} ==
\text{Sheap}_{724,1:753.8}.\text{-replace}(p3 \rightarrow \text{Sheap}_{724,1:753.8}.p3)) \lor (-1 < \text{Sheap}_{724,1:753.8}.p3)
[Copy term 1.56]
[80.0] ((-1 < -$heap<sub>funcend_724,1.</sub>p1) \vee (-1 < -$heap<sub>funcend_724,1.</sub>p2) \vee (-1 <
-\$heap_{funcend\_724,1}.p3) \lor (30268 < \$heap_{funcend\_724,1}.p1) \lor (30306 < \$heap_{funcend\_724,1}.p3)
\text{Sheap}_{funcend\_724,1}.\text{p2}) \lor (30322 < \text{Sheap}_{funcend\_724,1}.\text{p3})) \lor
(\text{\$heap}_{funcend\_724,1} == \text{\$heap}_{724,1;753,8}.\_\mathbf{replace}(p3 \to \text{\$heap}_{724,1;753,8}.p3)) \lor
(-1 < \text{$heap}_{724,1;753,8}.\text{p3})
\rightarrow [from term 78.0, $heap_{funcend\_724,1}$ is equal to $heap_{724,1;753,8}._replace(p3)
\rightarrow 30323 + $heap_{724,1;753,8}.p3)]
[80.1] ((-1 < -$heap<sub>724,1:753,8</sub>._replace(p3 \rightarrow (30323 +
\text{Sheap}_{724,1;753,8}.\text{p3}).\text{p1}) \lor (-1 < -\text{Sheap}_{funcend\_724,1}.\text{p2}) \lor (-1 <
-\$heap_{funcend\_724,1}.p3) \lor (30268 < \$heap_{funcend\_724,1}.p1) \lor (30306 < funcend\_724,1)
\text{Sheap}_{funcend\_724,1}.\text{p2}) \lor (30322 < \text{Sheap}_{funcend\_724,1}.\text{p3})) \lor \dots
\rightarrow [simplify]
[80.2] ((-1 < -$heap<sub>724,1;753,8</sub>.p1) \vee (-1 < -$heap<sub>funcend_724,1</sub>.p2) \vee (-1 <
-\$heap_{funcend\_724,1}.p3) \lor (30268 < \$heap_{funcend\_724,1}.p1) \lor (30306 < funcend\_724,1)
\text{Sheap}_{funcend\_724,1}.\text{p2}) \vee (30322 < \text{Sheap}_{funcend\_724,1}.\text{p3})) \vee ...
\rightarrow [from term 78.0, $heap_{funcend\_724,1}$ is equal to $heap_{724,1;753,8}._replace(p3
\rightarrow 30323 + \$heap_{724,1;753,8}.p3)
```

```
[80.3] ((-1 < -$heap<sub>724,1;753,8</sub>.p1) \vee (-1 < -$heap<sub>724,1;753,8</sub>.replace(p3 \rightarrow
(30323 + \text{\$heap}_{724,1;753,8}.\text{p3})).\text{p2}) \lor (-1 < -\text{\$heap}_{funcend\_724,1}.\text{p3}) \lor (30268 < -\text{\$heap}_{funcend\_724,1}.\text{p3})
\text{Sheap}_{funcend\_724,1}.\text{p1}) \lor (30306 < \text{Sheap}_{funcend\_724,1}.\text{p2}) \lor (30322 < \text{property})
heap_{funcend\_724,1}.p3) \lor ...
\rightarrow [simplify]
[80.4] ((-1 < -$heap<sub>724,1:753,8</sub>.p1) \vee (-1 < -$heap<sub>724,1:753,8</sub>.p2) \vee (-1 <
-\$heap_{funcend\_724,1}.p3) \lor (30268 < \$heap_{funcend\_724,1}.p1) \lor (30306 < funcend\_724,1)
\text{heap}_{funcend\_724,1.p2}) \lor (30322 < \text{heap}_{funcend\_724,1.p3})) \lor \dots
\rightarrow [from term 78.0, $heap_{funcend\_724,1}$ is equal to $heap_{724,1;753,8}._replace(p3
\rightarrow 30323 + \text{\$heap}_{724,1;753,8}.p3)
[80.5] ((-1 < -$heap<sub>724.1:753.8</sub>.p1) \vee (-1 < -$heap<sub>724.1:753.8</sub>.p2) \vee (-1 <
-\$heap_{724,1:753,8}._replace(p3 \rightarrow (30323 + \$heap_{724,1:753,8}.p3)).p3) \lor (30268 <
\text{Sheap}_{funcend\_724,1}.\text{p1}) \lor (30306 < \text{Sheap}_{funcend\_724,1}.\text{p2}) \lor (30322 < \text{p3})
heap_{funcend\_724,1.p3}) \lor ...
\rightarrow [simplify]
[80.10] ((-1 < -$heap<sub>724,1;753,8</sub>.p1) \vee (-1 < -$heap<sub>724,1;753,8</sub>.p2) \vee (30322 <
-\$heap_{724,1;753,8}.p3) \lor (30268 < \$heap_{funcend\_724,1}.p1) \lor (30306 < functions)
\$ heap_{funcend\_724,1}.p2) \lor (30322 < \$ heap_{funcend\_724,1}.p3)) \lor \dots
\rightarrow [from term 78.0, $heap_{funcend\_724,1}$ is equal to $heap_{724,1;753,8}._replace(p3
\rightarrow 30323 + \$heap_{724,1;753,8}.p3)
[80.11] ((-1 < -$heap<sub>724,1;753,8</sub>.p1) \vee (-1 < -$heap<sub>724,1;753,8</sub>.p2) \vee (30322 <
-\text{$heap}_{724,1:753.8}.\text{p3}) \lor (30268 < \text{$heap}_{724,1:753.8}.\text{\_replace}(p3 \rightarrow (30323 +
\text{heap}_{724,1:753,8}.\text{p3}).\text{p1}) \lor (30306 < \text{heap}_{funcend\_724,1}.\text{p2}) \lor (30322 <
heap_{funcend\_724,1}.p3) \lor ...
\rightarrow [simplify]
[80.12] ((-1 < -\$heap_{724,1;753,8}.p1) \lor (-1 < -\$heap_{724,1;753,8}.p2) \lor (30322 <
-\$heap_{724,1;753,8}.p3) \lor (30268 < \$heap_{724,1;753,8}.p1) \lor (30306 < \$heap_{724,1;753,8}.p3)
\text{Sheap}_{funcend\_724,1}.\text{p2}) \vee (30322 < \text{Sheap}_{funcend\_724,1}.\text{p3})) \vee ...
\rightarrow [from term 78.0, $heap_{funcend\_724,1}$ is equal to $heap_{724,1;753,8}._replace(p3
\rightarrow 30323 + \text{\$heap}_{724,1;753,8}.p3)
[80.13] ((-1 < -$heap<sub>724,1;753,8</sub>.p1) \vee (-1 < -$heap<sub>724,1;753,8</sub>.p2) \vee (30322 <
-\$heap_{724,1;753,8}.p3) \lor (30268 < \$heap_{724,1;753,8}.p1) \lor (30306 < \$heap_{724,1;753,8}.p3)
\text{heap}_{724.1:753.8}. replace(p3 \rightarrow (30323 + \text{heap}_{724.1:753.8}.p3)).p2) \lor (30322 <
heap_{funcend\_724,1.p3}) \vee ...
\rightarrow [simplify]
[80.14] ((-1 < -$heap<sub>724.1:753.8</sub>.p1) \vee (-1 < -$heap<sub>724.1:753.8</sub>.p2) \vee (30322 <
-\$heap_{724,1:753,8}.p3) \lor (30268 < \$heap_{724,1:753,8}.p1) \lor (30306 < \$heap_{724,1:753,8}.p3)
```

 \rightarrow [from term 78.0, \$heap_{funcend_724,1}\$ is equal to \$heap_{724,1;753,8}._replace(p3)

 $\text{Sheap}_{724,1;753,8}.\text{p2}) \lor (30322 < \text{Sheap}_{funcend_724,1}.\text{p3})) \lor \dots$

```
\rightarrow 30323 + \text{$heap}_{724.1:753.8}.p3)
[80.15] ((-1 < -$heap<sub>724,1:753,8</sub>.p1) \vee (-1 < -$heap<sub>724,1:753,8</sub>.p2) \vee (30322 <
-\$heap_{724,1:753,8}.p3) \lor (30268 < \$heap_{724,1:753,8}.p1) \lor (30306 < \$heap_{724,1:753,8}.p3)
heap_{724.1:753.8}.p_{3}).p_{3}) \vee ...
\rightarrow [simplify]
[80.18] ((-1 < -$heap<sub>724,1;753,8</sub>.p1) \vee (-1 < -$heap<sub>724,1;753,8</sub>.p2) \vee (30322 <
-\$heap_{724,1:753,8}.p3) \lor (30268 < \$heap_{724,1:753,8}.p1) \lor (30306 < \$heap_{724,1:753,8}.p3)
\text{Sheap}_{724,1;753,8}.\text{p2}) \lor (-1 < \text{Sheap}_{724,1;753,8}.\text{p3})) \lor \dots
\rightarrow [from term 79.0, literala < $heap<sub>724.1:753.8</sub>.p3 is false whenever -2 < (0 +
literala)]
    Proof of rule precondition:
    [80.18.0] - 2 < (-1 + 0)
    \rightarrow [simplify]
    [80.18.2] true
[80.19] ((-1 < -$heap<sub>724.1:753.8</sub>.p1) \vee (-1 < -$heap<sub>724.1:753.8</sub>.p2) \vee (30322 <
-\$heap_{724,1:753,8}.p3) \lor (30268 < \$heap_{724,1:753,8}.p1) \lor (30306 < \$heap_{724,1:753,8}.p3)
heap_{724,1;753,8}.p2) \lor false) \lor ...
\rightarrow [simplify]
[80.20]\;((\text{-}1<-\$\text{heap}_{724,1;753,8}.\text{p1})\;\vee\;(\text{-}1<-\$\text{heap}_{724,1;753,8}.\text{p2})\;\vee\;(30268<-30268)
\text{heap}_{724,1:753.8}.\text{p1}) \lor (30306 < \text{heap}_{724,1:753.8}.\text{p2}) \lor (30322 <
-\$heap_{724,1;753,8}.p3)) \lor ...
[Branch on disjunction or conditional in term 72.24]
[81.0] ($heap<sub>724,1;753,8</sub> == $heap<sub>724,1;752,8</sub>._replace(p2 \rightarrow (30307 +
\text{Sheap}_{724,1;752,8}.\text{p2}))) \lor (\text{Sheap}_{724,1;753,8} == \text{Sheap}_{724,1;752,8}.\textbf{replace}(\text{p2} \rightarrow
\text{sheap}_{724,1;752,8}.\text{p2}) \lor (-1 < \text{sheap}_{724,1;752,8}.\text{p2})
[Branch on disjunction or conditional in term 72.24]
[82.0] (0 < -$heap<sub>724,1;752,8</sub>.p2) \vee ($heap<sub>724,1;753,8</sub> ==
\text{Sheap}_{724,1;752,8}._replace(p2 \to \text{Sheap}_{724,1;752,8}.p2)) \lor (-1 < \text{Sheap}_{724,1;752,8}.p2)
[Copy term 80.20]
[89.0] ((-1 < -$heap<sub>724.1:753.8</sub>.p1) \vee (-1 < -$heap<sub>724.1:753.8</sub>.p2) \vee (30268 <
\text{heap}_{724,1:753.8}.\text{p1}) \lor (30306 < \text{heap}_{724,1:753.8}.\text{p2}) \lor (30322 <
-\$heap_{724,1;753,8}.p3)) \lor (\$heap_{funcend\_724,1} == \$heap_{724,1;753,8}.replace(p3)
\rightarrow \text{$heap}_{724,1:753,8}.p3)) \lor (-1 < \text{$heap}_{724,1:753,8}.p3) \lor (\text{$heap}_{724,1:753,8} ==
\text{$heap}_{724,1;752,8}.\text{replace}(p2 \rightarrow \text{$heap}_{724,1;752,8}.p2)) \lor (-1 < \text{$heap}_{724,1;752,8}.p2)
\rightarrow [from term 81.0, $heap<sub>724,1:753,8</sub> is equal to $heap<sub>724,1:752,8</sub>._replace(p2 \rightarrow
30307 + \text{$heap}_{724,1;752,8}.p2)
```

[89.1] ((-1 < -\$heap_{724,1;752,8}._**replace**(p2 \rightarrow (30307 +

```
\text{heap}_{724,1:752,8}.\text{p2}).\text{p1}) \lor (-1 < -\text{heap}_{724,1:753,8}.\text{p2}) \lor (30268 <
\text{$heap}_{724,1;753,8}.\text{p1}) \lor (30306 < \text{$heap}_{724,1;753,8}.\text{p2}) \lor (30322 <
-\$heap_{724,1;753,8}.p3)) \lor ...
\rightarrow [simplify]
[89.2] ((-1 < -\$heap_{724,1;752,8}.p1) \lor (-1 < -\$heap_{724,1;753,8}.p2) \lor (30268 <
\text{$heap}_{724,1;753,8}.\text{p1}) \lor (30306 < \text{$heap}_{724,1;753,8}.\text{p2}) \lor (30322 <
-\$heap_{724,1:753,8}.p3)) \lor ...
\rightarrow [from term 81.0, $heap_{724,1;753,8}$ is equal to $heap_{724,1;752,8}._replace(p2 \rightarrow
30307 + \text{$heap}_{724,1;752,8}.p2)
[89.3] ((-1 < -\$heap_{724,1;752,8}.p1) \lor (-1 < -\$heap_{724,1;752,8}.\_replace(p2 \rightarrow
(30307 + \text{$heap}_{724,1:752,8},\text{p2})).\text{p2}) \lor (30268 < \text{$heap}_{724,1:753,8},\text{p1}) \lor (30306 <
\text{heap}_{724,1;753,8}.\text{p2}) \lor (30322 < -\text{heap}_{724,1;753,8}.\text{p3})) \lor \dots
\rightarrow [simplify]
[89.8] ((-1 < -\$heap_{724,1;752,8}.p1) \lor (30306 < -\$heap_{724,1;752,8}.p2) \lor (30268)
< $heap<sub>724,1;753,8</sub>.p1) \lor (30306 < $heap<sub>724,1;753,8</sub>.p2) \lor (30322 <
-\$heap_{724,1;753,8}.p3)) \lor ...
\rightarrow [from term 81.0, $heap_{724,1;753,8}$ is equal to $heap_{724,1;752,8}$._replace(p2 \rightarrow
30307 + \$heap_{724,1;752,8}.p2)
[89.9] ((-1 < -$heap<sub>724,1;752,8</sub>.p1) \vee (30306 < -$heap<sub>724,1;752,8</sub>.p2) \vee (30268)
< $heap<sub>724,1;752,8</sub>._replace(p2 \rightarrow (30307 + $heap<sub>724,1;752,8</sub>.p2)).p1) \lor (30306
< $heap<sub>724,1;753,8</sub>.p2) \lor (30322 < -$heap<sub>724,1;753,8</sub>.p3)) \lor ...
\rightarrow [simplify]
[89.10] \; ((\text{-}1 < -\$ \text{heap}_{724,1;752,8}.\text{p1}) \; \vee \; (30306 < -\$ \text{heap}_{724,1;752,8}.\text{p2}) \; \vee \; (30268)
< $heap<sub>724.1:752.8</sub>.p1) \lor (30306 < $heap<sub>724.1:753.8</sub>.p2) \lor (30322 <
-\$heap_{724,1:753.8}.p3)) \lor ...
\rightarrow [from term 81.0, $heap<sub>724,1;753,8</sub> is equal to $heap<sub>724,1;752,8</sub>._replace(p2 \rightarrow
30307 + \text{$heap_{724,1;752,8}.p2)}
[89.11] ((-1 < -\$heap_{724,1;752,8}.p1) \lor (30306 < -\$heap_{724,1;752,8}.p2) \lor (30268)
< $heap<sub>724,1;752,8</sub>.p1) \lor (30306 < $heap<sub>724,1;752,8</sub>.replace(p2 \rightarrow (30307 +
heap_{724,1;752,8}.p_{2}).p_{2} \lor (30322 < -heap_{724,1;753,8}.p_{3})) \lor ...
\rightarrow [simplify]
[89.14] ((-1 < -$heap<sub>724,1;752,8</sub>.p1) \vee (30306 < -$heap<sub>724,1;752,8</sub>.p2) \vee (30268)
< $heap<sub>724,1;752,8</sub>.p1) \lor (-1 < $heap<sub>724,1;752,8</sub>.p2) \lor (30322 <
-\$heap_{724,1;753,8}.p3)) \lor ...
\rightarrow [from term 82.0, literala < $heap_{724,1:752,8}.p2 is false whenever -2 < (0 +
literala)
```

Proof of rule precondition:

$$[89.14.0] - 2 < (-1 + 0)$$

```
\rightarrow [simplify]
    [89.14.2] true
[89.15] ((-1 < -$heap<sub>724.1:752.8.p1) \vee (30306 < -$heap<sub>724.1:752.8.p2</sub>) \vee (30268)</sub>
< $heap<sub>724,1;752,8</sub>.p1) \lor false \lor (30322 < -$heap<sub>724,1;753,8</sub>.p3)) \lor ...
\rightarrow [from term 81.0, $heap_{724,1;753,8}$ is equal to $heap_{724,1;752,8}$._replace(p2 \rightarrow
30307 + \$heap_{724,1;752,8}.p2)
[89.16] \; ((-1 < -\$heap_{724,1;752,8}.p1) \; \lor \; (30306 < -\$heap_{724,1;752,8}.p2) \; \lor \; (30268)
< $\text{heap}_{724,1:752,8}.p1) \lor false \lor (30322 < -$\text{heap}_{724,1:752,8}._\text{replace}(p2 \to
(30307 + \text{\$heap}_{724,1;752,8}.\text{p2})).\text{p3})) \vee \dots
\rightarrow [simplify]
[89.18] ((-1 < -$heap<sub>724.1:752.8.p1)</sub> \lor (30268 < $heap<sub>724.1:752.8.p1</sub>) \lor (30306 <
-\$heap_{724,1:752,8}.p2) \lor (30322 < -\$heap_{724,1:752,8}.p3)) \lor ...
[Branch on disjunction or conditional in term 71.45]
[90.0] ($heap<sub>724,1;752,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart\_724,1.p2, 176}.rem))._replace(p3 \rightarrow ((-63 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}. p3, 178).quot) + (170 * div(heapIs
\$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem))).\_\mathbf{replace}(p1 \rightarrow
(30269 + (-2 * div(heapIs \$heap_{funcstart\_724.1}, \$heap_{funcstart\_724.1}, p1,
177).quot) + (171 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}, p_{funcstart\_724,1}
177).rem)))) \lor ($heap<sub>724,1;752,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart\_724,1}.p2, 176).rem))._replace(p3 \rightarrow ((-63 * div(heapIs))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p3, 178).quot) + (170 * div(heapIs)
\rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).rem)))) \lor (0 <
((-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).quot) +
(171 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart\_724,1}, \text{\$heap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem})))
[Branch on disjunction or conditional in term 71.45]
[91.0] (0 < ((-171 * div(heapIs heapIs f_{uncstart_{-724,1}}, heap_{funcstart_{-724,1}}, p1,
177).rem) + (2 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1,
(-2 * 177).quot))) \lor (\$heap_{724,1;752,8} == \$heap_{funcstart\_724,1}.\_replace(p1 \rightarrow ((-2 * 175).quot))))
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
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177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2, 176}.rem)._replace(p3 \rightarrow ((-63 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p3, 178).quot) + (170 * div(heapIs)
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p3, 178).rem))).\_replace(p1 \rightarrow ((-2 * funcstart\_724,1)))._replace(p1 \rightarrow ((-2 * funcstart\_724,1))))
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).rem)))) \lor (0 <
((-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).quot) +
(171 * \text{div}(\textbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem})))
[Copy term 81.0]
[92.0] ($\text{heap}_{724,1;753,8} == $\text{heap}_{724,1;752,8}._\text{replace}(p2 \rightarrow (30307 +
\{\text{heap}_{724,1;752,8}.\text{p2}\}\)\) \lor (\{\text{heap}_{724,1;753,8} == \{\text{heap}_{724,1;752,8}.\_\textbf{replace}\}\)
\text{sheap}_{724,1;752,8}.\text{p2})) \lor (-1 < \text{sheap}_{724,1;752,8}.\text{p2}) \lor (\text{sheap}_{724,1;752,8} = -1)
\text{Sheap}_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs \text{Sheap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p1, 177).rem}))._replace(p2 \rightarrow ((-35 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
\text{Sheap}_{funcstart\_724.1}, \text{Sheap}_{funcstart\_724.1}.p2, 176).rem))).\_replace(p3 \rightarrow ((-63)))
* div(heapIs heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 178).quot) + (170 *
\operatorname{div}(\mathbf{heapIs}\ \$ \operatorname{heap}_{funcstart\_724,1},\ \$ \operatorname{heap}_{funcstart\_724,1}.p3,
178).rem)))._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{tuncstart_724.1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem})))) \lor (0 < ((-2 * \text{div}(\textbf{heapIs}))))) \lor (0 < ((-2 * \text{div}(\textbf{heapIs}))))))
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, 177).rem)
\rightarrow [from term 90.0, $heap<sub>724,1;752,8</sub> is equal to $heap<sub>funcstart_724,1</sub>._replace(p1
\rightarrow ((-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).quot) +
(171 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1,
 177).rem)))._replace(p2 \rightarrow ((-35 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2},\ 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart\_724,1}.p2, 176).rem))).\_replace(p3 \rightarrow ((-63 * div(heapIs))).\_replace(p3 \rightarrow ((-63 * div(heapIs)))))._replace(p3 \rightarrow ((-63 * div(heapIs)))))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).quot) + (170 * div(heapIs)
\rho_{uncstart\_724,1}, \rho_{uncstart\_724,1},
 + (-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).quot) +
(171 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem))]
[92.2] ($heap<sub>724,1;753,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart_724,1}.p2, 176).rem))._replace(p3 \rightarrow ((-63 * div(heapIs
\text{Sheap}_{funcstart\_724.1}, \text{Sheap}_{funcstart\_724.1}.p3, 178).quot) + (170 * div(heapIs)
\rho_{funcstart\_724.1}, \rho_{func
(30269 + (-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1,
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177).quot) + (171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow (30307 + $heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2
* div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p1, \ 177).quot) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart\_724,1.p2, 176).rem})).\_replace(p3 \rightarrow ((-63 * div(heapIs))).\_replace(p3 \rightarrow ((-63 * div(heapIs)))).\_replace(p3 \rightarrow ((-63 * div(heapIs)))))
\theta_{funcstart_{-724,1}}, \theta_{funcstart_{-724,1}}, \theta_{funcstart_{-724,1}}, \theta_{funcstart_{-724,1}}, \theta_{funcstart_{-724,1}}
\rho_{funcstart_{724,1}}, \rho_{funcstart_{724,1},p3,178}.rem))._replace(p1 \rightarrow
(30269 + (-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1,
177).quot) + (171 * div(heapIs \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}
177).rem))).p2))) \vee \dots
\rightarrow [simplify]
[92.6] ($heap<sub>724,1;753,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart_724,1},
\rho_{funcstart\_724.1.p2, 176}.rem)._replace(p3 \rightarrow ((-63 * div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}.p3, 178).quot) + (170 * div(heapIs)
\rho_{funcstart_{724,1}}, \rho_{funcstart_{724,1},p3,178}.rem))._replace(p1 \rightarrow
(30269 + (-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1,
177).quot) + (171 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart\_724,1}, \text{\$heap}_{funcstart\_724,1}.\text{p1},
177).rem)))._replace(p2 \rightarrow (30307 + (-35 * div(heapIs $heap_{funcstart\_724.1},
\text{Sheap}_{funcstart_{-724,1},p2, 176}.quot) + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart_{-724,1}},
heap_{funcstart_{724,1}.p2, 176).rem}))) \vee ...
[Copy term 82.0]
[94.0] (0 < -$heap<sub>724,1;752,8</sub>.p2) \vee ($heap<sub>724,1;753,8</sub> ==
\text{heap}_{724,1;752,8}.\_\mathbf{replace}(p2 \to \text{heap}_{724,1;752,8}.p2)) \lor (-1 <
\text{Sheap}_{724,1:752.8}.\text{p2}) \lor (\text{Sheap}_{724,1:752.8} == \text{Sheap}_{funcstart\_724,1}.\textbf{replace}(\text{p1} \to
((-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).quot) +
(171 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart\_724,1}, \text{\$heap}_{funcstart\_724,1}.\text{p1},
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem}))._replace(p3 \rightarrow ((-63 * div(heapIs
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).quot) + (170 * div(heapIs)
\$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem))).\_\textbf{replace}(p1 \rightarrow ((-2 * left) + left)))
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}. p1, \ 177).rem)))) \lor (0 <
((-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).quot) +
(171 * \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, 177).\operatorname{rem})))
\rightarrow [from term 90.0, $heap<sub>724,1:752,8</sub> is equal to $heap<sub>funcstart_724,1</sub>._replace(p1
\rightarrow ((-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).quot) +
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(171 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p2, 176).quot + (172 * div(heapIs $heap_{funcstart\_724,1}, 176).quot) + (172 * div(heapIs $heap_{funcstart\_724,1}, 17
heap_{funcstart\_724,1}.p2, 176).rem))._replace(p3 \rightarrow ((-63 * div(heapIs)))._
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).quot) + (170 * div(heapIs)
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
+ (-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).quot) +
(171 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem))]
[94.1] (0 < -$heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 * div(heapIs
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1, 177).quot) + (171 * div(heapIs)
\rho_{uncstart_{-724,1}}, \rho_{uncstart_{-724,1}}, \rho_{uncstart_{-724,1}}, \rho_{uncstart_{-724,1}}, \rho_{uncstart_{-724,1}}, \rho_{uncstart_{-724,1}}
* div(heapIs heap_{funcstart_{724.1}}, heap_{funcstart_{724.1}}, 176).quot) + (172 *
div(heapIs $heap_{uncstart, 724,1}, $heap_{uncstart, 724,1,p2},
176).rem)))._replace(p3 \rightarrow ((-63 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p3}, 178).\text{quot} + (170 * \text{div}(\text{heapIs} \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p3}, 178).rem)._replace(p1 \rightarrow (30269 + (-2 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs}))
\text{Sheap}_{funcstart_{724,1}}, \text{Sheap}_{funcstart_{724,1}}.p1, 177).rem))).p2) \lor ...
\rightarrow [simplify]
[94.7] (0 < ((35 * div(heap
Is $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p2,
176).quot) + (-172 * div(heapIs \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}
176).rem))) \vee \dots
[Copy term 89.18]
[96.0] ((-1 < -\$heap_{724,1;752,8}.p1) \lor (30268 < \$heap_{724,1;752,8}.p1) \lor (30306 <
-\$heap_{724,1:752,8}.p2) \lor (30322 < -\$heap_{724,1:752,8}.p3)) \lor (\$heap_{funcend\_724,1}.p2)
== $heap<sub>724,1:753,8</sub>._replace(p3 \rightarrow $heap<sub>724,1:753,8</sub>.p3)) \lor (-1 <
\text{Sheap}_{724,1;753,8}.\text{p3}) \lor (\text{Sheap}_{724,1;753,8} == \text{Sheap}_{724,1;752,8}.\textbf{replace}(\text{p2} \to \text{p3}))
\text{Sheap}_{724,1;752,8}.\text{p2})) \lor (-1 < \text{Sheap}_{724,1;752,8}.\text{p2}) \lor (\text{Sheap}_{724,1;752,8} = -1)
\text{Sheap}_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs \text{Sheap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p1, 177}.rem)._replace(p2 \rightarrow ((-35 * div(heapIs
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.
* div(heapIs heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 178).quot) + (170 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p3,
178).rem)))._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\text{heap}_{funcstart\_724.1.p1, 177}.\text{rem}))) \lor (0 < ((-2 * div(\mathbf{heapIs}))))
\text{Sheap}_{funcstart\_724.1}, \text{Sheap}_{funcstart\_724.1}, \text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs}))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).rem)))
\rightarrow [from term 90.0, $heap<sub>724,1;752,8</sub> is equal to $heap<sub>funcstart_724,1</sub>._replace(p1
\rightarrow ((-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).quot) +
(171 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1,
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177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1},p2, 176}, quot) + (172 * div(heapIs p_{funcstart_{724,1},p2}
\rho_{funcstart\_724,1.p2, 176}.rem))._replace\rho_{funcstart\_724,1.p2, 176}.rem))._replace
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).quot) + (170 * div(heapIs)
heap_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}
+ (-2 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).quot) +
(171 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem))]
[96.1] ((-1 < -$heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 * div(heapIs
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}.p1, 177).quot) + (171 * div(heapIs)
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
* div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, p2, 176).quot) + (172 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p2,
176).rem)))._replace(p3 \rightarrow ((-63 * div(heapIs $heap_{funcstart_724.1},
\text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} + (170 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p3}, 178).rem)._replace(p1 \rightarrow (30269 + (-2 * div(heapIs))
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1},p1, 177}.quot + (171 * div(heapIs))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem})).\text{p1}) \lor (30268 <
\text{heap}_{724,1;752,8}.\text{p1}) \lor (30306 < -\text{heap}_{724,1;752,8}.\text{p2}) \lor (30322 < -\text{heap}_{724,1;752,8}.\text{p2})
-\$heap_{724,1;752,8}.p3)) \lor ...
\rightarrow [simplify]
[96.10] ((30268 < ((-171 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}))) \lor (30268 < \text{Sheap}_{724,1;752,8}.\text{p1}) \lor (30306)
<-\$heap_{724,1;752,8}.p2) \lor (30322 < -\$heap_{724,1;752,8}.p3)) \lor ...
\rightarrow [from term 60.11, literala < ((-171 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_724,1}.p1, 177).quot) is false whenever -2 < (-30269 + literala)
    Proof of rule precondition:
    [96.10.0] - 2 < (-30269 + 30268)
    \rightarrow [simplify]
    [96.10.2] true
[96.11] (false \lor (30268 < $heap<sub>724,1;752,8</sub>.p1) \lor (30306 < -$heap<sub>724,1;752,8</sub>.p2)
\vee (30322 < -\$heap_{724,1:752.8}.p3)) \vee ...
\rightarrow [from term 90.0, $heap<sub>724,1:752,8</sub> is equal to $heap<sub>funcstart_724,1</sub>._replace(p1)
\rightarrow ((-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).quot) +
(171 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2},\ 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart\_724,1}.p2, 176).rem))).\_replace(p3 \rightarrow ((-63 * div(heapIs))).\_replace(p3 \rightarrow (-63 * div(heapIs)))).\_replace(p3 \rightarrow (-63 * div(heapIs))))
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p_{3,178}, p_{3,178}, p_{3,178}, p_{4,178}
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
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+ (-2 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).quot) +
(171 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem))]
[96.12] (false \vee (30268 < $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2, 176}.rem))._replace(p3 \rightarrow ((-63 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p3, 178).quot) + (170 * div(heapIs)
\rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}
+ (-2 * div(heapIs $heap_{tuncstart\_724,1}, $heap_{tuncstart\_724,1}.p1, 177).quot) +
(171 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart\_724.1}, \text{\$heap}_{funcstart\_724.1}.\text{p1}, 177).\text{rem}))).\text{p1})
\vee (30306 < -\$heap_{724,1:752,8}.p2) \vee (30322 < -\$heap_{724,1:752,8}.p3)) \vee ...
\rightarrow [simplify]
[96.15] (false \vee (-1 < ((-2 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}))) \lor (30306 < -\text{Sheap}_{724,1:752,8}.\text{p2}) \lor (30322)
< -\$heap_{724.1:752.8}.p3)) \lor ...
\rightarrow [from term 91.0, literala < ((-2 * div(heapIs $heap_{funcstart_724.1},
heap_{funcstart_{724,1},p1, 177}, quot) + (171 * div(heapIs p_{funcstart_{724,1},p1, 177}).
\text{Sheap}_{funcstart\_724,1.p1}, 177).\text{rem} is false whenever -2 < (0 + \text{literala})
         Proof of rule precondition:
         [96.15.0] - 2 < (-1 + 0)
         \rightarrow [simplify]
         [96.15.2] true
[96.16] (false \vee false \vee (30306 < -$heap<sub>724,1;752,8</sub>.p2) \vee (30322 <
-\$heap_{724,1:752.8}.p3)) \lor ...
\rightarrow [from term 90.0, $heap<sub>724,1:752,8</sub> is equal to $heap<sub>funcstart_724,1</sub>._replace(p1
\rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).quot) +
(171 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1,
 177).rem)))._replace(p2 \rightarrow ((-35 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p2, 176).quot + (172 * div(heapIs $heap_{funcstart\_724,1}, 176).quot) + (172 * div(heapIs $heap_{funcstart\_724,1}, 17
heap_{funcstart\_724,1}.p2, 176).rem))).\_replace(p3 \rightarrow ((-63 * div(heapIs))).\_replace(p3 \rightarrow ((-63 * div(heapIs)))))._replace(p3 \rightarrow ((-63 * div(heapIs)))))
heap_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
 + (-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).quot) +
(171 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem))]
[96.17] (false \vee false \vee (30306 < -$heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}. \operatorname{pl},
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
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\text{Sheap}_{funcstart_{-724,1},p2, 176}.quot) + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart_{-724,1}},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem}))._replace(p3 \rightarrow ((-63 * div(heapIs
\$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).quot) + (170 * div(\textbf{heapIs}))
\rho_{funcstart\_724,1}, \rho_{func
(30269 + (-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1,
177).quot) + (171 * \text{div}(\text{heapIs } \text{heap}_{funcstart\_724,1}, \text{heap}_{funcstart\_724,1}.\text{p1},
(177).rem)).p2) \lor (30322 < -\$heap_{724.1:752.8}.p3)) \lor ...
\rightarrow [simplify]
[96.23] (false \vee false \vee (30306 < ((35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724.1.p2}, 176).\text{quot} + (-172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724.1},
\label{eq:linear_funcstart_724,1.p2, 176).rem))) \lor (30322 < -\$heap_{724,1;752,8}.p3)) \lor \dots
\rightarrow [from term 64.12, literala < ((-172 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724.1.p2}, 176).\text{rem} + (35 * div(\text{heapIs } \text{Sheap}_{funcstart\_724.1},
heap_{funcstart\_724.1.p2}, 176).quot) is false whenever -2 < (-30307 + literala)
         Proof of rule precondition:
         [96.23.0] - 2 < (-30307 + 30306)
         \rightarrow [simplify]
         [96.23.2] true
[96.24] (false \vee false \vee false \vee (30322 < -$heap<sub>724.1:752.8</sub>.p3)) \vee ...
\rightarrow [from term 90.0, $heap<sub>724,1:752,8</sub> is equal to $heap<sub>funcstart_724,1</sub>._replace(p1)
\rightarrow ((-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).quot) +
(171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1,
 177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.p2, 176).quot) + (172 * div(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart\_724,1}.p2, 176).rem))).\_replace(p3 \rightarrow ((-63 * div(heapIs))).\_replace(p3 \rightarrow ((-63 * div(heapIs)))).\_replace(p3 \rightarrow ((-63 * div(heapIs)))))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).quot) + (170 * div(heapIs)
\rho_{uncstart_724,1}, \rho_{uncstart_724,1}
 + (-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).quot) +
 (171 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem))]
[96.25] (false \vee false \vee false \vee (30322 < -\$heap_{funcstart\_724,1}._replace(p1
\rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).quot) +
(171 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2, 176}.rem))._replace(p3 \rightarrow ((-63 * div(heapIs
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).quot) + (170 * div(heapIs
\$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem))).\_\mathbf{replace}(p1 \rightarrow
(30269 + (-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1,
177).quot) + (171 * div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p1,
(177).rem))).p3)) \lor ...
\rightarrow [simplify]
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[96.30] (false \vee false \vee false \vee (30322 < ((63 * div(heapIs
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).quot) + (-170 * div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p3, 178).rem)))) \lor ...
\rightarrow [from term 68.13, literala < ((-170 * div(heapIs $heap_{funcstart\_724.1},
\text{Sheap}_{funcstart\_724.1.p3}, 178).\text{rem} + (63 * div(\text{heapIs} \$\text{heap}_{funcstart\_724.1},
heap_{funcstart_{-724,1}.p3}, 178).quot)) is false whenever -2 < (-30323 + literala)
    Proof of rule precondition:
    [96.30.0] - 2 < (-30323 + 30322)
    \rightarrow [simplify]
     [96.30.2] true
[96.31] (false \vee false \vee false \vee false) \vee ...
\rightarrow [simplify]
[96.32] false \vee \dots
[Remove 'false' term 96.32 and fetch new term from containing clause]
[97.0] ($heap<sub>724,1;752,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}. p1, \ 177). \operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2, 176}.rem).-replace(p3 \rightarrow ((-63 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p3, 178).quot) + (170 * div(heapIs)
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p3, 178).rem))).replace(p1 \rightarrow ((-2 * funcstart\_724,1))).replace(p1 \rightarrow ((-2 * funcstart\_724,1)))).replace(p1 \rightarrow ((-2 * funcstart\_724,1))))
\operatorname{div}(\mathbf{heapIs} \ \operatorname{\$heap}_{funcstart\_724,1}, \ \operatorname{\$heap}_{funcstart\_724,1}.\operatorname{p1}, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{$heap}_{funcstart\_724.1}, \ \text{$heap}_{funcstart\_724.1}.p1, \ 177).rem)))) \lor
(\text{\$heap}_{funcend\_724,1} == \text{\$heap}_{724,1;753,8}.\mathbf{replace}(p3 \rightarrow \text{\$heap}_{724,1;753,8}.p3)) \lor
(-1 < \text{\$heap}_{724,1;753,8}.\text{p3}) \lor (\text{\$heap}_{724,1;753,8} == \text{\$heap}_{724,1;752,8}.\textbf{\_replace}(\text{p2})
\rightarrow $heap<sub>724,1;752,8</sub>.p2)) \lor (-1 < $heap<sub>724,1;752,8</sub>.p2)
[Remove 'false' term 96.32 and fetch new term from containing clause]
[98.0] (0 < ((-2 * div(heap
Is $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1,
177).quot) + (171 * div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, p1,
177).rem))) \lor ($heap<sub>funcend_724,1</sub> == $heap<sub>724,1;753,8</sub>._replace(p3 \rightarrow
\text{Sheap}_{724,1;753,8}.\text{p3})) \lor (-1 < \text{Sheap}_{724,1;753,8}.\text{p3}) \lor (\text{Sheap}_{724,1;753,8} ==
\text{Sheap}_{724,1:752.8}.replace(p2 \rightarrow \text{Sheap}_{724,1:752.8}.p2)) \vee (-1 < \text{Sheap}_{724,1:752.8}.p2)
[Copy term 80.20]
[89.18] ((-1 < -$heap<sub>724.1:752.8.p1) \lor (30268 < $heap<sub>724.1:752.8.p1</sub>) \lor (30306 <</sub>
-\$heap_{724,1:752,8}.p2) \lor (30322 < -\$heap_{724,1:752,8}.p3)) \lor (\$heap_{funcend\_724,1}.p3)
== \text{heap}_{724,1;753,8}._replace(p3 \rightarrow \text{heap}_{724,1;753,8}.p3)) \lor (-1 <
\text{Sheap}_{724,1;753,8}.\text{p3}) \lor (\text{Sheap}_{724,1;753,8} == \text{Sheap}_{724,1;752,8}.\textbf{replace}(\text{p2} \to \text{p3}))
heap_{724,1:752.8}.p2) \lor (-1 < heap_{724,1:752.8}.p2)
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\rightarrow [from term 97.0, $heap<sub>724,1:752,8</sub> is equal to $heap<sub>funcstart_724,1</sub>._replace(p1)
\rightarrow ((-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).quot) +
(171 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1,
 177).rem)))._replace(p2 \rightarrow ((-35 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p2, 176).quot + (172 * div(heapIs $heap_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2, 176}.rem))._replace\rho_{funcstart\_724,1.p2, 176}.rem))._replace
heap_{funcstart\_724,1}, pages heap_{funcstart\_724,1}, pages heap_{funcstart\_724,1}, pages heap_{funcstart\_724,1}, pages heap_{funcstart\_724,1}
\rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p1, \ 177).rem))]
[89.19] ((-1 < -$heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 * div(heapIs
\text{Sheap}_{funcstart\_724.1}, \text{Sheap}_{funcstart\_724.1}, \text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs}))
\rho_{tuncstart,724,1}, \rho_{tuncstart,724,1}
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 *
\label{eq:div_heap} \text{div}(\textbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p2},
176).rem)))._replace(p3 \rightarrow ((-63 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} + (170 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p3, 178}.rem)._replace(p1 \rightarrow ((-2 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs}))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).rem))).p1) \lor (30268 <
\$heap_{724,1;752,8}.p1) \lor (30306 < -\$heap_{724,1;752,8}.p2) \lor (30322 <
-\$heap_{724,1;752,8}.p3)) \lor ...
\rightarrow [simplify]
\textit{[89.23]} \; ((-1 < ((2 * \text{div}(\textbf{heapIs} \; \$ \text{heap}_{funcstart\_724,1}, \, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, \,
177).quot) + (-171 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).rem))) \vee (30268 < $heap<sub>724,1;752,8</sub>.p1) \vee (30306 < -$heap<sub>724,1;752,8</sub>.p2) \vee
(30322 < -\$heap_{724,1:752,8}.p3)) \lor ...
\rightarrow [from term 98.0, literala < ((-171 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.p1, 177).rem) + (2 * div(\textbf{heapIs} \$heap_{funcstart\_724,1},
heap_{funcstart-724.1.p1, 177}, quot) is false whenever -2 < (0 + literala)
         Proof of rule precondition:
          [89.23.0] - 2 < (-1 + 0)
         \rightarrow [simplify]
          [89.23.2] true
[89.24] (false \lor (30268 < $heap<sub>724.1:752.8</sub>.p1) \lor (30306 < -$heap<sub>724.1:752.8</sub>.p2)
\vee (30322 < -\$heap_{724,1;752,8}.p3)) \vee ...
\rightarrow [from term 97.0, $heap<sub>724,1;752,8</sub> is equal to $heap<sub>funcstart_724,1</sub>._replace(p1
\rightarrow ((-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).quot) +
(171 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1,
 (-35 * div(\mathbf{heapIs} \$heap_{funcstart\_724.1},
\text{Sheap}_{funcstart\_724,1}.\text{p2},\ 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
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heap_{funcstart\_724.1}.p2, 176).rem))._replace(p3 \rightarrow ((-63 * div(heapIs)))._
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).quot) + (170 * div(heapIs)
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem)))._replace(p1 \rightarrow (-2 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p1, \ 177).rem))]
[89.25] (false \vee (30268 < $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{tuncstart\_724.1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2, 176).rem}))._replace(p3 \rightarrow ((-63 * div(heapIs
\text{Sheap}_{funcstart\_724.1}, \text{Sheap}_{funcstart\_724.1}.p3, 178).quot) + (170 * div(heapIs)
\rho_{funcstart=724.1}, \rho_{funcstart=724.1}
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).rem))).p1) \lor
(30306 < -\$heap_{724,1;752,8}.p2) \lor (30322 < -\$heap_{724,1;752,8}.p3)) \lor \dots
\rightarrow [simplify]
[89.26] (false \vee (30268 < ((-2 * div(heapIs $heap_{tuncstart_{724.1}},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}))) \lor (30306 < -\text{Sheap}_{724,1;752,8}.\text{p2}) \lor (30322)
 < -\$heap_{724,1;752,8}.p3)) \lor ...
\rightarrow [from term 62.17, literala < ((-2 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p1, 177).rem} is false whenever -2 < (-30269 + literala)
           Proof of rule precondition:
           [89.26.0] - 2 < (-30269 + 30268)
           \rightarrow [simplify]
           [89.26.2] true
[89.27] (false \lor false \lor (30306 < -\$heap_{724,1;752,8}.p2) \lor (30322 <
 -\$heap_{724,1;752,8}.p3)) \lor ...
\rightarrow [from term 97.0, $heap<sub>724,1;752,8</sub> is equal to $heap<sub>funcstart_724,1</sub>._replace(p1
\rightarrow ((-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).quot) +
(171 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1,
 177).rem)))._replace(p2 \rightarrow ((-35 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p2, 176).quot + (172 * div(heapIs $heap_{funcstart\_724,1}, 176).quot) + (172 * div(heapIs $heap_{funcstart\_724,1}, 17
heap_{funcstart\_724,1}.p2, 176).rem))._replace(p3 \rightarrow ((-63 * div(heapIs)))._
 $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p3, 178).quot) + (170 * div(heapIs)
 \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p1, \ 177).rem))]
[89.28] (false \vee false \vee (30306 < -$heap<sub>funcstart 724.1</sub>._replace(p1 \rightarrow ((-2 *
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\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{funcstart\_724,1.p2, 176}.rem))._replace(p3 \rightarrow ((-63 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p3, 178).quot) + (170 * div(heapIs)
\rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).rem))).p2) \lor
(30322 < -\$heap_{724,1;752,8}.p3)) \lor \dots
\rightarrow [simplify]
[89.34] (false \vee false \vee (30306 < ((35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (-172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2, 176}.\text{rem}))) \lor (30322 < -\text{Sheap}_{724,1:752,8.p3})) \lor ...
\rightarrow [from term 64.12, literala < ((-172 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.p2, 176).rem + (35 * div(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p2, 176).quot) is false whenever -2 < (-30307 + literala)
    Proof of rule precondition:
    [89.34.0] - 2 < (-30307 + 30306)
    \rightarrow [simplify]
    [89.34.2] true
[89.35] (false \vee false \vee (30322 < -$heap<sub>724,1;752,8</sub>.p3)) \vee ...
\rightarrow [from term 97.0, $heap<sub>724,1;752,8</sub> is equal to $heap<sub>funcstart_724,1</sub>._replace(p1
\rightarrow ((-2*div(\textbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).quot) +\\
(171 * div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
heap_{funcstart_{724,1},p2, 176}, quot) + (172 * div(heapIs p_{funcstart_{724,1},p2})
heap_{funcstart\_724.1}.p2, 176).rem))._replace(p3 \rightarrow ((-63 * div(heapIs)))._replace
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).quot) + (170 * div(heapIs)
\rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}
div(\mathbf{heapIs} \ \$heap_{funcstart\_724.1}, \ \$heap_{funcstart\_724.1}.p1, \ 177).quot) + (171 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p1, \ 177).rem))]
 [89.36] (false \vee false \vee false \vee (30322 < -$heap_funcstart_724,1._replace(p1
\rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1, 177).quot) +
(171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2, 176}.rem)._replace(p3 \rightarrow ((-63 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs}))
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
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\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).rem))).p3)) \lor \dots
\rightarrow [simplify]
[89.41] (false \vee false \vee false \vee (30322 < ((63 * div(heapIs
\theta_{funcstart_{-724,1}}, \theta_{funcstart_{-724,1}}, \theta_{funcstart_{-724,1}}, \theta_{funcstart_{-724,1}}, \theta_{funcstart_{-724,1}}
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p3, 178).rem)))) \lor ...
\rightarrow [from term 68.13, literala < ((-170 * div(heapIs $heap_{funcstart\_724.1},
\text{Sheap}_{funcstart\_724,1}.p3, 178).rem) + (63 * div(\text{heapIs} \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p3}, 178).quot)) is false whenever -2 < (-30323 + literala)
    Proof of rule precondition:
    [89.41.0] - 2 < (-30323 + 30322)
    \rightarrow [simplify]
    [89.41.2] true
[89.42] (false \vee false \vee false \vee false) \vee ...
\rightarrow [simplify]
[89.43] false \vee \dots
[Remove 'false' term 89.43 and fetch new term from containing clause]
[101.0] ($\text{heap}_{724,1;753,8} == $\text{heap}_{724,1;752,8}._\text{replace}(p2 \rightarrow)
\text{Sheap}_{724,1;752,8}.\text{p2})) \lor (\text{Sheap}_{funcend\_724,1} == \text{Sheap}_{724,1;753,8}.\_\text{replace}(\text{p3} \to \text{p3}))
heap_{724,1;753,8}.p3) \lor (-1 < heap_{724,1;753,8}.p3)
[Copy term 1.56]
[80.20] ((-1 < -$heap<sub>724,1:753,8</sub>.p1) \vee (-1 < -$heap<sub>724,1:753,8</sub>.p2) \vee (30268 <
\text{$heap}_{724,1;753,8}.\text{p1}) \lor (30306 < \text{$heap}_{724,1;753,8}.\text{p2}) \lor (30322 <
-\$heap_{724,1;753,8}.p3)) \lor (\$heap_{funcend\_724,1} == \$heap_{724,1;753,8}.\_replace(p3))
\rightarrow $heap<sub>724,1:753,8</sub>.p3)) \lor (-1 < $heap<sub>724,1:753,8</sub>.p3)
\rightarrow [from term 101.0, $heap<sub>724.1:753.8</sub> is equal to $heap<sub>724.1:752.8</sub>._replace(p2 \rightarrow
heap_{724,1;752,8}.p2)
[80.21] ((-1 < -\$heap_{724,1;752,8}._replace(p2 \rightarrow \$heap_{724,1;752,8}.p2).p1) \lor (-1 <
-\$heap_{724,1:753,8}.p2) \lor (30268 < \$heap_{724,1:753,8}.p1) \lor (30306 < \$heap_{724,1:753,8}.p2)
\text{sheap}_{724,1;753,8}.\text{p2}) \lor (30322 < -\text{sheap}_{724,1;753,8}.\text{p3})) \lor \dots
\rightarrow [simplify]
[80.22] ((-1 < -\$heap_{724,1;752,8}.p1) \lor (-1 < -\$heap_{724,1;753,8}.p2) \lor (30268 <
\text{$heap}_{724,1;753,8}.\text{p1}) \lor (30306 < \text{$heap}_{724,1;753,8}.\text{p2}) \lor (30322 <
-\$heap_{724,1;753,8}.p3)) \lor ...
\rightarrow [from term 101.0, $heap<sub>724,1:753,8</sub> is equal to $heap<sub>724,1:752,8</sub>._replace(p2 \rightarrow
heap_{724,1;752,8}.p2)
[80.23] ((-1 < -\$heap_{724,1;752,8}.p1) \lor (-1 < -\$heap_{724,1;752,8}._replace(p2 \rightarrow
\text{sheap}_{724,1:752,8}.\text{p2}).\text{p2}) \lor (30268 < \text{sheap}_{724,1:753,8}.\text{p1}) \lor (30306 <
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\text{heap}_{724,1:753,8}.\text{p2}) \lor (30322 < -\text{heap}_{724,1:753,8}.\text{p3})) \lor \dots
\rightarrow [simplify]
[80.24] ((-1 < -$heap<sub>724,1;752,8</sub>.p1) \vee (-1 < -$heap<sub>724,1;752,8</sub>.p2) \vee (30268 <
\text{Sheap}_{724,1;753,8}.\text{p1}) \lor (30306 < \text{Sheap}_{724,1;753,8}.\text{p2}) \lor (30322 <
-\$heap_{724,1;753,8}.p3)) \lor ...
[Remove 'false' term 89.43 and fetch new term from containing clause]
[102.0] (-1 < \text{$heap}_{724,1;752,8}.\text{p2}) \lor (\text{$heap}_{funcend\_724,1} ==
\text{sheap}_{724,1:753.8}.replace(p3 \rightarrow \text{sheap}_{724,1:753.8}.p3)) \lor (-1 < \text{sheap}_{724,1:753.8}.p3)
[Copy term 101.0]
[104.0] ($heap<sub>724,1:753,8</sub> == $heap<sub>724,1:752,8</sub>._replace(p2 \rightarrow
\text{Sheap}_{724,1;752,8}.\text{p2})) \lor (\text{Sheap}_{funcend\_724,1} == \text{Sheap}_{724,1;753,8}.\_\text{replace}(\text{p3} \rightarrow
\text{Sheap}_{724,1;753,8}.\text{p3})) \lor (-1 < \text{Sheap}_{724,1;753,8}.\text{p3}) \lor (\text{Sheap}_{724,1;752,8} = -1)
\text{Sheap}_{funcstart\_724.1}._replace(p1 \rightarrow ((-2 * div(heapIs \text{Sheap}_{funcstart\_724.1}),
\text{Sheap}_{funcstart\_724.1.p1, 177}.\text{quot}) + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724.1},
\rho_{funcstart\_724,1.p1, 177}.rem)._replace(p2 \rightarrow ((-35 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
* div(heapIs heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 178).quot) + (170 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p3,
178).rem)))._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p1, 177).rem))) \lor (0 < ((-2 * div(heapIs))))
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1},p1, 177}.quot + (171 * div(heapIs))
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, 177).rem)
\rightarrow [from term 90.0, $heap<sub>724,1;752,8</sub> is equal to $heap<sub>funcstart_724,1</sub>._replace(p1
\rightarrow ((-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).quot) +
(171 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724.1}.p2, 176).quot) + (172 * div(\text{heapIs } \text{Sheap}_{funcstart\_724.1},
heap_{funcstart\_724,1}.p2, 176).rem))._replace(p3 \rightarrow ((-63 * div(heapIs)))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).quot) + (170 * div(heapIs)
\$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem))).\_\mathbf{replace}(p1 \rightarrow 30269)
+ (-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).quot) +
(171 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem))]
[104.2] ($heap<sub>724,1;753,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\$heap_{funcstart\_724,1}.p2,\ 176).rem))).\_\textbf{replace}(p3 \rightarrow ((-63 * div(\textbf{heapIs}
\theta_{funcstart_{-724,1}}, \theta_{funcstart_{-724,1}}, \theta_{funcstart_{-724,1}}, \theta_{funcstart_{-724,1}}, \theta_{funcstart_{-724,1}}
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p3, 178).rem))).\_replace(p1 \rightarrow
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(30269 + (-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1,
177).quot) + (171 * div(heapIs \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}
177).rem)))._replace(p2 \rightarrow $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\text{heap}_{tuncstart\_724.1.p2}, 176).rem))._replace(p3 \rightarrow ((-63 * div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p3, 178).quot) + (170 * div(heapIs)
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p3, 178).rem))).\_replace(p1 \rightarrow
(30269 + (-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1,
177).quot) + (171 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart\_724.1}, \text{\$heap}_{funcstart\_724.1}, \text{p1},
(177).rem))).p2)) \lor ...
\rightarrow [simplify]
[104.5] ($heap<sub>724,1;753,8</sub> == $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724.1},
heap_{funcstart\_724,1}.p2, 176).quot + (172 * div(heapIs heap_{funcstart\_724,1}, fixed by the substantial fixed by the 
\rho_{tuncstart\_724.1.p2, 176}.rem)._replace(p3 \rightarrow ((-63 * div(heapIs
\text{Sheap}_{funcstart\_724.1}, \text{Sheap}_{funcstart\_724.1}.p3, 178).quot) + (170 * div(heapIs)
\rho_{funcstart_{724,1}}, \rho_{funcstart_{724,1},p3, 178}.rem))._replace(p1 \rightarrow
(30269 + (-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1,
177).quot) + (171 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart\_724,1}, \text{\$heap}_{funcstart\_724,1}.\text{p1},
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724.1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{724,1}.p2, 176).rem}))) \vee ...
[Copy term 102.0]
[105.0] (-1 < \text{heap}_{724,1;752,8}.p2) \vee (\text{heap}_{funcend\_724,1} ==
\text{heap}_{724,1;753,8}.replace(p3 \rightarrow \text{heap}_{724,1;753,8}.p3)) \lor (-1 <
\text{Sheap}_{724,1;753,8}.\text{p3}) \lor (\text{Sheap}_{724,1;752,8} == \text{Sheap}_{funcstart\_724,1}.\_\textbf{replace}(\text{p1} \rightarrow
((-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).quot) +
(171 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2, 176}.rem)._replace(p3 \rightarrow ((-63 * div(heapIs
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).quot) + (170 * div(heapIs)
\rho_{funcstart_{724,1}}, \rho_{funcstart_{724,1},p3, 178}.rem))._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, 177).rem)))) \lor (0 <
((-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).quot) +
(171 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)))
\rightarrow [from term 90.0, $heap<sub>724,1:752,8</sub> is equal to $heap<sub>funcstart_724,1</sub>._replace(p1
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\rightarrow ((-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).quot) +
(171 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2, 176}.rem))._replace\rho_{funcstart\_724,1.p2, 176}.rem))._replace
heap_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
 + (-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).quot) +
(171 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem))]
[105.1] (-1 < \text{heap}_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p1, 177).quot) + (171 * div(heapIs
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1},p1, 177}.rem))._replace(p2 \rightarrow ((-35)
* div(heapIs heap_{funcstart_{-724.1}}, heap_{funcstart_{-724.1}}, p2, 176).quot) + (172 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p2,
176).rem)))._replace(p3 \rightarrow ((-63 * div(heapIs $heap_{funcstart_724,1},
\text{Sheap}_{funcstart\_724,1.p3}, 178).\text{quot} + (170 * \text{div}(\text{heapIs} \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p3}, 178).rem)._replace(p1 \rightarrow (30269 + (-2 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
\$ heap_{funcstart\_724,1},\,\$ heap_{funcstart\_724,1}.p1,\,177).rem))).p2) \,\vee\, \dots
\rightarrow [simplify]
\label{eq:continuous} \mbox{$[105.4]$ $(-1 < ((-35 * div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p2, \ ]) $(-1 < ((-35 * div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p2, \ ]) $(-1 < ((-35 * div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p2, \ ]) $(-1 < ((-35 * div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p2, \ ]) $(-1 < ((-35 * div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p2, \ ]) $(-1 < ((-35 * div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p2, \ ]) $(-1 < ((-35 * div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p2, \ ]) $(-1 < ((-35 * div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p2, \ )) $(-1 < ((-35 * div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p2, \ )) $(-1 < ((-35 * div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p2, \ )) $(-1 < ((-35 * div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p2, \ )) $(-1 < ((-35 * div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p2, \ )) $(-1 < ((-35 * div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p2, \ )) $(-1 < ((-35 * div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p2, \ )) $(-1 < ((-35 * div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p2, \ )) $(-1 < ((-35 * div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p2, \ )) $(-1 < ((-35 * div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p2, \ )) $(-1 < ((-35 * div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p2, \ )) $(-1 < (-35 * div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}.p2, \ )) $(-1 < (-35 * div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}.p2, \ )) $(-1 < (-35 * div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}.p2, \ ))) $(-1 < (-35 * div(\mathbf{heapIs} \ \$heap_{funcst
176).quot) + (172 * \text{div}(\text{heapIs } \text{heap}_{funcstart\_724,1}, \text{heap}_{funcstart\_724,1}.p2,
176).rem))) \vee ...
\rightarrow [from term 65.3, -1 < ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
$heap<sub>funcstart_724,1.</sub>p2, 176).rem)) is true if and only if 0 < ((-35 * div(\mathbf{heapIs})))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem))]
[105.5] (0 < ((-35 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p2,
176).quot) + (172 * div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2,
176).rem))) \vee ...
[Copy term 80.20]
[108.0] ((-1 < -$heap<sub>724,1:753,8</sub>.p1) \vee (-1 < -$heap<sub>724,1:753,8</sub>.p2) \vee (30268 <
\text{heap}_{724,1;753,8}.\text{p1}) \lor (30306 < \text{heap}_{724,1;753,8}.\text{p2}) \lor (30322 <
-\$heap_{724,1;753,8}.p3)) \lor (\$heap_{funcend\_724,1} == \$heap_{724,1;753,8}.\_replace(p3))
\rightarrow $heap<sub>724,1:753,8</sub>.p3)) \lor (-1 < $heap<sub>724,1:753,8</sub>.p3) \lor ($heap<sub>724,1:752,8</sub> ==
\text{Sheap}_{funcstart\_724.1}._replace(p1 \rightarrow ((-2 * div(heapIs \text{Sheap}_{funcstart\_724.1}),
\text{Sheap}_{funcstart\_724,1.p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs} \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p1, 177}.rem)._replace(p2 \rightarrow ((-35 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}. \theta_{funcstart\_724,1}
\rho_{tuncstart_{724,1}}, \rho_{tuncstart_{724,1}}, \rho_{tuncstart_{724,1}}, \rho_{tuncstart_{724,1}}, \rho_{tuncstart_{724,1}}, \rho_{tuncstart_{724,1}}
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).quot) + (170 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p3,
```

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178).rem)))._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p1, 177}.\text{rem})))) \lor (0 < ((-2 * div(\mathbf{heapIs}))))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs}))
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, 177).rem))
\rightarrow [from term 104.5, $heap<sub>724,1;753,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs *heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724.1}.p1, 177).rem))._replace(p2 \rightarrow ((-35 * div(heapIs)))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
\rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}
* div(\mathbf{heapIs} \ \$heap_{funcstart\_724.1}, \ \$heap_{funcstart\_724.1}.p3, \ 178).quot) + (170 \ *
div(heapIs $heap_{uncstart, 724,1}, $heap_{uncstart, 724,1},p3,
178).rem)))._replace(p1 \rightarrow (30269 + (-2 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.p1, 177).quot) + (171 * div(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{funcstart\_724,1}.p1, 177).rem))._replace(p2 \rightarrow (-35 * div(\mathbf{heapIs})))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, p2, 176).rem)
[108.1] ((-1 < -$heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 * div(heapIs
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1},p1, 177}.quot) + (171 * div(heapIs)
\rho_{tuncstart\_724.1}, \rho_{tuncstart\_724.1}, \rho_{tuncstart\_724.1}, \rho_{tuncstart\_724.1}, \rho_{tuncstart\_724.1}, \rho_{tuncstart\_724.1}
* div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, p2, 176).quot) + (172 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p2,
176).rem)))._replace(p3 \rightarrow ((-63 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart_{724,1}}, p3, 178).quot) + (170 * div(heapIs \text{Sheap}_{funcstart_{724,1}},
\text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{rem}))._replace(p1 \rightarrow (30269 + (-2 * div(heapIs))
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1},p1, 177}.quot + (171 * div(heapIs))
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
* div(heapIs heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 176).quot) + (172 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p2}, \ 176).\operatorname{rem}))).\operatorname{p1}) \lor (-1)
<-$heap<sub>724,1:753,8</sub>.p2) \lor (30268 <$heap<sub>724,1:753,8</sub>.p1) \lor (30306 <
\text{sheap}_{724,1;753,8}.\text{p2}) \lor (30322 < -\text{sheap}_{724,1;753,8}.\text{p3})) \lor \dots
\rightarrow [simplify]
[108.11] ((30268 < ((-171 * div(heapIs $heap_{tuncstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}))) \lor (-1 < -\text{Sheap}_{724,1;753,8}.\text{p2}) \lor (30268 < -\text{Sheap}_{724,1;753,8}.\text{p2})
\text{heap}_{724,1:753,8}.\text{p1}) \lor (30306 < \text{heap}_{724,1:753,8}.\text{p2}) \lor (30322 <
-\$heap_{724,1;753,8}.p3)) \lor ...
\rightarrow [from term 60.11, literala < ((-171 * div(heapIs $heap_{funcstart_724.1},
\text{Sheap}_{funcstart\_724,1}.p1, 177).rem) + (2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.p1, 177).quot) is false whenever -2 < (-30269 + \text{literala})
    Proof of rule precondition:
```

[108.11.0] - 2 < (-30269 + 30268)

```
\rightarrow [simplify]
    [108.11.2] true
[108.12] (false \vee (-1 < -$heap<sub>724.1:753.8</sub>.p2) \vee (30268 < $heap<sub>724.1:753.8</sub>.p1) \vee
(30306 < \text{$heap}_{724,1;753,8}.\text{p2}) \lor (30322 < -\text{$heap}_{724,1;753,8}.\text{p3})) \lor \dots
\rightarrow [from term 104.5, $heap<sub>724,1;753.8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.p1, 177).quot) + (171 * div(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p1, 177}.rem))._replace\rho_{funcstart\_724,1.p1, 177}.rem))._replace
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem))._replace(p3 \rightarrow ((-63)
* \operatorname{div}(\mathbf{heapIs} \ \$ heap_{funcstart\_724,1}, \ \$ heap_{funcstart\_724,1}.p3, \ 178).quot) + (170 \ *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3,
178).rem)))._replace(p1 \rightarrow (30269 + (-2 * div(heapIs $heap_{funcstart\_724.1},
heap_{funcstart_{724,1},p1,177}, quot) + (171 * div(heapIs $heap_{funcstart_{724,1}})
\rho_{funcstart\_724.1}.p1, 177).rem)._replace\rho_{funcstart\_724.1}.p1, 177).rem)._replace
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, p2, 176).rem)
[108.13] (false \lor (-1 < -$heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).quot) + (171 * div(heapIs)
\rho_{funcstart_{724,1}}, \rho_{funcstart_{724,1}}, \rho_{funcstart_{724,1}}, \rho_{funcstart_{724,1}}, \rho_{funcstart_{724,1}}, \rho_{funcstart_{724,1}}
* div(heapIs heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 176).quot) + (172 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p2,
176).rem)))._replace(p3 \rightarrow ((-63 * div(heapIs $heap_{tuncstart_724.1},
\text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} + (170 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p3}, 178).rem)._replace(p1 \rightarrow (30269 + (-2 * div(heapIs))
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p1, 177).quot) + (171 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}))._replace(p2 \rightarrow ((-35)
* div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, p2, 176).quot) + (172 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p2}, \ 176).\operatorname{rem}))).\operatorname{p2}) \ \lor
(30268 < \text{heap}_{724,1:753.8}.\text{p1}) \lor (30306 < \text{heap}_{724,1:753.8}.\text{p2}) \lor (30322 <
-\$heap_{724,1;753,8}.p3)) \lor ...
\rightarrow [simplify]
[108.17] (false \vee (-1 < ((35 * div(heapIs $heap_{funcstart\_724,1},
\rho_{tuncstart_{-724,1},p2, 176} = (-172 * div(heapIs $heap_{tuncstart_{-724,1}}, -176)]
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem})) \lor (30268 < \text{Sheap}_{724,1;753,8}.\text{p1}) \lor (30306 <
\text{sheap}_{724,1:753.8}.\text{p2}) \lor (30322 < -\text{sheap}_{724,1:753.8}.\text{p3})) \lor \dots
\rightarrow [from term 105.5, literala < ((-172 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724.1}.p2, 176).rem + (35 * div(heapIs p_{funcstart\_724.1})
heap_{funcstart-724,1}.p2, 176, quot) is false whenever -2 < (0 + literala)
    Proof of rule precondition:
```

[108.17.0] - 2 < (-1 + 0)

```
\rightarrow [simplify]
            [108.17.2] true
[108.18] (false \vee false \vee (30268 < $heap<sub>724.1:753.8</sub>.p1) \vee (30306 <
\$heap_{724,1;753,8}.p2) \lor (30322 < -\$heap_{724,1;753,8}.p3)) \lor \dots
\rightarrow [from term 104.5, $heap<sub>724,1;753.8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1},p1, 177}, quot) + (171 * div(heapIs p_{funcstart_{724,1},p1, 177}).
 heap_{funcstart\_724,1}.p1, 177).rem))).\_replace(p2 \rightarrow ((-35 * div(heapIs))).\_replace(p2 \rightarrow ((-35 * div(heapIs)))).\_replace(p2 \rightarrow ((-35 * div(heapIs)))))
 heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
 \text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem))._replace(p3 \rightarrow ((-63)
  * \operatorname{div}(\mathbf{heapIs} \ \$ heap_{funcstart\_724,1}, \ \$ heap_{funcstart\_724,1}.p3, \ 178).quot) + (170 \ *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3,
 178).rem)))._replace(p1 \rightarrow (30269 + (-2 * div(heapIs $heap_{funcstart\_724.1},
heap_{funcstart_{724,1},p1,177}, quot) + (171 * div(heapIs $heap_{funcstart_{724,1}})
heap_{funcstart\_724.1}.p1, 177).rem)._replace(p2 \rightarrow (-35 * div(heapIs))).
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, p2, 176).rem)
[108.19] (false \vee false \vee (30268 < place(p1 \rightarrow ((-2 * large term) + large term) (108.19)) (false <math display="inline">\vee
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724.1.p2}, 176).rem))._replace(p3 \rightarrow ((-63 * div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs}))
\rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}
(30269 + (-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1,
(177).quot + (171 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\text{heap}_{funcstart_{724,1},p2, 176}.\text{rem})).p1) \lor (30306 < \text{heap}_{724,1;753,8}.p2) \lor
(30322 < -\$heap_{724,1:753,8}.p3)) \lor \dots
\rightarrow [simplify]
 [108.23] (false \vee false \vee (-1 < ((-2 * div(heapIs $heap<sub>funcstart_724,1</sub>,
\theta_{funcstart\_724,1.p1}, 177).quot) + (171 * div(heapIs \theta_{funcstart\_724,1},
\label{eq:localization} \$ heap_{funcstart\_724,1}.p1,\ 177).rem))) \lor (30306 < \$ heap_{724,1;753,8}.p2) \lor (30322 < 1000) \lor (3
-\$heap_{724,1;753,8}.p3)) \lor ...
\rightarrow [from term 91.0, literala < ((-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1}, 177).quot) + (171 * div(heapIs $heap_{funcstart\_724,1}, 17
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} is false whenever -2 < (0 + \text{literala})
            Proof of rule precondition:
```

[108.23.0] - 2 < (-1 + 0)

```
\rightarrow [simplify]
         [108.23.2] true
[108.24] (false \vee false \vee false \vee (30306 < $heap<sub>724.1:753.8</sub>.p2) \vee (30322 <
-\$heap_{724,1;753,8}.p3)) \lor ...
\rightarrow [from term 104.5, $heap<sub>724,1;753.8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.p1, 177).quot) + (171 * div(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
 heap_{funcstart\_724,1}.p1, 177).rem))).\_replace(p2 \rightarrow ((-35 * div(heapIs))).\_replace(p2 \rightarrow ((-35 * div(heapIs)))).\_replace(p2 \rightarrow ((-35 * div(heapIs)))))
 heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
 \text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem))._replace(p3 \rightarrow ((-63)
 * \operatorname{div}(\mathbf{heapIs} \ \$ heap_{funcstart\_724,1}, \ \$ heap_{funcstart\_724,1}.p3, \ 178).quot) + (170 \ *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3,
 178).rem)))._replace(p1 \rightarrow (30269 + (-2 * div(heapIs $heap_{funcstart\_724.1},
heap_{funcstart_{724,1},p1,177}, quot) + (171 * div(heapIs $heap_{funcstart_{724,1}})
heap_{funcstart\_724.1}.p1, 177).rem)._replace(p2 \rightarrow (-35 * div(heapIs))).
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem)
[108.25] (false \vee false \vee false \vee (30306 < $heap_{funcstart\_724,1}._replace(p1 \rightarrow
((-2 * div(\mathbf{heapIs } \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).quot) +
(171 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_{-724,1}},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724.1.p2}, 176).rem))._replace(p3 \rightarrow ((-63 * div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs}))
\rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}
(30269 + (-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1,
177).quot) + (171 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\text{Sheap}_{funcstart=724,1}.\text{p2}, 176).\text{rem})).\text{p2}) \lor (30322 < -\text{Sheap}_{724,1;753,8}.\text{p3})) \lor \dots
\rightarrow [simplify]
[108.26] (false \vee false \vee false \vee (30306 < ((-35 * div(heapIs
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem))) \lor (30322 <
-\$heap_{724,1:753.8}.p3)) \lor ...
\rightarrow [from term 66.18, literala < ((-35 * div(heapIs $heap_{tuncstart\_724,1},
heap_{funcstart,724,1}.p2, 176).quot + (172 * div(heapIs * heap_{funcstart,724,1}, 176).quot) + (172 * div
heap_{funcstart_{-724,1}.p2, 176).rem is false whenever -2 < (-30307 + literala)
         Proof of rule precondition:
         [108.26.0] - 2 < (-30307 + 30306)
         \rightarrow [simplify]
```

```
[108.26.2] true
[108.27] (false \vee false \vee false \vee false \vee (30322 < -$heap<sub>724.1:753.8</sub>.p3)) \vee ...
\rightarrow [from term 104.5, $heap<sub>724,1;753,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs *heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs p_{funcstart\_724,1}),
heap_{funcstart\_724,1}.p1, 177).rem))).\_replace(p2 \rightarrow ((-35 * div(heapIs))).\_replace(p2 \rightarrow ((-35 * div(heapIs)))).\_replace(p2 \rightarrow ((-35 * div(heapIs)))))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem)))._replace(p3 \rightarrow ((-63)
* div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, 178).quot) + (170 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3,
178).rem)))._replace(p1 \rightarrow (30269 + (-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs p_{funcstart\_724,1})
\theta_{funcstart\_724,1}.p1, 177).rem))._replace(p2 \rightarrow (-35 * div(\mathbf{heapIs})))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, p2, 176).rem)
[108.28] (false \vee false \vee false \vee false \vee (30322 <
-\$heap_{funcstart\_724.1}._replace(p1 \rightarrow ((-2 * div(heapIs \$heap_{funcstart\_724.1}),
\text{Sheap}_{funcstart\_724.1.p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724.1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}))._replace(p2 \rightarrow ((-35 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}. p2, 176).quot) + (172 * div(heapIs
\$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p2, 176).rem))).\_\mathbf{replace}(p3 \rightarrow ((-63 - 200))))
* div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).quot) + (170 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p3,
178).rem)))._replace(p1 \rightarrow (30269 + (-2 * div(heapIs $heap_{tuncstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{tuncstart_{724,1},p1,177,rem})._replace(p2 \rightarrow ((-35 * div(heapIs
\theta_{funcstart_{-724,1}}, \theta_{funcstart_{-724,1}}, \theta_{funcstart_{-724,1}}, \theta_{funcstart_{-724,1}}, \theta_{funcstart_{-724,1}}
\$ \mathrm{heap}_{funcstart\_724,1},\,\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2},\,176).\mathrm{rem}))).\mathrm{p3})) \,\vee\, \dots
\rightarrow [simplify]
[108.34] (false \vee false \vee false \vee false \vee (30322 < ((63 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot}) + (-170 * \text{div}(\text{heapIs}))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p3, 178).rem)))) \lor ...
\rightarrow [from term 68.13, literala < ((-170 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{rem}) + (63 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart-724,1}.p3, 178).quot) is false whenever -2 < (-30323 + literala)
    Proof of rule precondition:
    [108.34.0] - 2 < (-30323 + 30322)
    \rightarrow [simplify]
    [108.34.2] true
[108.35] (false \lor false \lor false \lor false \lor false) \lor ...
\rightarrow [simplify]
```

```
[108.36] false \vee ...
[Remove 'false' term 108.36 and fetch new term from containing clause]
[109.0] (heap_{724,1;752,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2, 176}.rem)._replace(p3 \rightarrow ((-63 * div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}.p3, 178).quot) + (170 * div(heapIs)
\rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}. p1, \ 177).rem)))) \lor
(\text{\$heap}_{funcend\_724,1} == \text{\$heap}_{724,1;753,8}. \mathbf{replace}(p3 \to \text{\$heap}_{724,1;753,8}.p3)) \lor
(-1 < \text{$heap}_{724,1;753,8}.\text{p3})
Remove 'false' term 108.36 and fetch new term from containing clause
[110.0] \; (0 < ((-2 * \operatorname{div}(\mathbf{heapIs} \; \$ \operatorname{heap}_{funcstart\_724,1}, \, \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, \,
177).quot) + (171 * div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p1,
177).rem))) \lor ($heap_{funcend\_724,1} == $heap_{724,1;753,8}._replace(p3 \to
\text{Sheap}_{724,1;753,8}.\text{p3}) \lor (-1 < \text{Sheap}_{724,1;753,8}.\text{p3})
[Copy term 1.56]
[80.24] ((-1 < -$heap<sub>724.1:752.8.p1) \vee (-1 < -$heap<sub>724.1:752.8.p2) \vee (30268 <</sub></sub>
\text{heap}_{724,1:753,8}.\text{p1}) \lor (30306 < \text{heap}_{724,1:753,8}.\text{p2}) \lor (30322 <
-\$heap_{724,1;753,8}.p3)) \lor (\$heap_{funcend\_724,1} == \$heap_{724,1;753,8}.\_replace(p3)
\rightarrow $heap<sub>724,1:753,8</sub>.p3)) \lor (-1 < $heap<sub>724,1:753,8</sub>.p3)
\rightarrow [from term 102.0, -1 < -$heap<sub>724,1;752,8</sub>.p2 is true if and only if 0 ==
heap_{724,1;752,8}.p2
[80.25] ((-1 < -$heap<sub>724,1:752,8</sub>.p1) \vee (0 == $heap<sub>724,1:752,8</sub>.p2) \vee (30268 <
\text{$heap}_{724,1;753,8}.\text{p1}) \lor (30306 < \text{$heap}_{724,1;753,8}.\text{p2}) \lor (30322 <
-\$heap_{724,1;753,8}.p3)) \lor ...
\rightarrow [from term 101.0, $heap_{724,1;753,8}$ is equal to $heap_{724,1;752,8}._replace(p2 \rightarrow
heap_{724,1;752,8}.p2)
[80.26] ((-1 < -$heap<sub>724,1:752,8</sub>.p1) \vee (0 == $heap<sub>724,1:752,8</sub>.p2) \vee (30268 <
\text{heap}_{724,1:752.8}.replace(p2 \rightarrow \text{heap}_{724,1:752.8}.p2).p1) \lor (30306 <
\text{heap}_{724,1;753,8}.\text{p2}) \lor (30322 < -\text{heap}_{724,1;753,8}.\text{p3})) \lor \dots
\rightarrow [simplify]
[80.27] ((-1 < -$heap<sub>724,1;752,8</sub>.p1) \lor (0 == $heap<sub>724,1;752,8</sub>.p2) \lor (30268 <
\text{heap}_{724,1;752,8}.\text{p1}) \lor (30306 < \text{heap}_{724,1;753,8}.\text{p2}) \lor (30322 <
```

 \rightarrow [from term 101.0, \$heap_{724,1;753,8} is equal to \$heap_{724,1;752,8}._replace(p2 \rightarrow

 $-\$heap_{724,1:753,8}.p3)) \lor ...$

 $heap_{724.1:752.8}.p2)$

```
[80.28] ((-1 < -$heap<sub>724.1:752.8</sub>.p1) \vee (0 == $heap<sub>724.1:752.8</sub>.p2) \vee (30268 <
\text{Sheap}_{724,1;752,8}.\text{p1}) \lor (30306 < \text{Sheap}_{724,1;752,8}.\_\text{replace}(\text{p2} \rightarrow
heap_{724,1;752,8}.p_{2}).p_{2} \lor (30322 < -heap_{724,1;753,8}.p_{3})) \lor ...
\rightarrow [simplify]
[80.29] ((-1 < -\$heap_{724,1;752,8}.p1) \lor (0 == \$heap_{724,1;752,8}.p2) \lor (30268 <
\text{$heap}_{724,1;752,8}.\text{p1}) \lor (30306 < \text{$heap}_{724,1;752,8}.\text{p2}) \lor (30322 <
-\$heap_{724,1;753,8}.p3)) \lor ...
\rightarrow [from term 101.0, $heap<sub>724,1;753,8</sub> is equal to $heap<sub>724,1;752,8</sub>._replace(p2 \rightarrow
heap_{724,1;752,8}.p2)
[80.30] ((-1 < -\$heap_{724,1;752,8}.p1) \lor (0 == \$heap_{724,1;752,8}.p2) \lor (30268 <
\text{heap}_{724.1:752.8.p1}) \lor (30306 < \text{heap}_{724.1:752.8.p2}) \lor (30322 <
-\$heap_{724,1:752,8}.-replace(p2 \rightarrow \$heap_{724,1:752,8}.p2).p3)) \lor ...
\rightarrow [simplify]
[80.31] ((-1 < -\$heap_{724,1;752,8}.p1) \lor (0 == \$heap_{724,1;752,8}.p2) \lor (30268 <
\text{$heap}_{724,1;752,8}.\text{p1}) \lor (30306 < \text{$heap}_{724,1;752,8}.\text{p2}) \lor (30322 <
-\$heap_{724,1;752,8}.p3)) \lor ...
\rightarrow [from term 109.0, $heap<sub>724,1;752,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1},p1, 177}, quot) + (171 * div(heapIs heap_{funcstart_{724,1},p1, 177})
\rho_{funcstart\_724,1.p1, 177}.rem))._replace\rho_{funcstart\_724,1.p1, 177}.rem))._replace
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem)))._replace(p3 \rightarrow ((-63)
* div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).quot) + (170 \ *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3,
178).rem)))._replace(p1 \rightarrow (-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.p1, 177).quot) + (171 * div(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p1, 177).rem}
[80.32] ((0 == \text{heap}_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs})
\rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}
* div(heapIs heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 176).quot) + (172 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p2,
176).rem)))._replace(p3 \rightarrow ((-63 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart_724,1.p3}, 178).\text{quot} + (170 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart_724,1},
\rho_{funcstart\_724,1.p3, 178}.rem)._replace(p1 \rightarrow ((-2 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs}))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).rem))).p2) \lor (-1 <
-\$heap_{724.1:752.8}.p1) \lor (30268 < \$heap_{724.1:752.8}.p1) \lor (30306 < \$heap_{724.1:752.8}.p1)
\text{heap}_{724,1;752,8}.\text{p2}) \lor (30322 < -\text{heap}_{724,1;752,8}.\text{p3})) \lor \dots
\rightarrow [simplify]
```

```
176).quot) + (172 * div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, p_2,
176).rem))) \vee (-1 < -$heap<sub>724,1:752,8</sub>.p1) \vee (30268 < $heap<sub>724,1:752,8</sub>.p1) \vee
(30306 < \text{$heap}_{724,1;752,8}.\text{p2}) \lor (30322 < -\text{$heap}_{724,1;752,8}.\text{p3})) \lor \dots
\rightarrow [from term 65.3, 0 == ((-35 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1},p2, 176}, quot) + (172 * div(heapIs p_{funcstart_{724,1},p2}
heap_{funcstart\_724,1}.p2, 176).rem) is false
[80.36] (false \lor (-1 < -$heap<sub>724,1:752,8</sub>.p1) \lor (30268 < $heap<sub>724,1:752,8</sub>.p1) \lor
(30306 < \text{$heap}_{724,1:752,8}.\text{p2}) \lor (30322 < -\text{$heap}_{724,1:752,8}.\text{p3})) \lor \dots
\rightarrow [from term 109.0, \rho_{724,1;752,8} is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs *heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1}.p1, 177).rem))._replace\rho_{funcstart\_724,1}.p1, 177).rem))._replace
heap_{funcstart\_724.1}, heap_{funcstart\_724.1}.p2, 176).quot) + (172 * div(heapIs)
\rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}
* div(heapIs heap_{funcstart\_724.1}, heap_{funcstart\_724.1}, p_{funcstart\_724.1}), quot) + (170 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3,
178).rem)))._replace(p1 \rightarrow (-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724.1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177).rem)
[80.37] (false \lor (-1 < -$heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
* div(heapIs heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 176).quot) + (172 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p2,
176).rem)))._replace(p3 \rightarrow ((-63 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} + (170 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart\_724,1}.p3, 178).rem)._replace(p1 \rightarrow ((-2 * div(heapIs))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\textbf{heapIs}))
\$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem))).p1) \lor (30268 <
\text{heap}_{724.1:752.8.p1}) \lor (30306 < \text{heap}_{724.1:752.8.p2}) \lor (30322 <
-\$heap_{724,1;752,8}.p3)) \lor ...
\rightarrow [simplify]
[80.41] (false \vee (-1 < ((2 * div(heapIs $heap_{funcstart\_724,1},
\rho_{funcstart_{-724,1},p1, 177} (quot) + (-171 * div(heapIs \rho_{funcstart_{-724,1},p1}
\{\text{heap}_{funcstart\_724,1}.\text{p1}, 177\}.\text{rem}\} \forall (30268 < \{\text{heap}_{724,1;752,8}.\text{p1}\} \lor (30306 < \text{heap}_{724,1;752,8}.\text{p1})
\text{sheap}_{724,1:752.8}.\text{p2}) \lor (30322 < -\text{sheap}_{724,1:752.8}.\text{p3})) \lor \dots
\rightarrow [from term 110.0, literala < ((-171 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724.1.p1}, 177).\text{rem} + (2 * div(\text{heapIs } \text{Sheap}_{funcstart\_724.1},
\text{Sheap}_{funcstart\_724,1.p1}, 177).\text{quot} is false whenever -2 < (0 + \text{literala})
    Proof of rule precondition:
```

[80.41.0] - 2 < (-1 + 0)

```
\rightarrow [simplify]
       [80.41.2] true
[80.42] (false \vee false \vee (30268 < $heap<sub>724.1:752.8</sub>.p1) \vee (30306 <
heap_{724,1;752,8}.p2) \lor (30322 < -heap_{724,1;752,8}.p3)) \lor ...
\rightarrow [from term 109.0, $heap<sub>724,1;752,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.p1, 177).quot) + (171 * div(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\$heap_{funcstart\_724,1}.p1,\ 177).rem))).\_\mathbf{replace}(p2 \rightarrow ((-35\ *\ div(\mathbf{heapIs})))).
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem)))._replace(p3 \rightarrow ((-63
 * \operatorname{div}(\mathbf{heapIs} \ \$ heap_{funcstart\_724,1}, \ \$ heap_{funcstart\_724,1}.p3, \ 178).quot) + (170 \ *
div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3,
178).rem)))._replace(p1 \rightarrow (-2 * div(\textbf{heapIs } \$heap_{funcstart\_724.1},
heap_{funcstart\_724.1.p1}, 177).quot + (171 * div(heapIs $heap_{funcstart\_724.1}, 177).quot) + (171 * div(heapIs $heap_{funcstart\_724.1}, 17
heap_{funcstart_{724,1}}.p1, 177).rem)
[80.43] (false \lor false \lor (30268 < $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{tuncstart_724.1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2, 176}.rem))._replace(p3 \rightarrow ((-63 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs}))
\rho_{funcstart_724.1}, \rho_{funcstart_724.1}, \rho_{funcstart_724.1}, \rho_{funcstart_724.1}, \rho_{funcstart_724.1}, \rho_{funcstart_724.1}, \rho_{funcstart_724.1}
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).rem))).p1) \lor
(30306 < \text{$heap}_{724,1;752,8}.\text{p2}) \lor (30322 < -\text{$heap}_{724,1;752,8}.\text{p3})) \lor \dots
\rightarrow [simplify]
[80.44] (false \vee false \vee (30268 < ((-2 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724.1.p1, 177}.\text{quot}) + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724.1},
\{\text{heap}_{funcstart\_724,1}.\text{p1}, 177\}.\text{rem}\}
-\$heap_{724.1:752.8}.p3)) \lor ...
\rightarrow [from term 62.17, literala < ((-2 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.p1, 177).quot) + (171 * div(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p1, 177).rem} is false whenever -2 < (-30269 + literala)
       Proof of rule precondition:
       [80.44.0] - 2 < (-30269 + 30268)
       \rightarrow [simplify]
       [80.44.2] true
[80.45] (false \lor false \lor (30306 < $heap<sub>724,1:752,8</sub>.p2) \lor (30322 <
 -\$heap_{724,1;752,8}.p3)) \lor ...
```

```
\rightarrow [from term 109.0, $heap<sub>724,1;752,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs p_{funcstart\_724,1}),
\text{Sheap}_{funcstart\_724,1}.p1, 177).quot) + (171 * div(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).rem))._replace(p2 \rightarrow ((-35 * div(heapIs)))._
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
\rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}
* div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, n_{724,1}, n_{724,1}, n_{724,1}, n_{724,1}
div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3,
178).rem)))._replace(p1 \rightarrow (-2 * div(\textbf{heapIs } \$heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.p1, 177).quot) + (171 * div(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177).rem)
[80.46] (false \vee false \vee false \vee (30306 < $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow
((-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).quot) +
(171 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart\_724,1}, \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem}))._replace(p3 \rightarrow ((-63 * div(heapIs
\$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).quot) + (170 * div(\textbf{heapIs}))
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p3, 178).rem))).\_replace(p1 \rightarrow ((-2 * funcstart\_724,1)))
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).rem))).p2) \lor
(30322 < -\$heap_{724,1;752,8}.p3)) \lor \dots
\rightarrow [simplify]
[80.49] (false \vee false \vee false \vee (30306 < ((-35 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
\text{Sheap}_{funcstart_{724,1}}, \text{Sheap}_{funcstart_{724,1}}.p2, 176).rem))) \lor (30322 <
-\$heap_{724,1:752.8}.p3)) \lor ...
\rightarrow [from term 66.18, literala < ((-35 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p2, 176).quot + (172 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1},p2,176}, rem)) is false whenever -2 < (-30307 + literala)
    Proof of rule precondition:
    [80.49.0] - 2 < (-30307 + 30306)
    \rightarrow [simplify]
    [80.49.2] true
[80.50] (false \vee false \vee false \vee false \vee (30322 < -\$heap_{724.1;752.8}.p3)) <math>\vee ...
\rightarrow [from term 109.0, $heap<sub>724,1:752,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).rem))).\_replace(p2 \rightarrow ((-35 * div(heapIs))).\_replace(p2 \rightarrow ((-35 * div(heapIs)))))._replace(p2 \rightarrow ((-35 * div(heapIs)))))
\text{Sheap}_{funcstart\_724.1}, \text{Sheap}_{funcstart\_724.1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem)))._replace(p3 \rightarrow ((-63
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* div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).quot) + (170 \ *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3,
 178).rem)))._replace(p1 \rightarrow (-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1}, 177).quot) + (171 * div(heapIs $heap_{funcstart\_724,1}, 17
heap_{funcstart_{-724,1}.p1, 177).rem}
[80.51] (false \vee false \vee false \vee false \vee (30322 <
-\$heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs \$heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724.1}.\text{p1}, 177).\text{rem}))._replace(p2 \rightarrow ((-35 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}. \theta_{funcstart\_724,1}
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1},p2,176}.rem)))._replace(p3 \theta_{funcstart_{724,1}}
* div(heapIs heap_{funcstart_{-724.1}}, heap_{funcstart_{-724.1}}, p_{3}, p_{3}, p_{4}).quot) + (170 *
div(heapIs $heap<sub>funcstart</sub>, 724.1, $heap<sub>funcstart</sub>, 724.1.p3,
178).rem)))._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart_{724,1}},
\text{Sheap}_{funcstart\_724,1.p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{724,1}}.p1, 177).rem)).p3)) \vee ...
\rightarrow [simplify]
[80.56] (false \vee false \vee false \vee false \vee (30322 < ((63 * div(heapIs
\text{Sheap}_{funcstart_{724,1}}, \text{Sheap}_{funcstart_{724,1}}.p3, 178).quot) + (-170 * div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p3, 178).rem)))) \lor ...
\rightarrow [from term 68.13, literala < ((-170 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p3}, 178).rem) + (63 * div(heapIs \text{Sheap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.p3, 178).quot) is false whenever -2 < (-30323 + \text{literala})
          Proof of rule precondition:
          [80.56.0] - 2 < (-30323 + 30322)
          \rightarrow [simplify]
           [80.56.2] true
[80.57] (false \vee false \vee false \vee false \vee false) \vee ...
\rightarrow [simplify]
[80.58] false \vee \dots
[Remove 'false' term 80.58 and fetch new term from containing clause]
[112.0] \rho_{12.0} = \rho_{124,1;753,8} == $heap_{724,1;753,8}._replace(p3 \rightarrow
heap_{724,1;753,8}.p3
[Take goal term]
[1.56] (30322 < $heap_{funcend\_724,1}.p3) \vee (30306 < $heap_{funcend\_724,1}.p2) \vee
(30268 < \text{$heap_{funcend\_724,1}.p1}) \lor (-1 < -\text{$heap_{funcend\_724,1}.p1}) \lor (-1 < -\text{$heap_{funcend\_724,1}.p1}) \lor (-1 < -\text{$heap_{funcend\_724,1}.p1})
-\$heap_{funcend\_724,1}.p2) \lor (-1 < -\$heap_{funcend\_724,1}.p3)
\rightarrow [from term 112.0, $heap_{funcend\_724,1}$ is equal to $heap_{724,1;753,8}._replace(p3)
\rightarrow $heap_{724,1;753,8}.p3)]
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[1.57] (-1 < -$heap<sub>724,1;753,8</sub>.replace(p3 \rightarrow $heap<sub>724,1;753,8</sub>.p3).p1) \lor (-1 <
-\$heap_{funcend\_724,1}.p2) \lor (-1 < -\$heap_{funcend\_724,1}.p3) \lor (30268 <
\text{Sheap}_{funcend\_724,1}.\text{p1}) \lor (30306 < \text{Sheap}_{funcend\_724,1}.\text{p2}) \lor (30322 < \text{property})
heap_{funcend\_724,1.p3}
\rightarrow [simplify]
[1.58] (-1 < -\$heap_{724,1;753,8}.p1) \lor (-1 < -\$heap_{funcend\_724,1}.p2) \lor (-1 < -\$heap_{funcend\_724,1}.p2)
 -\text{$heap}_{funcend\_724,1}.\text{p3}) \lor (30268 < \text{$heap}_{funcend\_724,1}.\text{p1}) \lor (30306 < \text{$heap}_{funcend\_724,1}.\text{p2})
\text{heap}_{funcend\_724,1}.\text{p2}) \lor (30322 < \text{heap}_{funcend\_724,1}.\text{p3})
\rightarrow [from term 112.0, $heap_{funcend\_724,1}$ is equal to $heap_{724,1;753,8}._replace(p3
\rightarrow $heap_{724,1;753,8}.p3)
[1.59] (-1 < -\$heap_{724,1:753,8}.p1) \lor (-1 < -\$heap_{724,1:753,8}.\_replace(p3 \rightarrow
\$heap_{724,1;753,8}.p3).p2) \lor (-1 < -\$heap_{funcend\_724,1}.p3) \lor (30268 <
\text{Sheap}_{funcend\_724,1}.\text{p1}) \lor (30306 < \text{Sheap}_{funcend\_724,1}.\text{p2}) \lor (30322 <
heap_{funcend\_724,1}.p3
\rightarrow [simplify]
[1.60] (-1 < -$heap<sub>724,1;753,8</sub>.p1) \vee (-1 < -$heap<sub>724,1;753,8</sub>.p2) \vee (-1 <
-\$heap_{funcend\_724,1}.p3) \lor (30268 < \$heap_{funcend\_724,1}.p1) \lor (30306 < funcend\_724,1)
\text{Sheap}_{funcend\_724,1}.\text{p2}) \lor (30322 < \text{Sheap}_{funcend\_724,1}.\text{p3})
\rightarrow [from term 112.0, $heap_{funcend\_724,1}$ is equal to $heap_{724,1;753,8}._replace(p3
\rightarrow $heap_{724,1;753,8}.p3)
[1.61] (-1 < -$heap_{724,1;753,8}.p1) 
 \vee (-1 < -$heap_{724,1;753,8}.p2) 
 \vee (-1 <
-\$heap_{724,1:753,8}.-replace(p3 \rightarrow \$heap_{724,1:753,8}.p3).p3) <math>\lor (30268 < 1000)
\text{heap}_{funcend\_724,1.p1}) \lor (30306 < \text{heap}_{funcend\_724,1.p2}) \lor (30322 <
heap_{funcend\_724,1.p3}
\rightarrow [simplify]
[1.62] (-1 < -\$heap_{724,1;753,8}.p1) \lor (-1 < -\$heap_{724,1;753,8}.p2) \lor (-1 < -\$heap_{724,1;753,8}.p2)
  -\$heap_{724,1;753,8}.p3) \lor (30268 < \$heap_{funcend\_724,1}.p1) \lor (30306 < function for the sum of 
\text{Sheap}_{funcend\_724,1}.\text{p2}) \lor (30322 < \text{Sheap}_{funcend\_724,1}.\text{p3})
[Remove 'false' term 80.58 and fetch new term from containing clause]
[113.0] -1 < heap_{724,1;753,8}.p3
[Take goal term]
[1.62] (-1 < -\$heap_{724,1;753,8}.p1) \lor (-1 < -\$heap_{724,1;753,8}.p2) \lor (-1 < -\$heap_{724,1;753,8}.p2)
-\$heap_{724,1;753,8}.p3) \lor (30268 < \$heap_{funcend\_724,1}.p1) \lor (30306 < function for the sum of 
\text{$heap}_{funcend\_724,1}.p2) \lor (30322 < \text{$heap}_{funcend\_724,1}.p3)
\rightarrow [from term 113.0, -1 < -$heap<sub>724,1:753,8</sub>.p3 is true if and only if 0 ==
heap_{724,1:753,8}.p3
[1.63] (-1 < -\$heap_{724,1;753,8}.p1) \lor (-1 < -\$heap_{724,1;753,8}.p2) \lor (0 ==
\text{heap}_{724.1;753.8}.\text{p3}) \lor (30268 < \text{heap}_{funcend\_724.1}.\text{p1}) \lor (30306 <
\text{Sheap}_{funcend\_724,1}.\text{p2}) \lor (30322 < \text{Sheap}_{funcend\_724,1}.\text{p3})
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\rightarrow [from term 112.0, $heap_{funcend\_724,1}$ is equal to $heap_{724,1;753,8}._replace(p3
\rightarrow $heap_{724,1;753,8}.p3)]
[1.64] (-1 < -$heap<sub>724,1:753,8</sub>.p1) \vee (-1 < -$heap<sub>724,1:753,8</sub>.p2) \vee (0 ==
heap_{724,1;753,8}.p3) \lor (30268 < heap_{724,1;753,8}._replace(p3 \rightarrow
\text{Sheap}_{724,1;753,8}.\text{p3}.\text{p1}) \lor (30306 < \text{Sheap}_{funcend\_724,1}.\text{p2}) \lor (30322 < \text{p3})
heap_{funcend\_724,1}.p3
\rightarrow [simplify]
[1.65] (-1 < -\$heap_{724,1;753,8}.p1) \lor (-1 < -\$heap_{724,1;753,8}.p2) \lor (0 ==
\$heap_{724,1;753,8}.p3) \lor (30268 < \$heap_{724,1;753,8}.p1) \lor (30306 <
\text{Sheap}_{funcend\_724,1}.\text{p2}) \lor (30322 < \text{Sheap}_{funcend\_724,1}.\text{p3})
\rightarrow [from term 112.0, $heap_{funcend\_724,1}$ is equal to $heap_{724,1;753,8}._replace(p3
\rightarrow $heap_{724.1:753.8}.p3)
[1.66] (-1 < -\$heap_{724,1;753,8}.p1) \lor (-1 < -\$heap_{724,1;753,8}.p2) \lor (0 ==
\text{heap}_{724,1:753,8}.\text{p3}) \lor (30268 < \text{heap}_{724,1:753,8}.\text{p1}) \lor (30306 <
\text{heap}_{724,1;753,8}._replace(p3 \rightarrow \text{heap}_{724,1;753,8}.p3).p2) \lor (30322 <
heap_{funcend_{724.1}.p3}
\rightarrow [simplify]
[1.67] (-1 < -$heap_{724,1;753,8}.p1) \vee (-1 < -$heap_{724,1;753,8}.p2) \vee (0 ==
\$heap_{724,1;753,8}.p3) \lor (30268 < \$heap_{724,1;753,8}.p1) \lor (30306 <
\text{$heap}_{724,1;753.8}.\text{p2}) \lor (30322 < \text{$heap}_{funcend\_724,1}.\text{p3})
\rightarrow [from term 112.0, $heap_{funcend\_724,1}$ is equal to $heap_{724,1;753,8}._replace(p3
\rightarrow $heap_{724.1:753.8}.p3)
[1.68] (-1 < -$heap_{724,1;753,8}.p1) 
 \vee (-1 < -$heap_{724,1;753,8}.p2) 
 \vee (0 ==
\text{heap}_{724,1;753,8}.\text{p3}) \lor (30268 < \text{heap}_{724,1;753,8}.\text{p1}) \lor (30306 <
heap_{724,1;753,8}.p2) \lor (30322 < heap_{724,1;753,8}.replace(p3 \rightarrow
heap_{724,1;753,8}.p3).p3
\rightarrow [simplify]
[1.69] (-1 < -$heap<sub>724,1:753,8</sub>.p1) \vee (-1 < -$heap<sub>724,1:753,8</sub>.p2) \vee (0 ==
\text{Sheap}_{724,1:753,8}.\text{p3}) \lor (30268 < \text{Sheap}_{724,1:753,8}.\text{p1}) \lor (30306 <
heap_{724,1;753,8}.p2) \lor (30322 < heap_{724,1;753,8}.p3)
[Copy term 112.0]
[115.0] ($heap<sub>funcend_724,1</sub> == $heap<sub>724,1;753,8</sub>._replace(p3 \rightarrow
\$ heap_{724,1;752,8}.p2)) \lor (-1 < \$ heap_{724,1;752,8}.p2) \lor (\$ heap_{724,1;752,8} = =
\text{Sheap}_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs \text{Sheap}_{funcstart\_724,1}),
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).rem))._replace(p2 \rightarrow ((-35 * div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem))._replace(p3 \rightarrow ((-63)
* div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, 178).quot) + (170 *
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\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p3,
178).rem)))._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs p_{funcstart\_724,1})
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem})))) \lor (0 < ((-2 * div(\mathbf{heapIs}))))
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1},p1, 177}.quot + (171 * div(heapIs))
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 177).rem)
\rightarrow [from term 92.6, $heap_{724,1;753,8}$ is equal to $heap_{funcstart\_724,1}._replace(p1
\rightarrow ((-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).quot) +
(171 * div(\mathbf{heapIs} \$heap_{funcstart\_724.1}, \$heap_{funcstart\_724.1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(\textbf{heapIs } \$heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p2, 176).quot + (172 * div(heapIs $heap_{funcstart\_724,1},
\rho_{funcstart\_724.1.p2, 176}.rem))._replace\rho_{funcstart\_724.1.p2, 176}.rem))._replace
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, p_{3,178}, q_{100}, q_{100}, q_{100}
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
(30269 + (-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1,
177).quot) + (171 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow 30307 + (-35 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p2, 176).quot + (172 * div(heapIs $heap_{funcstart\_724,1}, 176).quot) + (172 * div(heapIs $heap_{funcstart\_724,1}, 17
heap_{funcstart_{-724,1}.p2, 176).rem}
[115.2] (\text{$heap}_{funcend\_724,1} == \text{$heap}_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{tuncstart_{724,1},p2,176,rem})._replace(p3 \rightarrow ((-63 * div(heapIs
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).quot) + (170 * div(heapIs)
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p3, 178).rem))).\_replace(p1 \rightarrow
(30269 + (-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1,
177).quot) + (171 * \text{div}(\text{heapIs} \$\text{heap}_{funcstart}, 724.1, \$\text{heap}_{funcstart}, 724.1.p1,
177).rem)))._replace(p2 \rightarrow (30307 + (-35 * div(heapIs $heap_{funcstart\_724.1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{funcstart\_724,1.p2, 176}.rem))._replace(p3 \rightarrow
\text{Sheap}_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs \text{Sheap}_{funcstart\_724,1}),
\text{Sheap}_{funcstart\_724,1.p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p1, 177}.rem)._replace(p2 \rightarrow ((-35 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem}))._replace(p3 \rightarrow ((-63)
* div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, p3, 178).quot) + (170 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p3,
178).rem)))._replace(p1 \rightarrow (30269 + (-2 * div(heapIs $heap_{funcstart\_724,1},
\theta_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1}, 177).quot) + (171 * div(heapIs $heap_{funcstart\_724,1}, 177).
\text{heap}_{funcstart\_724.1.p1, 177}.\text{rem}))._replace(p2 \rightarrow (30307 + (-35 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p2, \ 176).quot) + (172 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p2, \ 176).rem))).p3)) \lor \dots
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\rightarrow [simplify]
[115.5] (\text{$heap_{funcend\_724,1} == $heap_{funcstart\_724,1}.\_replace}(\text{p1} \rightarrow ((-2 * \text{p1})))
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724.1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2, 176}.rem))._replace(p3 \rightarrow ((-63 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs}))
\rho_{funcstart_{724,1}}, \rho_{funcstart_{724,1},p3,178}.rem))._replace(p1 \rightarrow
(30269 + (-2*div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1,
177).quot) + (171 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).rem))). replace(p2 \rightarrow (30307 + (-35 * div(heapIs $heap_{funcstart\_724.1},
\text{Sheap}_{funcstart_{-724,1},p2, 176}.quot) + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart_{-724,1}},
\rho_{funcstart\_724,1.p2, 176}.rem)._replace(p3 \rightarrow ((-63 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p3, 178).quot) + (170 * div(heapIs)
\text{Sheap}_{funcstart_{724,1}}, \text{Sheap}_{funcstart_{724,1}}, \text{p3}, 178).rem)))) \vee ...
[Copy term 113.0]
[116.0] (-1 < \text{$heap}_{724.1:753.8}.p3) \lor (\text{$heap}_{724.1:753.8} ==
\text{sheap}_{724,1;752,8}._replace(p2 \rightarrow \text{sheap}_{724,1;752,8}.p2)) \vee (-1 <
\text{Sheap}_{724,1;752,8}.\text{p2}) \lor (\text{Sheap}_{724,1;752,8} == \text{Sheap}_{funcstart\_724,1}.\_\textbf{replace}(\text{p1} \rightarrow
((-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).quot) +
(171 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem}))._replace(p3 \rightarrow ((-63 * div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p3, 178).quot) + (170 * div(heapIs)
\rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).rem)))) \lor (0 <
((-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).quot) +
(171 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart\_724,1}, \text{\$heap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem})))
\rightarrow [from term 92.6, $heap<sub>724,1:753,8</sub> is equal to $heap<sub>funcstart_724,1</sub>._replace(p1)
\rightarrow ((-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).quot) +
(171 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1,
(-35 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p2, 176).quot + (172 * div(heapIs $heap_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2, 176}.rem))._replace\rho_{funcstart\_724,1.p2, 176}.rem))._replace
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).quot) + (170 * div(heapIs)
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
(30269 + (-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1),
177).quot) + (171 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow 30307 + (-35 * div(heapIs $heap_{funcstart\_724.1},
\text{Sheap}_{funcstart_{724,1},p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart_{724,1}},
heap_{funcstart_{-724,1}}.p2, 176).rem)
```

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[116.1] (-1 < \text{heap}_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs}))
* div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, p2, 176).quot) + (172 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p2,
176).rem)))._replace(p3 \rightarrow ((-63 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p3}, 178).quot) + (170 * div(heapIs \text{Sheap}_{funcstart\_724,1},
\text{heap}_{funcstart,724,1}.p3, 178).rem))._replace(p1 \rightarrow (30269 + (-2 * div(heapIs))
\text{Sheap}_{funcstart_{-724,1}}, \text{Sheap}_{funcstart_{-724,1}}, \text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs}))
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p1, 177).rem)))._replace(p2 \rightarrow
(30307 + (-35 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}, p2,
176).quot) + (172 * div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1},p2},
176).rem))).p3) \vee ...
\rightarrow [simplify]
\label{eq:continuous} \textit{[116.4]} \ (-1 < ((-63 * {\rm div}(\mathbf{heapIs} \ \$ {\rm heap}_{funcstart\_724,1}, \ \$ {\rm heap}_{funcstart\_724,1}.{\rm p3},
178).quot) + (170 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3,
178).rem))) \vee ...
\rightarrow [from term 69.3, -1 < ((-63 * div(heapIs $heap_{funcstart_724.1},
\text{Sheap}_{funcstart\_724,1}.p3, 178).quot) + (170 * div(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart\_724,1}.p3, 178).rem is true if and only if 0 < ((-63 * div(\mathbf{heapIs})))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).quot) + (170 * div(heapIs)
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).rem))]
\label{eq:continuous} \mbox{[116.5]} \ (0 < ((-63 * \mbox{div}(\mathbf{heapIs} \ \$ \mbox{heap}_{funcstart\_724,1}, \ \$ \mbox{heap}_{funcstart\_724,1}.\mbox{p3},
178).quot) + (170 * div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, p_3,
178).rem))) \vee ...
[Copy term 1.56]
[117.0] ((-1 < -$heap<sub>funcend_724,1.p1</sub>) \vee (-1 < -$heap<sub>funcend_724,1.p2</sub>) \vee (-1 <
 -\$heap_{funcend\_724,1}.p3) \lor (30268 < \$heap_{funcend\_724,1}.p1) \lor (30306 < function for the second substitution of the second substitution for the second substitution f
\text{Sheap}_{funcend\_724,1.p2}) \lor (30322 < \text{Sheap}_{funcend\_724,1.p3})) \lor (\text{Sheap}_{724,1;753,8})
== $heap<sub>724.1:752.8</sub>.replace(p2 \rightarrow $heap<sub>724,1:752,8</sub>.p2)) \lor (-1 <
\$heap_{724,1;752,8}.p2) \lor (\$heap_{724,1;752,8} == \$heap_{funcstart\_724,1}.\_\mathbf{replace}(p1 \to 2000))
((-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724.1}, \$heap_{funcstart\_724.1}.p1, 177).quot) +
(171 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart\_724,1}, \text{\$heap}_{funcstart\_724,1}.\text{p1},
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724.1.p2, 176}.rem)._replace(p3 \rightarrow ((-63 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p3, 178).quot) + (170 * div(heapIs)
\$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem))).\_\textbf{replace}(p1 \rightarrow ((-2 * left) + left)))
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).rem)))) \lor (0 <
((-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).quot) +
(171 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)))
\rightarrow [from term 115.5, $heap<sub>funcend_724,1</sub> is equal to
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heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1},p1, 177}, quot) + (171 * div(heapIs heap_{funcstart_{724,1},p1, 177})
\rho_{funcstart\_724,1.p1, 177}.rem))._replace\rho_{funcstart\_724,1.p1, 177}.rem))._replace
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
\rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}
* div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, n_{724,1}, n_{724,1}, n_{724,1}, n_{724,1}
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3,
178).rem)))._replace(p1 \rightarrow (30269 + (-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724.1}.p1, 177).quot + (171 * div(heapIs p_{funcstart\_724.1})
\text{Sheap}_{funcstart\_724,1}.p1, 177).rem))).\_replace(p2 \to (30307 + (-35 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p2, \ 176).quot) + (172 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724.1}, \ \$heap_{funcstart\_724.1}.p2,
176).rem)))._replace(p3 \rightarrow (-63 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} + (170 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{724,1}.p3, 178.rem}
[117.1] ((-1 < -$heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs})
* div(\mathbf{heapIs} \ \$ heap_{funcstart\_724,1}, \ \$ heap_{funcstart\_724,1}.p2, \ 176).quot) + (172 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p2,
176).rem)))._replace(p3 \rightarrow ((-63 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} + (170 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{tuncstart\_724.1.p3}, 178).rem)._replace(p1 \rightarrow (30269 + (-2 * div(heapIs))
\text{Sheap}_{funcstart\_724.1}, \text{Sheap}_{funcstart\_724.1}, \text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs}))
\rho_{funcstart_{724,1}}, \rho_{funcstart_{724,1},p1, 177}.rem))._replace(p2 \rightarrow
(30307 + (-35 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p2,
176).quot) + (172 * div(heapIs heapIs = f_{uncstart\_724,1}, heap_{funcstart\_724,1}.p2,
176).rem)))._replace(p3 \rightarrow ((-63 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} + (170 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{rem})).\text{p1}) \lor (-1 < -\text{Sheap}_{funcend\_724,1}.\text{p2}) \lor (-1
<-$heap<sub>funcend_724,1.</sub>p3) \lor (30268 <$heap<sub>funcend_724,1.</sub>p1) \lor (30306 <
\text{Sheap}_{funcend\_724,1.p2}) \lor (30322 < \text{Sheap}_{funcend\_724,1.p3})) \lor \dots
\rightarrow [simplify]
[117.12] ((30268 < ((-171 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\$ heap_{funcstart\_724,1}.p1,\ 177).quot))) \ \lor \ (-1 < -\$ heap_{funcend\_724,1}.p2) \ \lor \ (-1 < -\$ heap_{funcend\_724,1}.p2) \ \lor \ (-1 < -\$ heap_{funcend\_724,1}.p2)
-\$heap_{funcend\_724,1}.p3) \lor (30268 < \$heap_{funcend\_724,1}.p1) \lor (30306 < \$heap_{funcend\_724,1}.p3)
\text{Sheap}_{funcend\_724,1}.\text{p2}) \vee (30322 < \text{Sheap}_{funcend\_724,1}.\text{p3})) \vee ...
\rightarrow [from term 60.11, literala < ((-171 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1},p1,177,quot} is false whenever -2 < (-30269 + literala)
    Proof of rule precondition:
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[117.12.0] - 2 < (-30269 + 30268)

```
\rightarrow [simplify]
    [117.12.2] true
[117.13] (false \vee (-1 < -$heap<sub>funcend_724,1.</sub>p2) \vee (-1 <
-\$heap_{funcend\_724,1}.p3) \lor (30268 < \$heap_{funcend\_724,1}.p1) \lor (30306 < funcend\_724,1)
\text{Sheap}_{funcend\_724,1.p2}) \lor (30322 < \text{Sheap}_{funcend\_724,1.p3})) \lor \dots
\rightarrow [from term 115.5, $heap<sub>funcend_724,1</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
\operatorname{Sheap}_{funcstart\_724,1}.p1, 177).\operatorname{quot} + (171 * \operatorname{div}(\mathbf{heapIs} \operatorname{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p1, 177}.rem))._replace\rho_{funcstart\_724,1.p1, 177}.rem))._replace
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem)))._replace(p3 \rightarrow ((-63)
* div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).quot) + (170 \ *
div(\mathbf{heapIs}\ \$heap_{funcstart\_724,1},\ \$heap_{funcstart\_724,1}.p3,
178).rem))).replace(p1 \rightarrow (30269 + (-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724.1},
heap_{funcstart_724,1}.p1, 177).quot + (171 * div(heapIs p_{funcstart_724,1})
heap_{funcstart\_724,1}.p1, 177).rem))._replace(p2 \rightarrow (30307 + (-35)^{*}))
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p2, \ 176).quot) + (172 *
div(\mathbf{heapIs} \$heap_{funcstart\_724.1}, \$heap_{funcstart\_724.1}.p2,
(176).\text{rem})._replace(p3 \rightarrow (-63 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} + (170 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p3, 178).rem))]
[117.14] (false \vee (-1 < -$heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 * div(heapIs
\text{Sheap}_{funcstart\_724.1}, \text{Sheap}_{funcstart\_724.1}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs})
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
* div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, p2, 176).quot) + (172 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p2,
176).rem)))._replace(p3 \rightarrow ((-63 * div(heapIs $heap_{funcstart_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} + (170 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{uncstart_{-724,1},p3,178,rem})._replace(p1 \rightarrow (30269 + (-2 * div(heapIs
\text{Sheap}_{funcstart_{-724,1}}, \text{Sheap}_{funcstart_{-724,1}}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\textbf{heapIs})
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p1, 177).rem))).\_replace(p2 \rightarrow
(30307 + (-35 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p2,
176).quot) + (172 * div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2,
176).rem)))._replace(p3 \rightarrow ((-63 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p3}, 178).\text{quot} + (170 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p3}, 178).rem)).p2) \lor (-1 < -\text{Sheap}_{funcend\_724,1.p3}) \lor 
(30268 < \text{\$heap}_{funcend\_724,1}.\text{p1}) \lor (30306 < \text{\$heap}_{funcend\_724,1}.\text{p2}) \lor (30322 < \text{\$heap}_{funcend\_724,1}.\text{p2}) \lor (30322 < \text{\$heap}_{funcend\_724,1}.\text{p2})
heap_{funcend\_724,1}.p3) \lor ...
\rightarrow [simplify]
[117.24] (false \vee (30306 < ((-172 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).rem) + (35 * div(heapIs \text{Sheap}_{funcstart\_724,1},
\{\text{heap}_{funcstart\_724,1.p2}, 176\}.quot))) \lor (-1 < -\{\text{heap}_{funcend\_724,1.p3}\}) \lor (30268)
< $\text{heap}_{funcend_724,1.p1}) \lor (30306 < $\text{heap}_{funcend_724,1.p2}) \lor (30322 <
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heap_{funcend\_724,1}.p3) \lor ...
\rightarrow [from term 64.12, literala < ((-172 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.p2, 176).rem) + (35 * div(\text{heapIs} \text{Sheap}_{funcstart\_724,1},
heap_{funcstart\_724,1}.p2, 176).quot) is false whenever -2 < (-30307 + literala)
       Proof of rule precondition:
       [117.24.0] - 2 < (-30307 + 30306)
       \rightarrow [simplify]
       [117.24.2] true
[117.25] (false \vee false \vee (-1 < –$heap _{funcend\_724,1}.p3) <math display="inline">\vee (30268 <
\text{Sheap}_{funcend\_724.1.p1}) \lor (30306 < \text{Sheap}_{funcend\_724.1.p2}) \lor (30322 <
heap_{funcend\_724,1}.p3) \lor ...
\rightarrow [from term 115.5, \rho_{124,1} is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.p1, 177).quot) + (171 * div(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{1.5}(p_1, p_1, p_2, p_3, p_4, p_5)._replace(p_2 \rightarrow ((-35 * div(\mathbf{heapIs})))._replace(p_3, p_4, p_4, p_5)
heap_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem)))._replace(p3 \rightarrow ((-63)
 * div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, p_{3,178}).quot) + (170 *
div(\textbf{heapIs}~\$heap_{funcstart\_724,1},~\$heap_{funcstart\_724,1}.p3,
178).rem)))._replace(p1 \rightarrow (30269 + (-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1},p1, 177,rem})._replace(p2 \to (30307 + (-35 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724.1}, \ \$heap_{funcstart\_724.1}.p2, \ 176).quot) + (172 \ *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p2,
176).rem)))._replace(p3 \rightarrow (-63 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.p3, 178).quot) + (170 * div(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p3, 178, rem}
[117.26] (false \vee false \vee (-1 < -$heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart_724,1}.p2, 176).rem))._replace(p3 \rightarrow ((-63 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}. p3, 178).quot) + (170 * div(heapIs
\rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}
(30269 + (-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1,
177).quot) + (171 * \text{div}(\text{heapIs } \text{$heap}_{funcstart\_724,1}, \text{$heap}_{funcstart\_724,1}.\text{p1},
(177).rem)...replace(p2 \rightarrow (30307 + (-35 * div(heapIs $heap_{tuncstart_{724.1}},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2, 176}.rem)._replace(p3 \rightarrow ((-63 * div(heapIs
\theta_{funcstart-724,1}, \theta_{funcstart-724,1}, \theta_{funcstart-724,1}, \theta_{funcstart-724,1}, \theta_{funcstart-724,1}
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p3, 178).rem))).p3) \lor (30268 <
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Sheap_{funcend\_724,1}.p3)) \lor ...
\rightarrow [simplify]
[117.30] (false \vee false \vee (-1 < ((63 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} + (-170 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\text{heap}_{funcstart_{-724,1},p3, 178,rem})) \vee (30268 < \text{heap}_{funcend_{-724,1},p1}) \vee
(30306 < \text{$heap_{funcend\_724,1}.p2}) \lor (30322 < \text{$heap_{funcend\_724,1}.p3})) \lor \dots
\rightarrow [from term 116.5, literala < ((-170 * div(heapIs $heap_{funcstart\_724.1},
heap_{funcstart\_724,1}.p3, 178).rem + (63 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p3, 178, 200} is false whenever -2 < (0 + literala)
    Proof of rule precondition:
    [117.30.0] - 2 < (-1 + 0)
    \rightarrow [simplify]
    [117.30.2] true
[117.31] (false \vee false \vee false \vee (30268 < $heap_{funcend\_724,1}.p1) \vee (30306 <
\text{Sheap}_{funcend\_724,1.p2}) \lor (30322 < \text{Sheap}_{funcend\_724,1.p3})) \lor \dots
\rightarrow [from term 115.5, $heap<sub>funcend_724,1</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.p1, 177).quot) + (171 * div(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{1.5}(p2) = \rho_{1.5}(p2) - \rho_{1.5}(p2) $\text{heapIs} \div(\text{heapIs})._\text{replace}
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
\$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p2, 176).rem))).\_\mathbf{replace}(p3 \rightarrow ((-63), -20)))
* div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).quot) + (170 \ *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3,
178).rem)))._replace(p1 \rightarrow (30269 + (-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs p_{funcstart\_724,1}),
heap_{funcstart_{724,1},p1, 177,rem})._replace(p2 \rightarrow (30307 + (-35 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p2, \ 176).quot) + (172 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p2,
176).rem)))._replace(p3 \rightarrow (-63 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.p3, 178).quot) + (170 * div(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{724,1}}.p3, 178).rem)
[117.32] (false \vee false \vee false \vee (30268 < $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow
((-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).quot) +
(171 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart\_724,1}, \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724.1},
\theta_{funcstart\_724,1.p2}, 176).quot) + (172 * div(heapIs \theta_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2, 176}.rem)._replace(p3 \rightarrow ((-63 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs}))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p3, 178).rem))._replace(p1 \rightarrow
(30269 + (-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1,
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 $\text{heap}_{funcend_724,1}.\text{p1}) \lor (30306 < \text{heap}_{funcend_724,1}.\text{p2}) \lor (30322 <$

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177).quot) + (171 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow (30307 + (-35 * div(heapIs $heap_{funcstart\_724.1},
\rho_{tuncstart_{724,1},p2,176} + (172 * div(heapIs $heap_{tuncstart_{724,1}})
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem}))._replace(p3 \rightarrow ((-63 * div(heapIs)
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{rem}))).\text{p1}) \lor (30306 <
\text{Sheap}_{funcend\_724,1.p2}) \lor (30322 < \text{Sheap}_{funcend\_724,1.p3})) \lor \dots
\rightarrow [simplify]
[117.37] (false \vee false \vee false \vee (-1 < ((-2 * div(heapIs $heap_{tuncstart\_724,1},
\text{Sheap}_{funcstart\ 724,1}, \text{p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\ 724,1},
\text{Sheap}_{funcstart\_724,1.p1, 177).rem})) \lor (30306 < \text{Sheap}_{funcend\_724,1.p2}) \lor
(30322 < \text{\$heap}_{funcend\_724,1}.p3)) \lor ...
\rightarrow [from term 91.0, literala < ((-2 * div(heapIs $heap_{funcstart_724.1},
heap_{funcstart_{724,1},p1, 177}, quot) + (171 * div(heapIs p_{funcstart_{724,1},p1, 177}), quot)
heap_{funcstart_{724,1}.p1, 177).rem} is false whenever -2 < (0 + literala)
     Proof of rule precondition:
     [117.37.0] - 2 < (-1 + 0)
     \rightarrow [simplify]
     [117.37.2] true
[117.38] (false \vee false \vee false \vee false \vee (30306 < $heap_{funcend\_724,1}.p2) \vee
(30322 < \text{$heap}_{funcend\_724.1}.p3)) \lor \dots
\rightarrow [from term 115.5, \rho_{funcend\_724,1} is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.p1, 177).quot) + (171 * div(\textbf{heapIs} \text{Sheap}_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).rem))).\_replace(p2 \rightarrow ((-35 * div(heapIs))).\_replace(p2 \rightarrow ((-35 * div(heapIs))))._replace(p2 \rightarrow ((-35 * div(heapIs)))))._replace(p2 \rightarrow ((-35 * div(heapIs)))))._replace(p2 \rightarrow ((-35 * div(heapIs)))))._replace(p2 \rightarrow ((-35 * div(heapIs)))))._replace(p2 \rightarrow ((-35 * div(heapIs)))))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
\theta_{funcstart\_724.1}, \theta_{funcstart\_724.1}, \theta_{funcstart\_724.1}, \theta_{funcstart\_724.1}, \theta_{funcstart\_724.1}, \theta_{funcstart\_724.1}
* div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).quot) + (170 \ *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3,
178).rem)))._replace(p1 \rightarrow (30269 + (-2 * div(heapIs $heap_{funcstart\_724.1},
\text{Sheap}_{funcstart\_724,1}.p1, 177).quot) + (171 * div(\mathbf{heapIs} \; \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart_{-724,1},p1, 177).rem})).\_replace(p2 \to (30307 + (-35 * 
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p2, \ 176).quot) + (172 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p2,
(176).\text{rem})._replace(p3 \rightarrow (-63 * \text{div}(\text{heapIs } \$\text{heap}_{funcstart}))._
heap_{funcstart\_724,1}.p3, 178).quot) + (170 * div(heapIs p_{funcstart\_724,1}),
heap_{funcstart_{724,1}.p3, 178.rem}
[117.39] (false \lor false \lor false \lor false \lor (30306 <
\rho_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs \rho_{funcstart\_724,1}),
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p1, 177).rem}))._replace(p2 \rightarrow ((-35 * div(heapIs
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\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs}))
\$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p2, 176).rem))).\_\mathbf{replace}(p3 \rightarrow ((-63 - 200))))
* div(\mathbf{heapIs} \ \$ heap_{funcstart\_724,1}, \ \$ heap_{funcstart\_724,1}.p3, \ 178).quot) + (170 \ *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p3,
178).rem)))._replace(p1 \rightarrow (30269 + (-2 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p1, 177).rem}))._replace(p2 \rightarrow (30307 + (-35 *
div(heapIs \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p2, 176).quot) + (172 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p2,
176).rem)))._replace(p3 \rightarrow ((-63 * div(heapIs $heap_{funcstart_724,1},
heap_{funcstart\_724,1.p3}, 178).quot) + (170 * div(heapIs heap_{funcstart\_724,1},
\text{heap}_{funcstart_724,1.p3}, 178).\text{rem})).p2) \lor (30322 < \text{heap}_{funcend_724,1.p3})) \lor
\rightarrow [simplify]
[117.43] (false \vee false \vee false \vee false \vee (-1 < ((-35 * div(heapIs
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}.p2, 176).quot) + (172 * div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem}))) \lor (30322 <
heap_{funcend_{724,1}.p3}
\rightarrow [from term 94.7, literala < ((-35 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1},p2, 176}, quot) + (172 * div(heapIs p_{funcstart_{724,1},p2}
heap_{funcstart_{724,1}.p2, 176).rem} is false whenever -2 < (0 + literala)
    Proof of rule precondition:
    [117.43.0] - 2 < (-1 + 0)
    \rightarrow [simplify]
    [117.43.2] true
[117.44] (false \vee false \vee false \vee false \vee false \vee (30322 <
heap_{funcend\_724,1.p3}) \lor ...
\rightarrow [from term 115.5, $heap_{funcend\_724,1}$ is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724.1.p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724.1},
\rho_{tuncstart\_724.1.p1, 177).rem}))._replace\rho_{tuncstart\_724.1.p1, 177).rem})
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem)))._replace(p3 \rightarrow ((-63)
* div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).quot) + (170 \ *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724.1}, \ \$heap_{funcstart\_724.1}.p3,
178).rem)))._replace(p1 \rightarrow (30269 + (-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs p_{funcstart\_724,1})
heap_{funcstart\_724,1}.p1, 177).rem))._replace(p2 \to (30307 + (-35 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p2, \ 176).quot) + (172 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p2,
176).rem)))._replace(p3 \rightarrow (-63 * div(heapIs $heap_{funcstart\_724.1},
\text{Sheap}_{funcstart\_724,1}.p3, 178).quot) + (170 * div(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
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heap_{funcstart_{-724,1}.p3, 178, rem}
[117.45] (false \vee false \vee false \vee false \vee false \vee (30322 <
\rho_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1}),
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs p_{funcstart\_724,1}),
\rho_{funcstart_724,1}.p1, 177).rem))._replace(p2 \rightarrow ((-35 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2, 176).rem)))._replace(p3 \theta_{funcstart\_724,1}.p2, 176).rem)))
* div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, 178).quot) + (170 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p3,
178).rem)))._replace(p1 \rightarrow (30269 + (-2 * div(heapIs $heap_{funcstart\_724,1},
\theta_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs \theta_{funcstart\_724,1}),
\rho_{funcstart\_724,1.p1, 177).rem}))._replace(p2 \rightarrow (30307 + (-35 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p2, \ 176).quot) + (172 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p2,
176).rem)))._replace(p3 \rightarrow ((-63 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p3}, 178).\text{quot} + (170 * \text{div}(\text{heapIs} \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{724,1}.p3, 178, rem)}.p3) \vee ...
\rightarrow [simplify]
[117.46] (false \vee false \vee false \vee false \vee false \vee (30322 < ((-63 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs}))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p3, 178).rem)))) \lor ...
\rightarrow [from term 70.19, literala < ((-63 * div(heapIs $heap_{tuncstart\_724.1},
heap_{funcstart\_724,1}.p3, 178).quot + (170 * div(heapIs $heap_{funcstart\_724,1},
\rho_{funcstart\_724,1.p3}, 178).rem)) is false whenever -2 < (-30323 + literala)
    Proof of rule precondition:
    [117.46.0] - 2 < (-30323 + 30322)
    \rightarrow [simplify]
    [117.46.2] true
[117.47] (false \vee false \vee false \vee false \vee false \vee false) \vee ...
\rightarrow [simplify]
[117.48] false \vee ...
[Remove 'false' term 117.48 and fetch new term from containing clause]
[118.0] (\text{$heap}_{724,1;752,8} == \text{$heap}_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}. p1, \ 177). \operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2, 176}.rem)._replace(p3 \rightarrow ((-63 * div(heapIs
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).quot) + (170 * div(heapIs)
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p3, 178).rem)))._replace(p1 \theta_{funcstart\_724,1}
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\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}. p1, \ 177). \operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1, \ 177).rem)))) \lor
(\text{\$heap}_{724,1;753,8} == \text{\$heap}_{724,1;752,8}.\_\mathbf{replace}(p2 \to \text{\$heap}_{724,1;752,8}.p2)) \lor (-1)
< $heap<sub>724,1;752,8</sub>.p2)
[Remove 'false' term 117.48 and fetch new term from containing clause]
[119.0] (0 < ((-2 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1,
177).quot) + (171 * div(heapIs heapIs = f_{uncstart_{-724,1}}, heap_{funcstart_{-724,1}}.p1,
(177).rem))) \lor (\$heap_{724,1:753.8} == \$heap_{724,1:752.8}._replace(p2 \rightarrow
heap_{724,1;752,8}.p2) \lor (-1 < heap_{724,1;752,8}.p2)
[Copy term 1.69]
[120.0] ((0 == $heap<sub>724.1:753.8</sub>.p3) \vee (-1 < -$heap<sub>724.1:753.8</sub>.p1) \vee (-1 <
-\$heap_{724,1:753,8}.p2) \lor (30268 < \$heap_{724,1:753,8}.p1) \lor (30306 < \$heap_{724,1:753,8}.p2)
\text{Sheap}_{724,1;753,8}.\text{p2}) \lor (30322 < \text{Sheap}_{724,1;753,8}.\text{p3})) \lor (\text{Sheap}_{724,1;753,8} = =
\text{Sheap}_{724,1;752,8}.\text{-replace}(p2 \to \text{Sheap}_{724,1;752,8}.p2)) \lor (-1 < \text{Sheap}_{724,1;752,8}.p2)
\rightarrow [from term 81.0, $heap_{724,1;753,8}$ is equal to $heap_{724,1;752,8}._replace(p2 \rightarrow
30307 + \$heap_{724,1:752,8}.p2)
[120.1] ((0 == \text{heap}_{724,1;752,8}._replace(p2 \rightarrow (30307 +
\text{sheap}_{724,1;752,8}.\text{p2}).\text{p3}) \lor (-1 < -\text{sheap}_{724,1;753,8}.\text{p1}) \lor (-1 <
-\$heap_{724,1;753,8}.p2) \lor (30268 < \$heap_{724,1;753,8}.p1) \lor (30306 < \$heap_{724,1;753,8}.p2)
\text{Sheap}_{724,1;753,8}.\text{p2}) \lor (30322 < \text{Sheap}_{724,1;753,8}.\text{p3})) \lor \dots
\rightarrow [simplify]
[120.2] ((0 == $heap<sub>724.1:752.8</sub>.p3) \vee (-1 < -$heap<sub>724.1:753.8</sub>.p1) \vee (-1 <
-\$heap_{724,1:753,8}.p2) \lor (30268 < \$heap_{724,1:753,8}.p1) \lor (30306 < \$heap_{724,1:753,8}.p2)
\text{heap}_{724,1:753,8}.\text{p2}) \lor (30322 < \text{heap}_{724,1:753,8}.\text{p3})) \lor \dots
\rightarrow [from term 81.0, $heap<sub>724,1;753,8</sub> is equal to $heap<sub>724,1;752,8</sub>._replace(p2 \rightarrow
30307 + \text{$heap}_{724,1;752,8}.p2)
[120.3] ((0 == $heap<sub>724,1;752,8</sub>.p3) \vee (-1 < -$heap<sub>724,1;752,8</sub>._replace(p2 \rightarrow
(30307 + \text{$heap}_{724,1:752.8}, \text{p2})).\text{p1}) \lor (-1 < -\text{$heap}_{724,1:753.8}, \text{p2}) \lor (30268 <
\text{Sheap}_{724,1;753,8}.\text{p1}) \lor (30306 < \text{Sheap}_{724,1;753,8}.\text{p2}) \lor (30322 <
heap_{724,1;753,8}.p3) \lor ...
\rightarrow [simplify]
[120.4] ((0 == $heap<sub>724,1;752,8</sub>.p3) \vee (-1 < -$heap<sub>724,1;752,8</sub>.p1) \vee (-1 <
-\$heap_{724,1:753,8}.p2) \lor (30268 < \$heap_{724,1:753,8}.p1) \lor (30306 < \$heap_{724,1:753,8}.p2)
\text{heap}_{724,1:753,8},\text{p2}) \vee (30322 < \text{heap}_{724,1:753,8},\text{p3})) \vee \dots
\rightarrow [from term 81.0, $heap<sub>724,1;753,8</sub> is equal to $heap<sub>724,1;752,8</sub>._replace(p2 \rightarrow
30307 + \$heap_{724,1;752,8}.p2)
[120.5] ((0 == $heap<sub>724,1;752,8</sub>.p3) \vee (-1 < -$heap<sub>724,1;752,8</sub>.p1) \vee (-1 <
-\$heap_{724,1;752,8}.replace(p2 \rightarrow (30307 + \$heap_{724,1;752,8}.p2)).p2) \lor (30268 <
\text{Sheap}_{724,1:753,8}.\text{p1}) \lor (30306 < \text{Sheap}_{724,1:753,8}.\text{p2}) \lor (30322 < \text{property})
heap_{724,1;753,8}.p3) \lor ...
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\rightarrow [simplify]
[120.10] ((0 == $heap<sub>724,1:752,8</sub>.p3) \vee (-1 < -$heap<sub>724,1:752,8</sub>.p1) \vee (30306 <
-\$heap_{724,1:752,8}.p2) \lor (30268 < \$heap_{724,1:753,8}.p1) \lor (30306 < \$heap_{724,1:753,8}.p2)
\text{heap}_{724,1;753,8}.\text{p2}) \lor (30322 < \text{heap}_{724,1;753,8}.\text{p3})) \lor \dots
\rightarrow [from term 81.0, $heap<sub>724,1;753,8</sub> is equal to $heap<sub>724,1;752,8</sub>._replace(p2 \rightarrow
30307 + \text{\$heap}_{724,1;752,8}.p2)]
[120.11] ((0 == \theta_{724,1;752,8}.p3) \vee (-1 < -\theta_{724,1;752,8}.p1) \vee (30306 <
\text{sheap}_{724,1;752,8}.\text{p2}).\text{p1}) \lor (30306 < \text{sheap}_{724,1;753,8}.\text{p2}) \lor (30322 <
heap_{724,1;753,8}.p3) \lor ...
\rightarrow [simplify]
[120.12] ((0 == \text{heap}_{724,1:752,8}.\text{p3}) \vee (-1 < -\text{heap}_{724,1:752,8}.\text{p1}) \vee (30306 <
-\$heap_{724,1;752,8}.p2) \lor (30268 < \$heap_{724,1;752,8}.p1) \lor (30306 < \$heap_{724,1;752,8}.p2)
\text{heap}_{724,1:753,8}.\text{p2}) \lor (30322 < \text{heap}_{724,1:753,8}.\text{p3})) \lor \dots
\rightarrow [from term 81.0, $heap<sub>724,1;753,8</sub> is equal to $heap<sub>724,1;752,8</sub>._replace(p2 \rightarrow
30307 + \text{$heap}_{724,1;752,8}.p2)
[120.13] ((0 == $heap<sub>724,1:752,8</sub>.p3) \vee (-1 < -$heap<sub>724,1:752,8</sub>.p1) \vee (30306 <
 -\$heap_{724,1;752,8}.p2) \lor (30268 < \$heap_{724,1;752,8}.p1) \lor (30306 < \$heap_{724,1;752,8}.p2)
\$heap_{724,1;752,8}.\textbf{\_replace}(p2 \rightarrow (30307 + \$heap_{724,1;752,8}.p2)).p2) \lor (30322 < 30307 + \$heap_{724,1;752,8}.p2)
heap_{724,1;753,8}.p3) \lor ...
\rightarrow [simplify]
[120.16] \; ((0 == \$heap_{724,1;752,8}.p3) \; \lor \; (-1 < -\$heap_{724,1;752,8}.p1) \; \lor \; (30306 < -\$heap_{724,1;752,8}.p3) \; \lor \; (-1 < -\$heap_{724,1;752,8}.p3) \;
-\text{$heap}_{724,1;752,8}.\text{p2}) \lor (30268 < \text{$heap}_{724,1;752,8}.\text{p1}) \lor (-1 <
\text{Sheap}_{724,1;752,8}.\text{p2}) \lor (30322 < \text{Sheap}_{724,1;753,8}.\text{p3})) \lor \dots
\rightarrow [from term 82.0, literala < $heap_{724,1:752.8}.p2 is false whenever -2 < (0 +
literala)]
             Proof of rule precondition:
             [120.16.0] - 2 < (-1 + 0)
             \rightarrow [simplify]
             [120.16.2] true
[120.17] ((0 == $heap<sub>724,1;752,8</sub>.p3) \vee (-1 < -$heap<sub>724,1;752,8</sub>.p1) \vee (30306 <
-\$heap_{724,1:752,8}.p2) \lor (30268 < \$heap_{724,1:752,8}.p1) \lor false \lor (30322 < false)
heap_{724,1;753,8}.p3) \vee ...
\rightarrow [from term 81.0, $heap<sub>724,1;753,8</sub> is equal to $heap<sub>724,1;752,8</sub>._replace(p2 \rightarrow
30307 + \text{\$heap}_{724,1;752,8}.p2)]
[120.18] ((0 == \$heap_{724,1;752,8}.p3) \lor (-1 < -\$heap_{724,1;752,8}.p1) \lor (30306 < -\$heap_{724,1;752,8}.p3) \lor (-1 < -\$heap_{724,1
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 $-\$heap_{724,1;752,8}.p2) \lor (30268 < \$heap_{724,1;752,8}.p1) \lor false \lor (30322 < \$heap_{724,1;752,8}.replace(p2 \rightarrow (30307 + \$heap_{724,1;752,8}.p2)).p3)) \lor ...$

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\rightarrow [simplify]
[120.20] ((0 == $heap<sub>724.1:752.8</sub>.p3) \vee (-1 < -$heap<sub>724.1:752.8</sub>.p1) \vee (30268 <
\text{heap}_{724,1;752,8}.\text{p1}) \lor (30306 < -\text{heap}_{724,1;752,8}.\text{p2}) \lor (30322 < -\text{heap}_{724,1;752,8}.\text{p2})
heap_{724,1;752,8}.p3) \lor ...
\rightarrow [from term 118.0, $heap<sub>724,1;752,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs \text{Sheap}_{funcstart\_724,1}),
heap_{funcstart\_724,1}.p1, 177).rem))).\_replace(p2 \rightarrow ((-35 * div(heapIs)))._replace(p2 \rightarrow ((-35 * div(heapIs))))._replace(p2 \rightarrow ((-35 * div(heapIs)))))._replace(p2 \rightarrow ((-35 * div(heapIs)))))._replace(p2 \rightarrow ((-35 * div(heapIs)))))._replace(p2 \rightarrow ((-35 * div(heapIs)))))._replace(p2 \rightarrow ((-35 * div(heapIs)))))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
\rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}
 * div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).quot) + (170 \ *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3,
 178).rem)))._replace(p1 \rightarrow (-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
\operatorname{Sheap}_{funcstart\_724,1}.p1, 177).\operatorname{quot} + (171 * \operatorname{div}(\mathbf{heapIs} \operatorname{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p1, 177).rem}
[120.21] ((0 == \text{heap}_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1, 177).quot) + (171 * div(heapIs)
\rho_{tuncstart=724.1}, \rho_{tuncstart=724.1}, \rho_{tuncstart=724.1}, \rho_{tuncstart=724.1}, \rho_{tuncstart=724.1}, \rho_{tuncstart=724.1}
* div(heapIs heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p2, 176).quot) + (172 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p2,
176).rem)))._replace(p3 \rightarrow ((-63 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} + (170 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p3}, 178).rem))._replace(p1 \rightarrow ((-2 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).quot) + (171 * div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).rem))).p3) \lor (-1 <
-\$heap_{724,1:752.8}.p1) \lor (30268 < \$heap_{724,1:752.8}.p1) \lor (30306 < \$heap_{724,1:752.8}.p1)
-\$heap_{724,1;752,8}.p2) \lor (30322 < \$heap_{724,1;752,8}.p3)) \lor ...
\rightarrow [simplify]
[120.23] ((0 == ((-63 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\{\text{heap}_{funcstart\_724,1.p3}, 178\}.\text{rem}\} \forall (-1 < -\{\text{heap}_{724,1:752,8.p1}\}) \lor (30268 < -\{\text{heap}_{724,1:752,8.p1}\}) \lor (30268 < -\{\text{heap}_{724,1:752,8.p1}\})
\text{heap}_{724,1;752,8}.\text{p1}) \lor (30306 < -\text{heap}_{724,1;752,8}.\text{p2}) \lor (30322 <
heap_{724,1;752,8}.p3) \lor ...
\rightarrow [from term 69.3, 0 == ((-63 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} + (170 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{724,1},p3,178}, 178).rem)) is false
[120.24] (false \lor (-1 < -$heap<sub>724.1:752.8</sub>.p1) \lor (30268 < $heap<sub>724.1:752.8</sub>.p1) \lor
(30306 < -\$heap_{724,1;752,8}.p2) \lor (30322 < \$heap_{724,1;752,8}.p3)) \lor \dots
\rightarrow [from term 118.0, $heap_{724,1;752,8}$ is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs *heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs p_{funcstart\_724,1}),
\rho_{funcstart\_724,1}.p1, 177).rem))).\_replace(p2 \rightarrow ((-35 * div(heapIs))).\_replace(p2 \rightarrow ((-35 * div(heapIs))))).\_replace(p2 \rightarrow ((-35 * div(heapIs)))))
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heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
\$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p2, 176).rem))).\_\mathbf{replace}(p3 \rightarrow ((-63
 * div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).quot) + (170 \ *
div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3,
178).rem)))._replace(p1 \rightarrow (-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1}, 177).quot) + (171 * div(heapIs $heap_{funcstart\_724,1}, 17
heap_{funcstart_{-724,1}}.p1, 177).rem)
[120.25] (false \lor (-1 < -$heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs)
\text{Sheap}_{funcstart\_724.1}, \text{Sheap}_{funcstart\_724.1}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs})
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
* div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, p2, 176).quot) + (172 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p2,
176).rem)))._replace(p3 \rightarrow ((-63 * div(heapIs $heap_{tuncstart_724.1},
\text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} + (170 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p3, 178}.rem)._replace(p1 \rightarrow ((-2 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).quot) + (171 * div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).rem))).p1) \lor (30268 <
\text{heap}_{724,1;752,8}.\text{p1}) \lor (30306 < -\text{heap}_{724,1;752,8}.\text{p2}) \lor (30322 < -\text{heap}_{724,1;752,8}.\text{p2})
heap_{724,1;752,8}.p3) \lor ...
\rightarrow [simplify]
[120.29] (false \vee (-1 < ((2 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (-171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\{\text{heap}_{funcstart\_724,1}.\text{p1}, 177\}.\text{rem}\}
-\$heap_{724,1;752,8}.p2) \lor (30322 < \$heap_{724,1;752,8}.p3)) \lor ...
\rightarrow [from term 119.0, literala < ((-171 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.p1, 177).rem) + (2 * div(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177).quot) is false whenever -2 < (0 + literala)
        Proof of rule precondition:
        [120.29.0] - 2 < (-1 + 0)
        \rightarrow [simplify]
        [120.29.2] true
[120.30] (false \vee false \vee (30268 < $heap<sub>724.1:752.8</sub>.p1) \vee (30306 <
-\$heap_{724,1;752,8}.p2) \lor (30322 < \$heap_{724,1;752,8}.p3)) \lor ...
\rightarrow [from term 118.0, $heap<sub>724,1;752,8</sub> is equal to
heap_{funcstart\_724,1}.replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1},p1, 177}, quot) + (171 * div(heapIs p_{funcstart_{724,1},p1, 177}).
heap_{funcstart\_724,1}.p1, 177).rem))).\_replace(p2 \rightarrow ((-35 * div(heapIs))).\_replace(p2 \rightarrow ((-35 * div(heapIs)))))._replace(p2 \rightarrow ((-35 * div(heapIs)))))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}. p2, p2, p2, p3, p2, p3, p4, 
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.
 * div(heapIs heap_{funcstart\_724.1}, heap_{funcstart\_724.1}, p_{funcstart\_724.1}), quot) + (170 *
div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3,
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178).rem)))._replace(p1 \rightarrow (-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1}, 177).quot) + (171 * div(heapIs $heap_{funcstart\_724,1}, 17
heap_{funcstart_{-724,1}}.p1, 177).rem)
[120.31] (false \lor false \lor (30268 < $heap_funcstart_724,1._replace(p1 \to ((-2 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724.1}, \ \$heap_{funcstart\_724.1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724.1.p2}, 176).rem))._replace(p3 \rightarrow ((-63 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs}))
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p3, 178).rem))).\_replace(p1 \rightarrow ((-2 * funcstart\_724,1)))._replace(p1 \rightarrow ((-2 * funcstart\_724,1))))._replace(p1 \rightarrow ((-2 * funcstart\_724,1))))
div(\mathbf{heapIs} \ \$heap_{funcstart\_724.1}, \ \$heap_{funcstart\_724.1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724.1}, \ \$ \operatorname{heap}_{funcstart\_724.1}, p1, 177).\operatorname{rem}))).p1) \lor
(30306 < -\$heap_{724,1;752,8}.p2) \lor (30322 < \$heap_{724,1;752,8}.p3)) \lor \dots
\rightarrow [simplify]
[120.32] (false \vee false \vee (30268 < ((-2 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724.1.p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724.1},
\text{Sheap}_{funcstart=724,1}.\text{p1}, 177).\text{rem})) \lor (30306 < -\text{Sheap}_{724,1:752.8}.\text{p2}) \lor (30322)
< $heap<sub>724,1;752,8</sub>.p3)) \lor ...
\rightarrow [from term 62.17, literala < ((-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1},p1, 177}, quot) + (171 * div(heapIs p_{funcstart_{-724,1},p1, 177}).
heap_{funcstart_724,1}.p1, 177).rem is false whenever -2 < (-30269 + literala)
       Proof of rule precondition:
       [120.32.0] - 2 < (-30269 + 30268)
       \rightarrow [simplify]
       [120.32.2] true
[120.33] (false \vee false \vee false \vee (30306 < -$heap<sub>724,1;752,8</sub>.p2) \vee (30322 <
heap_{724.1:752.8}.p3) \lor ...
\rightarrow [from term 118.0, $heap<sub>724,1:752,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p1, 177}.rem))._replace\rho_{funcstart\_724,1.p1, 177}.rem))._replace
heap_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem))).replace(p3 \rightarrow ((-63)
 * div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, 178).quot) + (170 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3,
178).rem)))._replace(p1 \rightarrow (-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177).rem)
[120.34] (false \vee false \vee false \vee (30306 < -$heap<sub>funcstart_724,1</sub>._replace(p1
\rightarrow ((-2 * \text{div}(\mathbf{heapIs} \$ \text{heap}_{funcstart\_724,1}, \$ \text{heap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}) +
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(171 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart\_724,1}, \text{\$heap}_{funcstart\_724,1}.\text{p1},
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem}))._replace(p3 \rightarrow ((-63 * div(heapIs
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).quot) + (170 * div(heapIs
\rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, \ 177).\operatorname{rem}))).\operatorname{p2}) \lor
(30322 < \text{$heap}_{724,1:752,8}.p3)) \lor \dots
\rightarrow [simplify]
[120.40] (false \vee false \vee false \vee (30306 < ((35 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).quot) + (-172 * div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem))) \lor (30322 <
heap_{724,1;752,8}.p_{3}) \vee ...
\rightarrow [from term 64.12, literala < ((-172 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.p2, 176).rem) + (35 * div(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart-724,1}.p2, 176).quot) is false whenever -2 < (-30307 + literala)
    Proof of rule precondition:
    [120.40.0] - 2 < (-30307 + 30306)
    \rightarrow [simplify]
    [120.40.2] true
[120.41] (false \vee false \vee false \vee false \vee (30322 < \text{\$heap}_{724 \ 1.752 \ 8.p3})) <math>\vee \dots
\rightarrow [from term 118.0, $heap<sub>724,1:752,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).rem))).\_replace(p2 \rightarrow ((-35 * div(heapIs))).\_replace(p2 \rightarrow ((-35 * div(heapIs)))))._replace(p2 \rightarrow ((-35 * div(heapIs)))))
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p_{funcstart_{724,1}}, p_{funcstart_{724,1}}, p_{funcstart_{724,1}}, p_{funcstart_{724,1}}
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem)))._replace(p3 \rightarrow ((-63)
* div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).quot) + (170 \ *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3,
178).rem)))._replace(p1 \rightarrow (-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724.1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177).rem)
[120.42] (false \lor false \lor false \lor false \lor (30322 <
\rho_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1}),
\text{Sheap}_{funcstart\_724,1.p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{uncstart_{-724,1},p1,177,rem})._replace(p2 \rightarrow ((-35 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem))).\_replace(p3 \rightarrow ((-63)))
* div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).quot) + (170 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p3,
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178).rem)))._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\mathtt{\$heap}_{funcstart\_724,1}.\mathtt{p1},\,177).\mathtt{rem}))).\mathtt{p3}))\,\vee\,\dots
\rightarrow [simplify]
[120.44] (false \vee false \vee false \vee false \vee (30322 < ((-63 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs}))
\text{Sheap}_{funcstart_{724,1}}, \text{Sheap}_{funcstart_{724,1}}, \text{p3}, 178).rem)))) \lor ...
\rightarrow [from term 70.19, literala < ((-63 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p3, 178).quot) + (170 * div(heapIs p_{funcstart\_724,1}),
heap_{funcstart\_724,1}.p3, 178).rem) is false whenever -2 < (-30323 + literala)
    Proof of rule precondition:
    [120.44.0] - 2 < (-30323 + 30322)
    \rightarrow [simplify]
    [120.44.2] true
[120.45] (false \lor false \lor false \lor false \lor false) \lor ...
\rightarrow [simplify]
[120.46] false \vee ...
[Remove 'false' term 120.46 and fetch new term from containing clause]
[123.0] $\text{heap}_{724,1;753,8} == \text{$heap}_{724,1;752,8}._\text{$replace}(p2 \to \text{$heap}_{724,1;752,8}.p2)
[Take goal term]
[1.69] (-1 < -\$heap_{724,1;753,8}.p1) \lor (-1 < -\$heap_{724,1;753,8}.p2) \lor (0 ==
\text{$heap}_{724,1;753,8}.p3) \lor (30268 < \text{$heap}_{724,1;753,8}.p1) \lor (30306 < \text{$heap}_{724,1;753,8}.p3) \lor (30306 < \text{$heap}_{724,1;753,8}.p3)
\text{$heap}_{724,1;753,8}.\text{p2}) \lor (30322 < \text{$heap}_{724,1;753,8}.\text{p3})
\rightarrow [from term 123.0, $heap<sub>724,1;753,8</sub> is equal to $heap<sub>724,1;752,8</sub>._replace(p2 \rightarrow
heap_{724.1:752.8}.p2)
[1.70] (0 == $heap<sub>724,1:752,8</sub>._replace(p2 \rightarrow $heap<sub>724,1:752,8</sub>.p2).p3) \lor (-1 <
-\$heap_{724,1:753,8}.p1) \lor (-1 < -\$heap_{724,1:753,8}.p2) \lor (30268 < -\$heap_{724,1:753,8}.p2)
\text{heap}_{724,1:753,8}.\text{p1}) \lor (30306 < \text{heap}_{724,1:753,8}.\text{p2}) \lor (30322 <
$heap<sub>724,1;753,8</sub>.p3)
\rightarrow [simplify]
[1.71] (0 == \text{$heap}_{724,1;752,8}.p3) \vee (-1 < -\text{$heap}_{724,1;753,8}.p1) \vee (-1 <
-\$heap_{724,1;753,8}.p2) \lor (30268 < \$heap_{724,1;753,8}.p1) \lor (30306 < \$heap_{724,1;753,8}.p2)
\$heap_{724,1;753,8}.p2) \lor (30322 < \$heap_{724,1;753,8}.p3)
\rightarrow [from term 123.0, $heap<sub>724,1:753,8</sub> is equal to $heap<sub>724,1:752,8</sub>._replace(p2 \rightarrow
heap_{724,1;752,8}.p2)
[1.72] (0 == \text{\$heap}_{724,1;752,8}.p3) \lor (-1 < -\text{\$heap}_{724,1;752,8}.\_\textbf{replace}(p2 \rightarrow
\text{heap}_{724,1:752,8}.\text{p2}.\text{p1}) \lor (-1 < -\text{heap}_{724,1:753,8}.\text{p2}) \lor (30268 < -\text{heap}_{724,1:753,8}.\text{p2})
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\text{Sheap}_{724,1:753,8}.\text{p1}) \lor (30306 < \text{Sheap}_{724,1:753,8}.\text{p2}) \lor (30322 <
$heap<sub>724,1;753,8</sub>.p3)
\rightarrow [simplify]
[1.73] (0 == $heap<sub>724,1;752,8</sub>.p3) \vee (-1 < -$heap<sub>724,1;752,8</sub>.p1) \vee (-1 <
-\$heap_{724,1;753,8}.p2) \lor (30268 < \$heap_{724,1;753,8}.p1) \lor (30306 < \$heap_{724,1;753,8}.p2)
heap_{724,1;753,8}.p2) \lor (30322 < heap_{724,1;753,8}.p3)
\rightarrow [from term 123.0, $heap<sub>724,1;753,8</sub> is equal to $heap<sub>724,1;752,8</sub>._replace(p2 \rightarrow
heap_{724,1;752,8}.p2)
[1.74] (0 == $heap<sub>724.1:752.8</sub>.p3) \vee (-1 < -$heap<sub>724.1:752.8</sub>.p1) \vee (-1 <
-\$heap_{724,1:752.8}._replace(p2 \rightarrow \$heap_{724,1:752.8}.p2).p2) \lor (30268 <
\text{Sheap}_{724,1:753,8}.\text{p1}) \lor (30306 < \text{Sheap}_{724,1:753,8}.\text{p2}) \lor (30322 <
$heap<sub>724.1:753.8</sub>.p3)
\rightarrow [simplify]
[1.75] (0 == $heap<sub>724.1:752.8</sub>.p3) \vee (-1 < -$heap<sub>724.1:752.8</sub>.p1) \vee (-1 <
-\$heap_{724,1;752,8}.p2) \lor (30268 < \$heap_{724,1;753,8}.p1) \lor (30306 < \$heap_{724,1;753,8}.p2)
\text{$heap}_{724,1;753,8}.p2) \lor (30322 < \text{$heap}_{724,1;753,8}.p3)
[Remove 'false' term 120.46 and fetch new term from containing clause]
[124.0] -1 < \text{$heap}_{724,1;752,8}.p2
[Copy term 123.0]
[126.0] ($heap<sub>724,1;753,8</sub> == $heap<sub>724,1;752,8</sub>._replace(p2 \rightarrow
\text{Sheap}_{724,1;752,8}.\text{p2})) \vee (\text{Sheap}_{724,1;752,8} == \text{Sheap}_{funcstart\_724,1}.\_\mathbf{replace}(\text{p1} \rightarrow
((-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).quot) +
(171 * div(\mathbf{heapIs} \$ heap_{funcstart\_724,1}, \$ heap_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724.1},
\text{Sheap}_{funcstart_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart_724,1},
heap_{funcstart\_724,1.p2, 176}.rem)._replace(p3 \rightarrow ((-63 * div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs}))
\text{Sheap}_{funcstart\_724.1}, \text{Sheap}_{funcstart\_724.1.p3}, 178).rem))..replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).rem)))) \lor (0 <
((-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).quot) +
(171 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem)))
\rightarrow [from term 90.0, $heap<sub>724.1:752.8</sub> is equal to $heap<sub>funcstart_724.1</sub>._replace(p1)
\rightarrow ((-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).quot) +
(171 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2},\ 176).\text{quot}) + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724.1.p2, 176}.rem))._replace\rho_{funcstart\_724.1.p2, 176}.rem))._replace
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).quot) + (170 * div(heapIs)
\theta_{funcstart\_724.1}, \theta_{funcstart\_724.1}, \theta_{funcstart\_724.1}, \theta_{funcstart\_724.1}, \theta_{funcstart\_724.1}
+ (-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).quot) +
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(171 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem))]
[126.2] (heap_{724,1;753,8} == heap_{funcstart\_724,1}. replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{tuncstart_724.1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2, 176).rem}))._replace(p3 \rightarrow ((-63 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p3, 178).quot) + (170 * div(heapIs)
\$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).rem))).\_\textbf{replace}(p1 \rightarrow
(30269 + (-2*div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1,
177).quot) + (171 * div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, p1,
177).rem)))._replace(p2 \rightarrow $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724.1}, \ \$heap_{funcstart\_724.1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{rem}))._replace(p3 \rightarrow ((-63 * div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p3, 178).quot) + (170 * div(heapIs)
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p3, 178).rem))).\_replace(p1 \rightarrow
(30269 + (-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1,
177).quot) + (171 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart\_724,1}, \text{\$heap}_{funcstart\_724,1}.p1,
(177).rem))).p2)) \lor ...
\rightarrow [simplify]
[126.5] ($heap_{724,1;753,8} == $heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart} \ 724.1, \ \$ \operatorname{heap}_{funcstart} \ 724.1, \ p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2, 176}.rem))._replace(p3 \rightarrow ((-63 * div(heapIs
\text{Sheap}_{funcstart\_724.1}, \text{Sheap}_{funcstart\_724.1}.\text{p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs}))
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p3, 178).rem))._replace(p1 \rightarrow
(30269 + (-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1,
177).quot) + (171 * \text{div}(\text{heapIs } \text{$heap}_{funcstart\_724,1}, \text{$heap}_{funcstart\_724,1}.\text{p1},
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724.1},
\text{Sheap}_{funcstart\_724.1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724.1},
\$ \mathrm{heap}_{funcstart\_724,1}.\mathrm{p2},\,176).\mathrm{rem})))) \,\vee\, \dots
[Copy term 124.0]
[127.0] (-1 < \text{$heap}_{724,1;752,8}.p2) \vee (\text{$heap}_{724,1;752,8} ==
\text{Sheap}_{funcstart\_724.1}._replace(p1 \rightarrow ((-2 * div(heapIs \text{Sheap}_{funcstart\_724.1}),
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1}.p1, 177).rem))).\_replace(p2 \rightarrow ((-35 * div(heapIs)))._replace(p2 \rightarrow ((-35 * div(heapIs))))._replace(p2 \rightarrow ((-35 * div(heapIs))))._replace(p2 \rightarrow ((-35 * div(heapIs)))))._replace(p2 \rightarrow ((-35 * div(heapIs)))))._replace(p2 \rightarrow ((-35 * div(heapIs)))))._replace(p2 \rightarrow ((-35 * div(heapIs)))))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
\text{Sheap}_{funcstart\_724.1}, \text{Sheap}_{funcstart\_724.1}.p2, 176).rem)))._replace(p3 \rightarrow ((-63
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* div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, 178).quot) + (170 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p3,
178).rem)))._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p1, 177}.\text{rem})))) \lor (0 < ((-2 * div(\mathbf{heapIs}))))
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, 177).rem)
\rightarrow [from term 90.0, $heap_{724,1:752,8}$ is equal to $heap_{funcstart\_724,1}._replace(p1
\rightarrow ((-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).quot) +
(171 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
heap_{funcstart_{724,1},p2, 176}, quot) + (172 * div(heapIs p_{funcstart_{724,1},p2}
heap_{funcstart\_724.1}.p2, 176).rem))._replace(p3 \rightarrow ((-63 * div(heapIs)))._
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p3, 178).quot) + (170 * div(heapIs)
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
+ (-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).quot) +
(171 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).rem))]
[127.1] (-1 < \text{heap}_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1, 177).quot) + (171 * div(heapIs)
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p1, 177).rem))).\_replace(p2 \rightarrow ((-35))
* div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, p2, 176).quot) + (172 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p2,
176).rem)))._replace(p3 \rightarrow ((-63 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} + (170 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{uncstart_{-724,1},p3,178,rem})._replace(p1 \rightarrow (30269 + (-2 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs}))
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, 177).rem)).p2) \lor ...
\rightarrow [simplify]
\label{eq:continuous} \mbox{$[127.4]$ (-1 < ((-35 * div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p2, \ )]} }
176).quot) + (172 * div(heapIs heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2,
176).rem))) \vee ...
\rightarrow [from term 65.3, -1 < ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart\_724,1}.p2, 176).rem is true if and only if 0 < ((-35 * div(heapIs)))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}. p2, p2, p3, p4, p2, p3, p4, 
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p2, 176).rem
[127.5] (0 < ((-35 * div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}.p2,
176).quot) + (172 * div(heapIs heapI_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2,
176).rem))) \vee ...
[Copy term 1.69]
[129.0] ((0 == \text{heap}_{724,1;753,8}.\text{p3}) \lor (-1 < -\text{heap}_{724,1;753,8}.\text{p1}) \lor (-1 <
-\$heap_{724,1:753,8}.p2) \lor (30268 < \$heap_{724,1:753,8}.p1) \lor (30306 < \$heap_{724,1:753,8}.p2)
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\text{Sheap}_{724,1;753,8}.\text{p2}) \lor (30322 < \text{Sheap}_{724,1;753,8}.\text{p3})) \lor (\text{Sheap}_{724,1;752,8} = =
\text{Sheap}_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs \text{Sheap}_{funcstart\_724,1}),
\theta_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs \theta_{funcstart\_724,1})
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}))._replace(p2 \rightarrow ((-35 * div(heapIs)
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1},p2}, \theta_{funcstart_{724,1},p2}, \theta_{funcstart_{724,1}}
\$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p2, 176).rem))).\_\mathbf{replace}(p3 \rightarrow ((-63 - 200))))
* div(heapIs heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 178).quot) + (170 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p3,
178).rem)))._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart_724,1},
\text{Sheap}_{funcstart\_724,1.p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\theta_{1} = \theta_{1} + \theta_{2} = \theta_{2} = \theta_{1} + \theta_{2
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs})
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1},p1, 177}.rem)
\rightarrow [from term 126.5, $heap<sub>724.1:753.8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1},p1, 177}, quot) + (171 * div(heapIs heap_{funcstart_{724,1},p1, 177})
heap_{funcstart\_724,1}.p1, 177).rem))._replace(p2 \rightarrow ((-35 * div(heapIs)))._
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
\$heap_{funcstart\_724,1},\,\$heap_{funcstart\_724,1}.p2,\,176).rem))).\_\mathbf{replace}(p3\rightarrow((\text{-}63\text{-}176).rem})))
 * div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).quot) + (170 \ *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3,
178).rem)))._replace(p1 \rightarrow (30269 + (-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{-724,1},p1, 177}, quot) + (171 * div(heapIs heap_{funcstart_{-724,1}})
heap_{funcstart\_724.1}.p1, 177).rem)._replace(p2 \rightarrow (-35 * div(heapIs)))._replace
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p_{funcstart_{724,1}}, p_{funcstart_{724,1}}, p_{funcstart_{724,1}}
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p2, 176).rem)
[129.1] ((0 == \text{heap}_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
* div(\mathbf{heapIs} \ \$ heap_{funcstart\_724,1}, \ \$ heap_{funcstart\_724,1}.p2, \ 176).quot) + (172 \ *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p2,
176).rem)))._replace(p3 \rightarrow ((-63 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p3}, 178).\text{quot} + (170 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{rem}))._replace(p1 \rightarrow (30269 + (-2 * div(heapIs)
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
* div(\mathbf{heapIs} \ \text{$heap}_{funcstart\_724,1}, \ \text{$heap}_{funcstart\_724,1}.p2, \ 176).quot) + (172 \ \text{*}
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p2}, \ 176).\operatorname{rem}))).\operatorname{p3}) \ \lor \ (\text{-}1
<-\$heap_{724,1;753,8}.p1) \lor (-1 < -\$heap_{724,1;753,8}.p2) \lor (30268 < -\$heap_{724,1;753,8}.p2)
\text{heap}_{724,1:753.8}.\text{p1}) \lor (30306 < \text{heap}_{724,1:753.8}.\text{p2}) \lor (30322 <
heap_{724.1:753.8}.p3) \lor ...
\rightarrow [simplify]
[129.4] ((0 == ((-63 * div(heapIs $heap_{tuncstart\_724.1}, $heap_{tuncstart\_724.1}.p3,
178).quot) + (170 * div(heapIs heapIs = f_{uncstart_{-724,1}}, heap_{funcstart_{-724,1}}.p3,
```

```
(30268 < \text{heap}_{724,1:753,8}.\text{p1}) \lor (30306 < \text{heap}_{724,1:753,8}.\text{p2}) \lor (30322 < \text{p2})
heap_{724,1;753,8}.p3) \lor ...
\rightarrow [from term 69.3, 0 == ((-63 * div(heapIs $heap_{funcstart_724.1},
\text{Sheap}_{funcstart\_724.1.p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724.1},
heap_{funcstart\_724,1}.p3,\ 178).rem)) is false]
[129.5] (false \lor (-1 < -$heap<sub>724,1:753,8</sub>.p1) \lor (-1 < -$heap<sub>724,1:753,8</sub>.p2) \lor
(30268 < \text{$heap}_{724,1:753.8}.\text{p1}) \lor (30306 < \text{$heap}_{724,1:753.8}.\text{p2}) \lor (30322 < \text{$heap}_{724,1:753.8}.\text{p2}) \lor (30322 < \text{$heap}_{724,1:753.8}.\text{p2})
heap_{724,1:753,8}.p_{3}) \lor ...
\rightarrow [from term 126.5, $heap_{724,1;753,8}$ is equal to
\text{Sheap}_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1},
\rho_{funcstart\_724.1}.p1, 177).rem))).\_replace(p2 \rightarrow ((-35 * div(heapIs))).\_replace(p2 \rightarrow ((-35 * div(heapIs))))._replace(p2 \rightarrow ((-35 * div(heapIs))))._replace(p2 \rightarrow ((-35 * div(heapIs)))))._replace(p2 \rightarrow ((-35 * div(heapIs)))))._replace(p2 \rightarrow ((-35 * div(heapIs)))))._replace(p2 \rightarrow ((-35 * div(heapIs)))))
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p_{funcstart_{724,1}}, p_{funcstart_{724,1}}, p_{funcstart_{724,1}}
\text{Sheap}_{funcstart\_724.1}, \text{Sheap}_{funcstart\_724.1}.p2, 176).rem))).\_replace(p3 \rightarrow ((-63)))
 * div(\mathbf{heapIs}\ \$heap_{funcstart\_724,1},\ \$heap_{funcstart\_724,1}.p3,\ 178).quot) + (170\ *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3,
 178).rem)))._replace(p1 \rightarrow (30269 + (-2 * div(heapIs $heap_{funcstart\_724.1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1}, 177).quot) + (171 * div(heapIs $heap_{funcstart\_724,1}, 17
heap_{funcstart\_724,1}.p1, 177).rem))._replace(p2 \rightarrow (-35 * div(heapIs)))._
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}.p2, 176).rem))]
[129.6] (false \vee (-1 < -$heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow ((-2 * div(heapIs
heap_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}, p_{funcstart\_724,1}
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
* div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, 176).quot) + (172 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p2,
176).rem)))._replace(p3 \rightarrow ((-63 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} + (170 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{uncstart_{-724.1},p3, 178, rem})._replace(p1 \rightarrow (30269 + (-2 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).quot) + (171 * div(heapIs)
\rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}
* div(\mathbf{heapIs} \ \$ heap_{funcstart\_724,1}, \ \$ heap_{funcstart\_724,1}.p2, \ 176).quot) + (172 \ *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p2, \ 176).rem))).p1) \lor (-1)
<-$heap<sub>724,1:753,8</sub>.p2) \lor (30268 <$heap<sub>724,1:753,8</sub>.p1) \lor (30306 <
\text{Sheap}_{724,1;753,8}.\text{p2}) \lor (30322 < \text{Sheap}_{724,1;753,8}.\text{p3})) \lor \dots
\rightarrow [simplify]
[129.16] (false \vee (30268 < ((-171 * div(heapIs $heap_{funcstart\_724,1},))
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p1, 177}.\text{quot}))) \lor (-1 < -\text{Sheap}_{724,1:753.8.p2}) \lor (30268 < -\text{Sheap}_{724,1:753.8.p2}) \lor (30268 < -\text{Sheap}_{724,1:753.8.p2})
\text{heap}_{724,1:753,8}.\text{p1}) \lor (30306 < \text{heap}_{724,1:753,8}.\text{p2}) \lor (30322 <
heap_{724,1;753,8}.p3) \vee ...
\rightarrow [from term 60.11, literala < ((-171 * div(heapIs $heap_{funcstart\_724,1},
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178).rem))) \vee (-1 < $-\$heap_{724,1:753.8}.p1$) \vee (-1 < $-\$heap_{724,1:753.8}.p2$) \vee

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\text{Sheap}_{funcstart\_724,1}.p1, 177).rem) + (2 * div(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.p1, 177).quot) is false whenever -2 < (-30269 + \text{literala})
           Proof of rule precondition:
           [129.16.0] - 2 < (-30269 + 30268)
           \rightarrow [simplify]
           [129.16.2] true
[129.17] (false \vee false \vee (-1 < -$heap<sub>724,1:753,8</sub>.p2) \vee (30268 <
\text{Sheap}_{724,1:753.8}.\text{p1}) \lor (30306 < \text{Sheap}_{724,1:753.8}.\text{p2}) \lor (30322 <
heap_{724,1;753,8}.p3) \vee ...
\rightarrow [from term 126.5, $heap<sub>724.1:753.8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1},p1, 177}, quot) + (171 * div(heapIs p_{funcstart_{724,1},p1, 177}), quot)
 \rho_{funcstart\_724.1.p1, 177).rem}))._replace\rho_{funcstart\_724.1.p1, 177).rem})
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p_{funcstart_{724,1}}, p_{funcstart_{724,1}}, p_{funcstart_{724,1}}
heap_{funcstart\_724,1}, peap_{funcstart\_724,1}, peap_{funcstart\_724,1}, peap_{funcstart\_724,1}, peap_{funcstart\_724,1}, peap_{funcstart\_724,1}
 * div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).quot) + (170 \ *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3,
 178).rem)))._replace(p1 \rightarrow (30269 + (-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1},
\theta_{funcstart\_724,1}.p1, 177).rem))._replace(p2 \rightarrow (-35 * div(\mathbf{heapIs})))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p2, 176).rem)
[129.18] (false \vee false \vee (-1 < –$heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart_724,1}.p2, 176).rem))._replace(p3 \rightarrow ((-63 * div(heapIs
\text{Sheap}_{funcstart_{-724.1}}, \text{Sheap}_{funcstart_{-724.1}}.p3, 178).quot) + (170 * div(heapIs)
\rho_{funcstart\_724,1}, \rho_{func
(30269 + (-2 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1,
177).quot) + (171 * div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart_{-724,1},p2, 176,rem})).p2) \lor (30268 < \rho_{724,1;753,8}.p1) \lor (30268 < \rho_{724,1
(30306 < \$ heap_{724,1;753,8}.p2) \lor (30322 < \$ heap_{724,1;753,8}.p3)) \lor \dots
\rightarrow [simplify]
[129.22] (false \vee false \vee (-1 < ((35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart_{724,1},p2, 176}.\text{quot}) + (-172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart_{724,1},p2}))
\text{Sheap}_{funcstart\_724,1.p2}, 176).rem))) \lor (30268 < \text{Sheap}_{724,1:753.8.p1}) \lor (30306 < \text{Sheap}_{724,1:753.8.p1}) \lor (30306 < \text{Sheap}_{724,1:753.8.p1})
\text{heap}_{724,1:753,8}.\text{p2}) \lor (30322 < \text{heap}_{724,1:753,8}.\text{p3})) \lor \dots
```

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\rightarrow [from term 127.5, literala < ((-172 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.p2, 176).rem) + (35 * div(\text{heapIs} \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p2, 176).quot) is false whenever -2 < (0 + literala)
            Proof of rule precondition:
            [129.22.0] - 2 < (-1 + 0)
            \rightarrow [simplify]
            [129.22.2] true
[129.23] (false \vee false \vee false \vee (30268 < $heap<sub>724,1;753,8</sub>.p1) \vee (30306 <
\text{Sheap}_{724,1:753,8}.\text{p2}) \lor (30322 < \text{Sheap}_{724,1:753,8}.\text{p3})) \lor \dots
\rightarrow [from term 126.5, $heap<sub>724,1;753,8</sub> is equal to
$heap_{funcstart\_724,1}.$replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724.1.p1}, 177).quot + (171 * div(heapIs $heap_{funcstart\_724.1}, 177).quot) + (171 * div(heapIs $heap_{funcstart\_724.1}, 17
 \rho_{funcstart\_724.1.p1, 177).rem}))._replace\rho_{funcstart\_724.1.p1, 177).rem})
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p_{funcstart_{724,1}}, p_{funcstart_{724,1}}, p_{funcstart_{724,1}}
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem)))._replace(p3 \rightarrow ((-63)
  * div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).quot) + (170 \ *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3,
 178).rem)))._replace(p1 \rightarrow (30269 + (-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1},
\theta_{funcstart\_724,1}.p1, 177).rem))._replace(p2 \rightarrow (-35 * div(\mathbf{heapIs})))
 heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p2, 176).rem)
[129.24] (false \vee false \vee false \vee (30268 < $heap<sub>funcstart_724,1</sub>._replace(p1 \rightarrow
((-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).quot) +
(171 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart\_724,1}, \text{\$heap}_{funcstart\_724,1}.\text{p1},
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{tuncstart\_724.1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart_724,1}.p2, 176).rem))._replace(p3 \rightarrow ((-63 * div(heapIs
\text{Sheap}_{funcstart_{-724.1}}, \text{Sheap}_{funcstart_{-724.1}}.p3, 178).quot) + (170 * div(heapIs)
\rho_{funcstart\_724,1}, \rho_{func
(30269 + (-2 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p1,
177).quot) + (171 * div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart_{724,1},p2, 176,rem})).p1) \lor (30306 < \rho_{724,1;753,8}.p2) \lor (30306 < \rho_{724,1;
(30322 < \$heap_{724,1;753,8}.p3)) \lor \dots
\rightarrow [simplify]
[129.28] (false \vee false \vee (-1 < ((-2 * div(heapIs $heap_{funcstart\_724,1}, 
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}))) \lor (30306 < \text{Sheap}_{724,1:753,8}.\text{p2}) \lor (30322 < \text{p3})
```

 $heap_{724,1;753,8}.p3) \vee ...$

```
\rightarrow [from term 91.0, literala < ((-2 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs \text{Sheap}_{funcstart\_724,1}),
heap_{funcstart_{724,1}.p1, 177).rem} is false whenever -2 < (0 + literala)
       Proof of rule precondition:
       [129.28.0] - 2 < (-1 + 0)
       \rightarrow [simplify]
       [129.28.2] true
[129.29] (false \times false \times false \times false \times (30306 < $heap_{724.1:753.8}.p2) \times
(30322 < \text{$heap}_{724,1;753,8}.\text{p3})) \lor \dots
\rightarrow [from term 126.5, $heap<sub>724.1:753.8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1},p1, 177}, quot) + (171 * div(heapIs p_{funcstart_{724,1},p1, 177}), quot)
\rho_{tuncstart\_724.1.p1, 177).rem}))._replace(p2 \rightarrow ((-35 * div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p_{funcstart_{724,1}}, p_{funcstart_{724,1}}, p_{funcstart_{724,1}}
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem)))._replace(p3 \rightarrow ((-63)
 * div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).quot) + (170 \ *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3,
178).rem)))._replace(p1 \rightarrow (30269 + (-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1},
\rho_{funcstart\_724,1}.p1, 177).rem))._replace(p2 \rightarrow (-35 * div(heapIs))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p2, 176).rem)
[129.30] (false \vee false \vee false \vee false \vee (30306 <
\text{Sheap}_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs \text{Sheap}_{funcstart\_724,1},
\theta_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1}, 177).quot) + (171 * div(heapIs $heap_{funcstart\_724,1}, 177).
\rho_{funcstart\_724.1.p1, 177).rem}...replace(p2 \rightarrow ((-35 * div(heapIs
\text{Sheap}_{funcstart\_724.1}, \text{Sheap}_{funcstart\_724.1}.p2, 176).quot) + (172 * div(heapIs)
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
* div(heapIs heap_{funcstart_{724.1}}, heap_{funcstart_{724.1}}, 178).quot) + (170 *
\label{eq:div_heap} \text{div}(\textbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p3},
178).rem)))._replace(p1 \rightarrow (30269 + (-2 * div(heapIs $heap_{funcstart\_724,1},
\theta_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs \theta_{funcstart\_724,1})
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}))._replace(p2 \rightarrow ((-35 * div(heapIs)
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{724,1;753,8}.p3) \lor ...
\rightarrow [simplify]
[129.31] (false \vee false \vee false \vee false \vee (30306 < ((-35 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem))) \lor (30322 <
heap_{724,1:753,8}.p_{3}) \lor ...
```

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\rightarrow [from term 66.18, literala < ((-35 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p2, 176).quot + (172 * div(heapIs *heap_{funcstart\_724,1}, 176).quot) + (172 * div(heapIs *heap_funcstart\_724,1}, 176).quo
heap_{funcstart_{724,1}.p2, 176).rem is false whenever -2 < (-30307 + literala)
          Proof of rule precondition:
          [129.31.0] - 2 < (-30307 + 30306)
          \rightarrow [simplify]
          [129.31.2] true
[129.32] (false \vee false \vee false \vee false \vee false \vee (30322 < $heap<sub>724.1:753.8</sub>.p3))
\rightarrow [from term 126.5, $heap<sub>724 1.753 8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart_{724,1},p1, 177}, quot) + (171 * div(heapIs p_{funcstart_{724,1},p1, 177}), quot)
\rho_{tuncstart\_724.1.p1, 177).rem}))._replace(p2 \rightarrow ((-35 * div(heapIs
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p_{funcstart_{724,1}}, p_{funcstart_{724,1}}, p_{funcstart_{724,1}}
heap_{funcstart\_724,1}, peap_{funcstart\_724,1}, peap_{funcstart\_724,1}, peap_{funcstart\_724,1}, peap_{funcstart\_724,1}, peap_{funcstart\_724,1}
 * div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).quot) + (170 \ *
div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3,
 178).rem)))._replace(p1 \rightarrow (30269 + (-2 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1},
\rho_{funcstart\_724,1}.p1, 177).rem))._replace(p2 \rightarrow (-35 * div(heapIs))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, p2, 176).rem)
[129.33] (false \vee false \vee false \vee false \vee false \vee (30322 <
\text{Sheap}_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs \text{Sheap}_{funcstart\_724,1},
\theta_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1}, 177).quot) + (171 * div(heapIs $heap_{funcstart\_724,1}, 177).
\rho_{funcstart\_724.1.p1, 177).rem}...replace(p2 \rightarrow ((-35 * div(heapIs
\text{Sheap}_{funcstart\_724.1}, \text{Sheap}_{funcstart\_724.1}.p2, 176).quot) + (172 * div(heapIs)
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
* div(heapIs heap_{funcstart_{724.1}}, heap_{funcstart_{724.1}}, 178).quot) + (170 *
\label{eq:div_heap} \text{div}(\textbf{heapIs} \ \$ \text{heap}_{funcstart\_724,1}, \ \$ \text{heap}_{funcstart\_724,1}.\text{p3},
178).rem)))._replace(p1 \rightarrow (30269 + (-2 * div(heapIs $heap_{funcstart\_724,1},
\theta_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs \theta_{funcstart\_724,1})
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}))._replace(p2 \rightarrow ((-35 * div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs}))
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2, 176).rem)).p3)) \lor ...
\rightarrow [simplify]
[129.36] (false \lor false \lor false \lor false \lor false \lor (30322 < ((-63 * div(heapIs
\$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3, 178).quot) + (170 * div(\textbf{heapIs}))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p3, 178).rem)))) \lor ...
\rightarrow [from term 70.19, literala < ((-63 * div(heapIs $heap_{funcstart_724.1},
\text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} + (170 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
```

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heap_{funcstart-724,1}.p3, 178).rem) is false whenever -2 < (-30323 + literala)
    Proof of rule precondition:
    [129.36.0] - 2 < (-30323 + 30322)
    \rightarrow [simplify]
    [129.36.2] true
[129.37] (false \vee false \vee false \vee false \vee false \vee false) \vee ...
\rightarrow [simplify]
[129.38] false \vee \dots
[Remove 'false' term 129.38 and fetch new term from containing clause]
[130.0] heap_{724,1;752,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2, 176}.rem))._replace(p3 \rightarrow ((-63 * div(heapIs
\text{Sheap}_{funcstart_{-724.1}}, \text{Sheap}_{funcstart_{-724.1}}.p3, 178).quot) + (170 * div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{rem}))).\_\textbf{replace}(\text{p1} \rightarrow ((-2 * 
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, 177).rem)))
[Remove 'false' term 129.38 and fetch new term from containing clause]
[131.0] 0 < ((-2 * \text{div}(\textbf{heapIs } \$\text{heap}_{funcstart\_724.1}, \$\text{heap}_{funcstart\_724.1}.p1,
177).quot) + (171 * div(heapIs \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
177).rem))
[Take goal term]
[1.75] (0 == $heap<sub>724,1;752,8</sub>.p3) \vee (-1 < -$heap<sub>724,1;752,8</sub>.p1) \vee (-1 <
-\$heap_{724,1;752,8}.p2) \lor (30268 < \$heap_{724,1;753,8}.p1) \lor (30306 < \$heap_{724,1;753,8}.p2)
\text{$heap}_{724,1;753,8}.p2) \lor (30322 < \text{$heap}_{724,1;753,8}.p3)
\rightarrow [from term 124.0, -1 < -$heap<sub>724,1:752,8</sub>.p2 is true if and only if 0 ==
heap_{724,1;752,8}.p2
[1.76] (0 == $heap<sub>724,1;752,8</sub>.p3) \vee (-1 < -$heap<sub>724,1;752,8</sub>.p1) \vee (0 ==
\text{heap}_{724.1:752.8.p2}) \lor (30268 < \text{heap}_{724.1:753.8.p1}) \lor (30306 <
\text{heap}_{724,1:753,8}.\text{p2}) \lor (30322 < \text{heap}_{724,1:753,8}.\text{p3})
\rightarrow [from term 123.0, $heap<sub>724,1:753,8</sub> is equal to $heap<sub>724,1:752,8</sub>._replace(p2 \rightarrow
heap_{724,1;752,8}.p2)
[1.77] (0 == $heap<sub>724,1;752,8</sub>.p3) \vee (-1 < -$heap<sub>724,1;752,8</sub>.p1) \vee (0 ==
\text{$heap}_{724,1;752,8}.\text{p2}) \lor (30268 < \text{$heap}_{724,1;752,8}.\textbf{\_replace}(\text{p2} \rightarrow
\text{sheap}_{724,1;752,8}.\text{p2}).\text{p1}) \lor (30306 < \text{sheap}_{724,1;753,8}.\text{p2}) \lor (30322 <
$heap<sub>724.1:753.8</sub>.p3)
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\rightarrow [simplify]
[1.78] (0 == $heap<sub>724,1:752,8</sub>.p3) \vee (-1 < -$heap<sub>724,1:752,8</sub>.p1) \vee (0 ==
\text{heap}_{724,1:752,8}.\text{p2}) \lor (30268 < \text{heap}_{724,1:752,8}.\text{p1}) \lor (30306 <
\$heap_{724,1;753,8}.p2) \lor (30322 < \$heap_{724,1;753,8}.p3)
\rightarrow [from term 123.0, $heap_{724,1;753,8}$ is equal to $heap_{724,1;752,8}._replace(p2 \rightarrow
heap_{724,1;752,8}.p2)
[1.79] (0 == \text{heap}_{724,1;752,8}.\text{p3}) \vee (-1 < -\text{heap}_{724,1;752,8}.\text{p1}) \vee (0 ==
\text{heap}_{724,1;752,8}.\text{p2}) \lor (30268 < \text{heap}_{724,1;752,8}.\text{p1}) \lor (30306 <
\text{Sheap}_{724,1;752,8}.replace(p2 \rightarrow \text{Sheap}_{724,1;752,8}.p2).p2) \vee (30322 <
$heap<sub>724,1;753,8</sub>.p3)
\rightarrow [simplify]
[1.80] (0 == $heap<sub>724,1:752,8</sub>.p3) \vee (-1 < -$heap<sub>724,1:752,8</sub>.p1) \vee (0 ==
\text{heap}_{724,1;752,8}.\text{p2}) \lor (30268 < \text{heap}_{724,1;752,8}.\text{p1}) \lor (30306 <
\text{heap}_{724,1;752,8}.\text{p2}) \lor (30322 < \text{heap}_{724,1;753,8}.\text{p3})
\rightarrow [from term 123.0, $heap<sub>724,1;753,8</sub> is equal to $heap<sub>724,1;752,8</sub>._replace(p2 \rightarrow
heap_{724,1;752,8}.p2)
[1.81] (0 == $heap<sub>724,1:752,8</sub>.p3) \vee (-1 < -$heap<sub>724,1:752,8</sub>.p1) \vee (0 ==
\text{heap}_{724,1;752,8}.\text{p2}) \lor (30268 < \text{heap}_{724,1;752,8}.\text{p1}) \lor (30306 <
\text{heap}_{724,1;752,8}.\text{p2}) \lor (30322 < \text{heap}_{724,1;752,8}.\textbf{replace}(\text{p2} \rightarrow
heap_{724,1;752,8}.p2).p3
\rightarrow [simplify]
[1.82] (0 == $\text{heap}_{724,1;752,8}.p3) \times (-1 < -\text{$heap}_{724,1;752,8}.p1) \times (0 ==
\text{Sheap}_{724,1;752,8}.\text{p2}) \lor (30268 < \text{Sheap}_{724,1;752,8}.\text{p1}) \lor (30306 <
\text{Sheap}_{724,1;752,8}.\text{p2}) \lor (30322 < \text{Sheap}_{724,1;752,8}.\text{p3})
\rightarrow [from term 130.0, $heap<sub>724.1:752.8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs *heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs p_{funcstart\_724,1}),
\rho_{funcstart_{724.1},p1,177,rem})._replace\rho_{funcstart_{724.1},p1,177,rem})._replace
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem)))._replace(p3 \rightarrow ((-63)
 * div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).quot) + (170 \ *
div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3,
178).rem)))._replace(p1 \rightarrow (-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1}, 177).quot) + (171 * div(heapIs $heap_{funcstart\_724,1}, 17
heap_{funcstart_{-724,1}}.p1, 177).rem)
[1.83] (0 == \text{heap}_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs})
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
* div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}.p2, 176).quot) + (172 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p2,
176).rem)))._replace(p3 \rightarrow ((-63 * div(heapIs $heap_{funcstart\_724,1},
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heap_{funcstart\_724,1.p3}, 178).rem))._replace(p1 \rightarrow ((-2 * div(heapIs)))._replace(p1 \rightarrow ((-2 * div(heapIs))))._replace(p1 \rightarrow ((-2 * div(heapIs)))))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p1, 177).quot) + (171 * div(heapIs
\text{Sheap}_{funcstart_{724,1}}, \text{Sheap}_{funcstart_{724,1},p1, 177}.\text{rem})).p2) \lor (0 ==
\text{heap}_{724,1;752,8}.\text{p3}) \lor (-1 < -\text{heap}_{724,1;752,8}.\text{p1}) \lor (30268 <
\text{heap}_{724,1;752,8}.\text{p1}) \lor (30306 < \text{heap}_{724,1;752,8}.\text{p2}) \lor (30322 <
heap_{724,1;752,8}.p3
\rightarrow [simplify]
[1.86] (0 == ((-35 * div(heapIs $heap_{funcstart\_724,1}, $heap_{funcstart\_724,1}.p2,]
176).quot) + (172 * div(heapIs heapIs = f_{uncstart\_724,1}, heap_{funcstart\_724,1}.p2,
176).rem))) \vee (0 == \text{heap}_{724,1:752.8}.p3) \vee (-1 < -\text{heap}_{724,1:752.8}.p1) \vee
(30268 < \text{heap}_{724,1:752,8}.\text{p1}) \lor (30306 < \text{heap}_{724,1:752,8}.\text{p2}) \lor (30322 < \text{p2})
$heap<sub>724,1;752,8</sub>.p3)
\rightarrow [from term 65.3, 0 == ((-35 * div(heapIs $heap_{funcstart_724.1},
heap_{funcstart\_724,1}.p2, 176).quot + (172 * div(heapIs $heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p2, 176).rem) is false
[1.87] false \vee (0 == \text{$heap}_{724,1;752,8}.p3) \vee (-1 < -\text{$heap}_{724,1;752,8}.p1) \vee
(30268 < \text{$heap}_{724,1;752,8}.\text{p1}) \lor (30306 < \text{$heap}_{724,1:752,8}.\text{p2}) \lor (30322 < \text{$heap}_{724,1:752,8}.\text{p2})
$heap<sub>724.1:752.8</sub>.p3)
\rightarrow [from term 130.0, $heap<sub>724.1:752.8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs *heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1},
\rho_{funcstart\_724,1}.p1, 177).rem))).\_replace(p2 \rightarrow ((-35 * div(heapIs))).\_replace(p2 \rightarrow ((-35 * div(heapIs)))).\_replace(p2 \rightarrow ((-35 * div(heapIs)))).\_replace(p2 \rightarrow ((-35 * div(heapIs)))))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}. p2, p2, p3, p4, p2, p3, p4, 
\rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}
 * div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).quot) + (170 \ *
div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3,
 178).rem)))._replace(p1 \rightarrow (-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1}, 177).quot) + (171 * div(heapIs $heap_{funcstart\_724,1}, 17
heap_{funcstart_{-724,1}}.p1, 177).rem)
[1.88] false \vee (0 == $heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs
\text{Sheap}_{funcstart\_724.1}, \text{Sheap}_{funcstart\_724.1}, \text{p1}, 177).\text{quot}) + (171 * \text{div}(\text{heapIs}))
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}
* div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, p2, 176).quot) + (172 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1}, \$ \operatorname{heap}_{funcstart\_724,1}.p2,
176).rem)))._replace(p3 \rightarrow ((-63 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} + (170 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p3}, 178).rem))._replace(p1 \rightarrow ((-2 * div(heapIs
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1},p1, 177}.quot + (171 * div(heapIs))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p1, 177).rem))).p3) \lor (-1 <
 -\$heap_{724,1:752.8}.p1) \lor (30268 < \$heap_{724,1:752,8}.p1) \lor (30306 < \$heap_{724,1:752,8}.p1)
\text{heap}_{724,1;752,8}.\text{p2}) \lor (30322 < \text{heap}_{724,1;752,8}.\text{p3})
\rightarrow [simplify]
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 $\text{heap}_{funcstart_724,1}.\text{p3}, 178).\text{quot} + (170 * \text{div}(\text{heapIs } \text{heap}_{funcstart_724,1},$

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[1.90] false \vee (0 == ((-63 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} + (170 * \text{div}(\text{heapIs} \text{Sheap}_{funcstart\_724,1},
\{\text{heap}_{funcstart\_724,1.p3}, 178\}.\text{rem}\}
\text{heap}_{724,1;752,8}.\text{p1}) \lor (30306 < \text{heap}_{724,1;752,8}.\text{p2}) \lor (30322 <
heap_{724,1;752,8}.p3
\rightarrow [from term 69.3, 0 == ((-63 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot} + (170 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\$heap_{funcstart\_724,1}.p3,\ 178).rem)) \ is \ false]
[1.91] false \vee false \vee (-1 < -$heap<sub>724,1:752,8</sub>.p1) \vee (30268 <
\text{Sheap}_{724,1:752,8}.\text{p1}) \lor (30306 < \text{Sheap}_{724,1:752,8}.\text{p2}) \lor (30322 <
heap_{724,1;752,8}.p3
\rightarrow [from term 130.0, $heap<sub>724,1;752,8</sub> is equal to
heap_{funcstart\_724.1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724.1},
heap_{funcstart\_724.1.p1}, 177).quot + (171 * div(heapIs $heap_{funcstart\_724.1}, 177).quot) + (171 * div(heapIs $heap_{funcstart\_724.1}, 17
\theta_{uncstart\_724.1.p1, 177).rem}))._replace\theta_{uncstart\_724.1.p1, 177).rem})._replace
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
\$heap_{funcstart\_724,1},\,\$heap_{funcstart\_724,1}.p2,\,176).rem))).\_\mathbf{replace}(p3\rightarrow((-63-2)))
 * div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).quot) + (170 \ *
div(\textbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3,
 178).rem)))._replace(p1 \rightarrow (-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).quot + (171 * div(heapIs $heap_{funcstart\_724,1}, 177).quot) + (171 * div(heapIs $heap_{funcstart\_724,1}, 17
heap_{funcstart_{-724,1}}.p1, 177).rem)
[1.92] false \vee false \vee (-1 < -$heap<sub>funcstart_724.1</sub>._replace(p1 \rightarrow ((-2 *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724.1}, \ \$heap_{funcstart\_724.1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724.1}, p2, 176).quot) + (172 * div(heapIs \text{Sheap}_{funcstart\_724.1},
\theta_{funcstart\_724,1.p2, 176}.rem))._replace(p3 \rightarrow ((-63 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p3}, 178).\text{quot}) + (170 * \text{div}(\text{heapIs}))
\rho_{funcstart=724.1}, \rho_{funcstart=724.1}, \rho_{funcstart=724.1}, \rho_{funcstart=724.1}, \rho_{funcstart=724.1}
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p1, \ 177).quot) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, \ 177).\operatorname{rem}))).\operatorname{p1}) \lor
(30268 < \text{$heap}_{724,1:752.8}.\text{p1}) \lor (30306 < \text{$heap}_{724,1:752.8}.\text{p2}) \lor (30322 < \text{$heap}_{724,1:752.8}.\text{p2}) \lor (30322 < \text{$heap}_{724,1:752.8}.\text{p2})
$heap<sub>724,1;752,8</sub>.p3)
\rightarrow [simplify]
[1.96] false \vee false \vee (-1 < ((2 * div(heapIs $heap_{funcstart\_724.1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (-171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p1, 177}.\text{rem})) \lor (30268 < \text{Sheap}_{724,1;752,8.p1}) \lor (30306 < \text{Sheap}_{724,1;752,8.p1})
\text{$heap}_{724,1;752,8}.p2) \lor (30322 < \text{$heap}_{724,1;752,8}.p3)
\rightarrow [from term 131.0, literala < ((-171 * div(heapIs $heap_{funcstart\_724.1},
\text{Sheap}_{funcstart_{-724,1}}.\text{p1}, 177).\text{rem} + (2 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart_{-724,1}},
heap_{funcstart_{-724,1}}.p1, 177).quot) is false whenever -2 < (0 + literala)
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Proof of rule precondition:
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[1.96.0] - 2 < (-1 + 0)
       \rightarrow [simplify]
       [1.96.2] true
[1.97] false \vee false \vee false \vee (30268 < $heap<sub>724,1;752,8</sub>.p1) \vee (30306 <
\text{$heap}_{724,1;752,8}.p2) \lor (30322 < \text{$heap}_{724,1;752,8}.p3)
\rightarrow [from term 130.0, $heap<sub>724,1;752,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
\operatorname{Sheap}_{funcstart\_724,1}.p1, 177).\operatorname{quot} + (171 * \operatorname{div}(\mathbf{heapIs} \operatorname{Sheap}_{funcstart\_724,1},
heap_{funcstart\_724,1}.p1, 177).rem))).\_replace(p2 \rightarrow ((-35 * div(heapIs))).\_replace(p2 \rightarrow ((-35 * div(heapIs)))))._replace(p2 \rightarrow ((-35 * div(heapIs)))))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem))).\_replace(p3 \rightarrow ((-63)))
 * div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).quot) + (170 \ *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3,
178).rem)))._replace(p1 \rightarrow (-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724.1},
heap_{funcstart_{-724,1},p1, 177}, quot) + (171 * div(heapIs heap_{funcstart_{-724,1},p1, 177})
heap_{funcstart_{724,1}}.p1, 177).rem)
[1.98] false \vee false \vee (30268 < $heap_{funcstart\_724,1}._replace(p1 \rightarrow
((-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p1, 177).quot) +
(171 * \text{div}(\text{heapIs } \text{\$heap}_{funcstart\_724,1}, \text{\$heap}_{funcstart\_724,1}.p1,
177).rem)))._replace(p2 \rightarrow ((-35 * div(heapIs $heap_{funcstart_724,1},
\text{Sheap}_{funcstart\_724,1.p2}, 176).\text{quot} + (172 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p2, 176}.rem)._replace(p3 \rightarrow ((-63 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p3, 178).quot) + (170 * div(heapIs)
\rho_{funcstart\_724,1}, \rho_{funcstart\_724,1}
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p1, \ 177).\operatorname{quot}) + (171 *
\operatorname{div}(\mathbf{heapIs} \ \$ \operatorname{heap}_{funcstart\_724,1}, \ \$ \operatorname{heap}_{funcstart\_724,1}.\operatorname{p1}, \ 177).\operatorname{rem}))).\operatorname{p1}) \lor
(30306 < \text{$heap}_{724,1;752,8}.\text{p2}) \lor (30322 < \text{$heap}_{724,1;752,8}.\text{p3})
\rightarrow [simplify]
[1.99] false \vee false \vee false \vee (30268 < ((-2 * div(heapIs $heap_{funcstart\_724.1},
\text{Sheap}_{funcstart\_724,1.p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{rem}))) \lor (30306 < \text{Sheap}_{724,1:752.8}.\text{p2}) \lor (30322 < \text{p3})
heap_{724,1;752,8}.p3
\rightarrow [from term 62.17, literala < ((-2 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p1, 177).rem} is false whenever -2 < (-30269 + literala)
       Proof of rule precondition:
       [1.99.0] - 2 < (-30269 + 30268)
       \rightarrow [simplify]
       [1.99.2] true
```

```
[1.100] false \vee false \vee false \vee false \vee (30306 < $heap<sub>724.1:752.8</sub>.p2) \vee (30322)
< \text{$heap}_{724,1;752,8}.p3)
\rightarrow [from term 130.0, $heap<sub>724,1;752,8</sub> is equal to
heap_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart_{-724,1},p1, 177}.\text{quot}) + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart_{-724,1}})
heap_{funcstart\_724,1}.p1, 177).rem))).\_replace(p2 \rightarrow ((-35 * div(heapIs))))._replace(p2 \rightarrow ((-35 * div(heapIs)))))
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem)))._replace(p3 \rightarrow ((-63)
* div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).quot) + (170 \ *
div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3,
178).rem)))._replace(p1 \rightarrow (-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
heap_{funcstart_{724,1},p1, 177}, quot) + (171 * div(heapIs p_{funcstart_{724,1},p1, 177}), quot)
heap_{funcstart_{-724,1}}.p1, 177).rem)
[1.101] false \lor false \lor false \lor false \lor (30306 <
\text{Sheap}_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1.p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p1, 177}.rem).-replace(p2 \rightarrow ((-35 * div(heapIs
\text{Sheap}_{funcstart\_724.1}, \text{Sheap}_{funcstart\_724.1}.p2, 176).quot) + (172 * div(heapIs)
\theta_{funcstart\_724,1}, \theta_{funcstart\_724,1}.p2, 176).rem)))._replace(p3 \theta_{funcstart\_724,1}.p2, 176).rem)))
* div(heapIs heap_{funcstart_{-724,1}}, heap_{funcstart_{-724,1}}, p3, 178).quot) + (170 *
\operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724.1}, \$ \operatorname{heap}_{funcstart\_724.1}.p3,
178).rem)))._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{tuncstart_724.1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\text{heap}_{funcstart\_724,1.p1, 177}.\text{rem})).p2) \lor (30322 < \text{heap}_{724,1:752.8.p3})
\rightarrow [simplify]
[1.104] false \vee false \vee false \vee false \vee (30306 < ((-35 * div(heapIs
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.\text{p2}, 176).\text{quot}) + (172 * \text{div}(\text{heapIs}))
\text{Sheap}_{funcstart\_724,1}, \text{Sheap}_{funcstart\_724,1}.p2, 176).rem))) \lor (30322 <
heap_{724,1;752,8}.p3
\rightarrow [from term 66.18, literala < ((-35 * div(heapIs $heap_{tuncstart\_724,1},
heap_{funcstart_{724,1},p2, 176}, quot) + (172 * div(heapIs p_{funcstart_{724,1},p2}
heap_{funcstart_{-724,1}.p2, 176}.rem) is false whenever -2 < (-30307 + literala)
     Proof of rule precondition:
     [1.104.0] - 2 < (-30307 + 30306)
     \rightarrow [simplify]
     [1.104.2] true
[1.105] false \vee false \vee false \vee false \vee false \vee (30322 < \text{$heap}_{724.1:752.8}.p3)
\rightarrow [from term 130.0, $heap<sub>724.1:752.8</sub> is equal to
heap_{funcstart\_724.1}._replace(p1 \rightarrow ((-2 * div(heapIs heap_{funcstart\_724.1}),
\text{Sheap}_{funcstart_{-724,1},p1, 177}.\text{quot}) + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart_{-724,1}})
\rho_{funcstart\_724,1}.p1, 177).rem))._replace\rho_{funcstart\_724,1}.p1, 177).rem))._replace
```

```
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).quot) + (172 * div(heapIs)
heap_{funcstart\_724,1}, heap_{funcstart\_724,1}.p2, 176).rem)))._replace(p3 \rightarrow ((-63)
* div(\mathbf{heapIs} \ \$heap_{funcstart\_724,1}, \ \$heap_{funcstart\_724,1}.p3, \ 178).quot) + (170 \ *
div(\mathbf{heapIs} \$heap_{funcstart\_724,1}, \$heap_{funcstart\_724,1}.p3,
178).rem)))._replace(p1 \rightarrow (-2 * div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.p1, 177).quot) + (171 * div(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}}.p1, 177).rem)
[1.106] false \lor false \lor false \lor false \lor false \lor (30322 <
\text{Sheap}_{funcstart\_724,1}._replace(p1 \rightarrow ((-2 * div(heapIs \text{Sheap}_{funcstart\_724,1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
\rho_{funcstart\_724,1.p1, 177).rem}))._replace(p2 \rightarrow ((-35 * div(heapIs
\text{Sheap}_{funcstart_{-724,1}}, \text{Sheap}_{funcstart_{-724,1}}.p2, 176).quot) + (172 * div(heapIs)
\text{Sheap}_{funcstart\_724.1}, \text{Sheap}_{funcstart\_724.1}.p2, 176).rem))).\_replace(p3 \rightarrow ((-63)))
* div(heapIs heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 178).quot) + (170 *
\operatorname{div}(\mathbf{heapIs} \ \text{\$heap}_{funcstart\_724,1}, \ \text{\$heap}_{funcstart\_724,1}.p3,
178).rem)))._replace(p1 \rightarrow ((-2 * div(heapIs $heap_{tuncstart\_724.1},
\text{Sheap}_{funcstart\_724,1}.\text{p1}, 177).\text{quot} + (171 * \text{div}(\text{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p1, 177).rem})).p3)
\rightarrow [simplify]
[1.108] false \vee false \vee false \vee false \vee false \vee (30322 < ((-63 * div(heapIs
\theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}, \theta_{funcstart_{724,1}}
heap_{funcstart_{724,1}}, heap_{funcstart_{724,1}}, 178).rem)))
\rightarrow [from term 70.19, literala < ((-63 * div(heapIs $heap_{tuncstart\_724.1},
\text{Sheap}_{funcstart\_724,1}.p3, 178).quot + (170 * div(\textbf{heapIs } \text{Sheap}_{funcstart\_724,1},
heap_{funcstart_{-724,1}.p3, 178}.rem) is false whenever -2 < (-30323 + literala)
    Proof of rule precondition:
    [1.108.0] - 2 < (-30323 + 30322)
    \rightarrow [simplify]
    [1.108.2] true
[1.109] false \lor false \lor false \lor false \lor false
\rightarrow [simplify]
[1.110] false
Proof of verification condition: Precondition of 'operator /' satisfied
Condition generated at: C:\Escher\Customers\prang\prang.c (80,34)
Condition defined at: built in declaration
To prove: !(0.0 ==
asType < double > (static\_cast < real > ($heap_{funcend\_724,1}.M1)))
Given:
```

```
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
heap_{init}.M2 == asType < short int > ((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart\_724,1})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}))\ /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(asType<int>(asType<int>($heap_{tuncstart\_724.1}.p1)) %
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p1) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p1) = =
asType<integer>(div1.rem))
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
```

```
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p2})) \ / \\
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.quot)
(asType < int > (asType < int > (\$heap_{funcstart\_724,1}.p2)) \%
\mathbf{asType} {<} \mathbf{integer} {>} (\mathbf{asType} {<} \mathbf{int} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType < integer > (div2.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a2})) =>
(asType < integer > (\$heap_{funcstart_{-724.1}}.p2) = =
asType<integer>(div2.rem))
(asType<integer>(sheap_{funcstart\_724,1}.a2) \leq
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})) => !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
asType < int > (\$heap_{funcstart\_724,1}.a3))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}))~\%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p3) < 
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a3})) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}) ==
asType<integer>(div3.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a3) \le
asType < integer > (\$heap_{funcstart\_724,1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
heap_{724,1;745,8} == heap_{funcstart\_724,1}.\_replace(p1 \rightarrow asType < short)
int>((asType<int>(asType<short int>(div1.rem)) *
\mathbf{asType} \hspace{-0.1em}<\hspace{-0.1em} \mathbf{int} \hspace{-0.1em}> \hspace{-0.1em} (\$ heap_{funcstart\_724,1}.r1)) - (\mathbf{asType} \hspace{-0.1em}<\hspace{-0.1em} \mathbf{int} \hspace{-0.1em}> \hspace{-0.1em} (\mathbf{asType} \hspace{-0.1em}<\hspace{-0.1em} \mathbf{short})
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
-asType < integer\ const > (\$heap_{724,1;745,8}.M1) <
```

```
asType<integer>($heap<sub>724,1:745,8</sub>.p1)
!(0 == asType < integer > (\$heap_{724,1:745,8}.p1))
asType<integer>($heap<sub>724.1:745.8</sub>.p1) <
asType<integer>($heap<sub>724,1;745,8</sub>.M1)
heap_{724,1:747,8} == heap_{724,1:745,8}.replace(p2 \rightarrow asType<short
\mathbf{int}{>}((\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{short}\ \mathbf{int}{>}(\mathbf{div}2.\mathbf{rem}))\ ^*
\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{724,1;745,8}.\mathbf{r2})) - (\mathbf{asType} < \mathbf{int} > (\mathbf{asType} < \mathbf{short}))
int > (div2.quot)) * asType < int > (\$heap_{724,1:745,8}.b2))))
-asType < integer\ const > (\$heap_{724,1;747,8}.M2) < 
asType<integer>($heap<sub>724.1:747.8</sub>.p2)
!(0 == asType < integer > (\$heap_{724,1;747,8}.p2))
asType<integer>($heap<sub>724.1:747.8</sub>.p2) <
asType<integer>($heap<sub>724,1:747,8</sub>.M2)
heap_{724,1:749,8} == heap_{724,1:747,8}.replace(p3 \rightarrow asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType < int > (\$heap_{724,1:747,8}.r3)) - (asType < int > (asType < short)
\mathbf{int}{>}(\text{div3.quot})) * \mathbf{asType}{<} \mathbf{int}{>} (\$\text{heap}_{724,1;747,8}.\text{b3}))))
-asType<integer const>($heap<sub>724,1;749,8</sub>.M3) <
asType<integer>($heap<sub>724.1:749.8</sub>.p3)
!(0 == asType < integer > (\$heap_{724,1:749,8}.p3))
asType<integer>($heap<sub>724.1:749.8</sub>.p3) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;749,8}.\mathrm{M3})
heap_{724,1:752,8} == heap_{724,1:749,8}.replace(p1 \rightarrow asType<short
int>((asType<int>($heap<sub>724,1:749,8</sub>.M1) *
asType<int>(static_cast<integer>(asType<int>($heap<sub>724,1:749,8</sub>.p1) <
(int)(0)) + asType < int > (\$heap_{724,1:749,8}.p1)))
\$heap_{724,1;753,8} == \$heap_{724,1;752,8}. \textbf{\_replace}(p2 \rightarrow \textbf{asType} {<} \textbf{short}
int>((asType<int>($heap<sub>724,1;752,8</sub>.M2) *
asType<int>(static_cast<integer>(asType<int>($heap_{724.1:752.8}.p2) <
(int)(0) + asType<int>($heap<sub>724.1:752.8</sub>.p2)))
\$heap_{funcend\_724,1} == \$heap_{724,1;753,8}.\_\mathbf{replace}(p3 \rightarrow \mathbf{asType} < \mathbf{short}
int>((asType< int>(\$heap_{724,1;753,8}.M3) *
asType<int>(static_cast<integer>(asType<int>($heap_{724,1:753,8}.p3) <
(int)(0)) + asType < int > ($heap_{724,1;753,8}.p3)))
invariant1(heapIs heap_{funcend\_724,1})
Proof:
[Take goal term]
[1.0]!(0.0 ==
```

```
asType<double>(static_cast<real>($heap_{funcend\_724,1}.M1)))
\rightarrow [const static or extern object]
[1.1]!(0.0 == asType < double > (static\_cast < real > ($heap_{init}.M1)))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[1.2]!(0.0 == asType<double>(static_cast<real>(asType<short
int > ((int)30269))))
\rightarrow [simplify]
[1.9] true
Proof of verification condition: Precondition of 'operator /' satisfied
Condition generated at: C:\Escher\Customers\prang\prang.c (81,34)
Condition defined at: built in declaration
To prove: !(0.0 ==
asType<double>(static_cast<real>($heap_{funcend,724,1}.M2)))
heap_{init}.LIMIT == (int)80
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
heap_{init}.a3 == asType<short int>((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart_{-724,1}})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \$ \operatorname{heap}_{funcstart\_724,1},
```

```
asType < int > (\$heap_{funcstart\_724,1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ / \\
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}))) = =
asType<integer>(div1.quot)
(asType < int > (asType < int > (\$heap_{funcstart\_724,1}.p1)) \%
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a1}))) = =
asType<integer>(div1.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p1) = =
asType<integer>(div1.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathtt{a1}) \leq
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1})) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.quot)
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}))~\%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p2) < 
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a2})) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p2) = =
asType<integer>(div2.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a2) \le
asType < integer > (\$heap_{funcstart\_724,1}.p2)) => !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724.1}.a3))) = =
```

```
asType<integer>(div3.quot)
(asType<integer>(asType<int>($heap_{tuncstart_724,1}.p3)) %
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.rem)
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart_{-724,1}}.a3)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a3}) \leq
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3})) = > !(0 = =
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
\$heap_{724,1;745,8} == \$heap_{funcstart\_724,1}.\_\mathbf{replace}(p1 \to \mathbf{asType} < \mathbf{short}
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724.1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
-{\bf asType}{<} {\bf integer~const}{>} (\${\rm heap}_{724,1;745,8}.{\rm M1}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{p1})
!(0 == asType < integer > (\$heap_{724,1;745,8}.p1))
asType<integer>($heap<sub>724.1:745.8</sub>.p1) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{M1})
heap_{724,1:747,8} == heap_{724,1:745,8}.replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
\mathbf{asType} < \mathbf{int} > (\$ heap_{724,1:745,8}.r2)) - (\mathbf{asType} < \mathbf{int} > (\mathbf{asType} < \mathbf{short})
int>(div2.quot)) * asType< int>($heap_{724,1;745,8}.b2))))
-asType<integer const>($heap<sub>724.1:747.8</sub>.M2) <
asType<integer>($heap<sub>724.1:747.8</sub>.p2)
!(0 == asType < integer > (\$heap_{724,1:747.8}.p2))
asType<integer>($heap<sub>724.1:747.8</sub>.p2) <
asType<integer>($heap<sub>724.1:747.8</sub>.M2)
heap_{724,1:749,8} == heap_{724,1:747,8}.replace(p3 \rightarrow asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
asType < int > (\$heap_{724,1:747,8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType< int>($heap_{724,1:747.8}.b3))))
-asType<integer const>($heap<sub>724 1.749 8.</sub>M3) <
asType<integer>($heap<sub>724,1:749,8:p3</sub>)
!(0 == asType < integer > (\$heap_{724,1:749.8}.p3))
asType<integer>($heap<sub>724.1:749.8</sub>.p3) <
```

```
asType<integer>($heap<sub>724.1:749.8</sub>.M3)
heap_{724,1:752,8} == heap_{724,1:749,8}._replace(p1 \rightarrow asType<short
int>((asType<int>($heap<sub>724,1:749,8</sub>.M1) *
asType<int>(static_cast<integer>(asType<int>($heap_{724.1:749.8}.p1) <
(int)(0) + asType<int>($heap<sub>724.1:749.8</sub>.p1)))
heap_{724,1;753,8} == heap_{724,1;752,8}.replace(p2 \rightarrow asType<short
int>((asType<int>($heap<sub>724,1:752,8</sub>.M2) *
asType<int>(static_cast<integer>(asType<int>($heap_{724,1:752,8}.p2) <
(int)(0) + asType < int > (\$heap_{724,1:752,8}.p2))
heap_{funcend\_724,1} == heap_{724,1;753,8}.\_replace(p3 \rightarrow asType < short)
int>((asType<int>($heap<sub>724.1:753.8</sub>.M3) *
asType<int>(static_cast<integer>(asType<int>($heap_{724.1:753.8}.p3) <
(int)(0) + asType < int > ($heap_{724.1:753.8}.p3))
invariant
1(heap<br/>Is \theta_{funcend\_724,1}
raux1 == asType<double>(static_cast<real>($heap_{funcend\_724.1}.p1)) /
asType<double>(static_cast<real>($heap_{funcend\_724.1}.M1))
Proof:
[Take goal term]
[1.0]!(0.0 ==
asType < double > (static\_cast < real > (\$heap_{funcend\_724,1}.M2)))
\rightarrow [const static or extern object]
[1.1]!(0.0 == asType < double > (static\_cast < real > ($heap_{init}.M2)))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[1.2] !(0.0 == asType<double>(static_cast<real>(asType<short
int > ((int)30307)))
\rightarrow [simplify]
[1.9] true
Proof of verification condition: Precondition of 'operator /' satisfied
Condition generated at: C:\Escher\Customers\prang\prang.c (82,34)
Condition defined at: built in declaration
To prove: !(0.0 ==
asType < double > (static\_cast < real > ($heap_{funcend\_724,1}.M3)))
Given:
heap_{init}.LIMIT == (int)80
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
```

```
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
heap_{init}.M2 == asType < short int > ((int)30307)
\theta_{init}.r2 == asType<short int>((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs $heap_{tuncstart_724.1})
div1 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1})) \ / \\
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(\mathbf{asType} {<} \mathbf{integer} {>} (\mathbf{asType} {<} \mathbf{int} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) \ \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1})) =>
(asType < integer > (\$heap_{funcstart\_724.1}.p1) = =
asType<integer>(div1.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathtt{a1}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p1)) => !(0 ==
asType < integer > (div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))
```

```
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}))\ /
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.quot)
(asType<int>(asType<int>($heap_{funcstart\_724,1}.p2)) %
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_724,1}.p2) = =
asType<integer>(div2.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a2) \le
asType < integer > (\$heap_{funcstart\_724,1}.p2)) => !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart_{-724.1}},
\mathbf{asType} < \mathbf{int} > (\$ heap_{funcstart\_724,1}.p3),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3})) \ / \\
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a3}))) = =
asType<integer>(div3.quot)
(asType<integer>(asType<int>($heap_{tuncstart\_724.1}.p3)) %
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a3}))) = =
asType<integer>(div3.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a3})) = >
(asType < integer > ($heap_{funcstart\_724,1}.p3) = =
asType<integer>(div3.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a3}) \leq
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3})) => !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
-asType < integer const > (\$heap_{724,1:745.8}.M1) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{p1})
!(0 == asType < integer > (\$heap_{724,1;745,8}.p1))
```

```
asType < integer > (\$heap_{724,1;745,8}.p1) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{M1})
heap_{724,1:747,8} == heap_{724,1:745,8}.replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724.1:745.8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
-asType < integer const > (\$heap_{724,1:747,8}.M2) < 
asType<integer>($heap<sub>724.1:747.8</sub>.p2)
!(0 == asType < integer > (\$heap_{724,1:747,8}.p2))
asType<integer>($heap<sub>724.1:747.8</sub>.p2) <
asType<integer>($heap<sub>724,1:747,8</sub>.M2)
\text{Sheap}_{724,1;749,8} == \text{Sheap}_{724,1;747,8}.\text{replace}(p3 \to asType < short)
int>((asType<int>(asType<short int>(div3.rem)) *
asType < int > (\$heap_{724,1:747,8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap<sub>724.1:747.8</sub>.b3))))
-asType < integer const > (\$heap_{724,1:749.8}.M3) < 
asType<integer>($heap<sub>724,1;749,8</sub>.p3)
!(0 == asType < integer > (\$heap_{724,1:749.8}.p3))
asType<integer>($heap<sub>724.1:749.8</sub>.p3) <
asType<integer>($heap<sub>724,1:749.8</sub>.M3)
\text{sheap}_{724,1;752,8} == \text{sheap}_{724,1;749,8}. \text{replace}(\text{p1} \to \text{asType} < \text{short})
int>((asType<int>($heap<sub>724,1:749,8</sub>.M1) *
asType<int>(static_cast<integer>(asType<int>($heap<sub>724,1:749,8</sub>.p1) <
(int)(0) + asType<int>($heap<sub>724,1:749,8</sub>.p1)))
\text{heap}_{724.1;753.8} == \text{heap}_{724.1;752.8}. \text{replace}(p2 \to asType < short)
int>((asType<int>($heap<sub>724.1:752.8</sub>.M2) *
asType<int>(static_cast<integer>(asType<int>($heap<sub>724.1:752.8</sub>.p2) <
(int)(0)) + asType < int > (\$heap_{724,1;752,8}.p2)))
\theta_{124,1} == \theta_{124,1} == \theta_{124,1:753,8}. replace(p3 \to asType < short
int>((asType< int>(\$heap_{724,1;753,8}.M3) *
asType<int>(static_cast<integer>(asType<int>($heap_{724,1:753,8}.p3) <
(int)(0)) + asType < int > ($heap_{724,1;753,8}.p3)))
invariant
1(heapIs heap_{funcend\_724,1})
raux1 == asType < double > (static\_cast < real > ($heap_{funcend\_724,1}.p1)) /
asType < double > (static\_cast < real > ($heap_{funcend\_724,1}.M1))
asType<double>(static_cast<real>($heap_{funcend\_724.1}.M2))
Proof:
[Take goal term]
```

```
[1.0]!(0.0 ==
asType<double>(static_cast<real>($heap_{funcend\_724,1}.M3)))
\rightarrow [const static or extern object]
[1.1]!(0.0 == asType < double > (static\_cast < real > (\$heap_{init}.M3)))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[1.2]!(0.0 == asType < double > (static\_cast < real > (asType < short))
int > ((int)30323))))
\rightarrow [simplify]
[1.9] true
Proof of verification condition: Assertion valid
Condition generated at: C:\Escher\Customers\prang\prang.c (86,30)
To prove: asType<real>((double)0.0) < ((asType<real>(raux2) +
asType < real > (raux1)) + asType < real > (raux3))
Given:
heap_{init}.LIMIT == (int)80
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta = asType < short int > ((int)2)
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
\theta = asType < short int > ((int)30323)
\theta
heap_{init}.a3 == asType < short int > ((int)178)
heap_{init}.b3 == asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta = as Type < short int > ((int)2)
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart\_724,1})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \ \operatorname{\$heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
```

```
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))
(asType<integer>(asType<int>($heap_{funcstart\_724,1}.p1)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) ==
asType<integer>(div1.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a1) \le
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1})) = > !(0 = =
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2}),
asType < int > (\$heap_{funcstart\_724,1}.a2))
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2})) \ / \\
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heap_{tuncstart}, 724.1.p2)) %
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.rem)
(asType < integer > (\$heap_{funcstart\_724,1}.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p2) = =
asType<integer>(div2.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.a2) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p2)) => !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
asType < int > (\$heap_{funcstart\_724,1}.a3))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
```

```
(asType < int > (asType < int > (\$heap_{funcstart\_724,1}.p3)) \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.rem)
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(asType < integer > (\$heap_{funcstart\_724.1}.p3) = =
asType<integer>(div3.rem))
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a3}) \leq
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3})) => !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
heap_{724,1;745,8} == heap_{funcstart\_724,1}.\_replace(p1 \rightarrow asType < short)
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1.quot})) \ * \ \mathbf{asType}{<} \mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
-asType < integer const > (\$heap_{724.1:745.8}.M1) < 
asType < integer > ($heap_{724,1;745,8}.p1)
!(0 == asType < integer > (\$heap_{724,1;745,8}.p1))
asType<integer>($heap<sub>724,1:745,8</sub>.p1) <
asType<integer>($heap<sub>724.1:745.8</sub>.M1)
\text{heap}_{724.1:747.8} == \text{heap}_{724.1:745.8}._replace(p2 \rightarrow asType<short)
int>((asType<int>(asType<short int>(div2.rem))
asType < int > (\$heap_{724,1:745,8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724,1:745,8</sub>.b2))))
-asType < integer\ const > (\$heap_{724,1;747,8}.M2) < 1
\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{724,1;747,8}.\mathrm{p2})
!(0 == asType < integer > (\$heap_{724,1:747.8}.p2))
asType<integer>($heap<sub>724.1:747.8</sub>.p2) <
asType<integer>($heap<sub>724.1:747.8</sub>.M2)
\text{$heap}_{724,1;749,8} == \text{$heap}_{724,1;747,8}.\mathbf{replace}(p3 \to \mathbf{asType} < \mathbf{short}
int>((asType<int>(asType<short int>(div3.rem)) *
\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{724,1;747,8}.\mathrm{r3})) - (\mathbf{asType} < \mathbf{int} > (\mathbf{asType} < \mathbf{short}))
int>(div3.quot)) * asType<int>($heap<sub>724.1:747.8</sub>.b3))))
-asType<integer const>($heap_{724,1:749,8}.M3) <
asType<integer>($heap<sub>724,1:749,8</sub>.p3)
!(0 == asType < integer > (\$heap_{724,1;749,8}.p3))
asType<integer>($heap<sub>724,1:749,8</sub>.p3) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;749,8}.\mathrm{M3})
```

```
heap_{724,1;752,8} == heap_{724,1;749,8}._replace(p1 \rightarrow asType<short
int>((asType< int>(\$heap_{724,1;749,8}.M1) *
asType<int>(static_cast<integer>(asType<int>($heap_{724,1:749,8}.p1) <
(int)(0) + asType<int>($heap<sub>724,1:749,8</sub>.p1)))
\text{heap}_{724.1;753.8} == \text{heap}_{724.1;752.8}._replace(p2 \rightarrow asType<short)
int>((asType<int>($heap<sub>724.1:752.8</sub>.M2) *
asType<int>(static_cast<integer>(asType<int>($heap<sub>724.1:752.8</sub>.p2) <
(int)(0)) + asType < int > (\$heap_{724,1;752,8}.p2)))
\rho_{1753,8} = \rho_{
int>((asType<int>($heap<sub>724.1:753.8</sub>.M3) *
asType<int>(static_cast<integer>(asType<int>($heap<sub>724.1:753.8</sub>.p3) <
(int)(0)) + asType < int > (\$heap_{724,1;753,8}.p3)))
invariant
1<br/>(\mathbf{heapIs}\ \$ heap_{funcend\_724,1})
raux1 == asType < double > (static\_cast < real > ($heap_{funcend\_724,1}.p1)) /
asType < double > (static\_cast < real > (\$heap_{funcend\_724,1}.M1))
\mathbf{asType} \small{<} \mathbf{double} \small{>} (\mathbf{static\_cast} \small{<} \mathbf{real} \small{>} (\$ \mathbf{heap}_{funcend\_724,1}.\mathbf{M2}))
raux3 == asType < double > (static\_cast < real > (\$heap_{funcend\_724,1}.p3)) / (
\mathbf{asType}{<}\mathbf{double}{>}(\mathbf{static\_cast}{<}\mathbf{real}{>}(\$\mathbf{heap}_{funcend\_724,1}.\mathbf{M3}))
asType < real > ((double)0.0) < asType < real > (raux1)
asType<real>((double)0.0) < asType<real>(raux2)
asType<real>((double)0.0) < asType<real>(raux3)
Proof:
[Take given term]
[84.0] (asType<double>(static_cast<real>(parting = 1.00)) /
asType < double > (static\_cast < real > (\$heap_{funcend\_724,1}.M1))) == raux1
\rightarrow [simplify]
[84.2] (real($heap_{funcend_{-724,1}}.p1) /
asType < double > (static\_cast < real > (\$heap_{funcend\_724,1}.M1))) == raux1
\rightarrow [const static or extern object]
[84.3] (real($heap<sub>funcend_724,1</sub>.p1) /
asType < double > (static\_cast < real > (\$heap_{init}.M1))) == raux1
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[84.4] (real($heap_{funcend_{724,1}}.p1) /
asType<double>(static_cast<real>(asType<short int>((int)30269))))
== raux1
\rightarrow [simplify]
```

```
[84.10] \ 0.0 == (-\text{raux1} + (\text{real}(\$\text{heap}_{funcend\_724.1}.\text{p1}) / 30269.0))
[Take given term]
[85.0] (asType<double>(static_cast<real>($heap_{funcend\_724.1}.p2)) /
asType < double > (static\_cast < real > (\$heap_{funcend\_724,1}.M2))) == raux2
\rightarrow [simplify]
[85.2] (\mathbf{real}(\mathbf{\$}heap_{funcend\_724,1}.p2) /
asType < double > (static\_cast < real > (\$heap_{funcend\_724,1}.M2))) == raux2
\rightarrow [const static or extern object]
[85.3] (\mathbf{real}(\$heap_{funcend\_724,1}.p2) /
asType < double > (static\_cast < real > (\$heap_{init}.M2))) = = raux2
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[85.4] (real($heap_{funcend_{-724,1}}.p2) /
asType<double>(static_cast<real>(asType<short int>((int)30307))))
== raux2
\rightarrow [simplify]
[85.10] \ 0.0 == (-\text{raux}2 + (\text{real}(\text{\$heap}_{funcend\_724,1}.\text{p2}) / 30307.0))
[Take given term]
[86.0] (asType<double>(static_cast<real>($heap_{funcend\_724,1}.p3)) /
asType < double > (static\_cast < real > (\$heap_{funcend\_724,1}.M3))) == raux3
\rightarrow [simplify]
[86.2] \; (\mathbf{real}(\$ heap_{funcend\_724,1}.p3) \; / \;
\mathbf{asType} < \mathbf{double} > (\mathbf{static\_cast} < \mathbf{real} > (\$ \operatorname{heap}_{funcend\_724,1}.\mathrm{M3}))) == \operatorname{raux3}
\rightarrow [const static or extern object]
[86.3] (real($heap_{funcend\_724,1}.p3) /
asType < double > (static\_cast < real > (\$heap_{init}.M3))) == raux3
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[86.4] (real($heap_{funcend\_724,1}.p3) /
asType<double>(static_cast<real>(asType<short int>((int)30323))))
== raux3
\rightarrow [simplify]
[86.10] \ 0.0 == (-\text{raux3} + (\mathbf{real}(\$\text{heap}_{funcend\_724,1}.\text{p3}) \ / \ 30323.0))
[Take goal term]
[1.0] asType<real>((double)0.0) < ((asType<real>(raux2) +
asType<real>(raux1)) + asType<real>(raux3))
\rightarrow [simplify]
[1.2] 0.0 < ((asType < real > (raux2) + asType < real > (raux1)) +
```

```
asType<real>(raux3))
\rightarrow [from term 85.10, raux2 is equal to real($heap_{funcend\_724,1}.p2) / 30307.0]
[1.3] 0.0 < ((asType < real > (real (\$heap_{funcend\_724,1}.p2) / 30307.0) +
asType < real > (raux1)) + asType < real > (raux3))
\rightarrow [simplify]
[1.4] 0.0 < (((real(\$heap_{funcend\_724,1}.p2) / 30307.0) +
asType < real > (raux1)) + asType < real > (raux3))
\rightarrow [from term 84.10, raux1 is equal to real($heap_{funcend\_724,1}.p1) / 30269.0]
[1.5] 0.0 < (((real(\$heap_{funcend\_724,1}.p2) / 30307.0) +
asType < real > (real(\$heap_{funcend\_724,1}.p1) / 30269.0)) +
asType<real>(raux3))
\rightarrow [simplify]
[1.6] \ 0.0 < (((\mathbf{real}(\$heap_{funcend\_724,1}.p2) \ / \ 30307.0) \ +
(real(\text{heap}_{funcend\_724,1}.p1) / 30269.0)) + asType < real > (raux3))
\rightarrow [from term 86.10, raux3 is equal to real($heap_{funcend\_724,1}.p3) / 30323.0]
[1.7] 0.0 < (((real(\$heap_{funcend\_724,1}.p1) / 30269.0) +
(real(\text{$heap_{funcend\_724,1.p2}) / 30307.0})) +
\mathbf{asType}{<}\mathbf{real}{>}(\mathbf{real}(\$\mathsf{heap}_{funcend\_724,1}.\mathsf{p3})\ /\ 30323.0))
\rightarrow [simplify]
[1.9] \ 0.0 < ((real(\$heap_{funcend\_724,1}.p3) \ / \ 30323.0) +
(real(\$heap_{funcend\_724,1}.p1) / 30269.0) + (real(\$heap_{funcend\_724,1}.p2) / (real(\$heap_{funcend\_724,1}.p2)) / (real
30307.0))
\rightarrow [negate goal and search for contradiction]
[1.10]!(0.0 < ((real(\$heap_{funcend, 724.1.p3}) / 30323.0) +
(real(\$heap_{funcend\_724,1}.p1) / 30269.0) + (real(\$heap_{funcend\_724,1}.p2) / (real(\$heap_{funcend\_724,1}.p2)) / (real
30307.0)))
\rightarrow [simplify]
[1.17] 0.0 \le (-(\mathbf{real}(\hat{\mathbf{s}}_{1.724,1.p3}) / 30323.0) +
-(\mathbf{real}(\hat{p}_{funcend\_724,1}.p2) / 30307.0) + -(\mathbf{real}(\hat{p}_{funcend\_724,1}.p1) / (\mathbf{real}(\hat{p}_{funcend\_724,1}.p1) / (\mathbf{real}(\hat{p}_{funcend\_724,1}.p1)))
30269.0)
[Take given term]
[87.0] asType<real>((double)0.0) < asType<real>(raux1)
\rightarrow [simplify]
[87.2] \ 0.0 < asType < real > (raux1)
\rightarrow [from term 84.10, raux1 is equal to real($heap_{funcend\_724,1}.p1) / 30269.0]
[87.3] \ 0.0 < asType < real > (real(\$heap_{funcend\_724,1}.p1) / 30269.0)
```

```
\rightarrow [simplify]
[87.4] \ 0.0 < (\text{real}(\text{\$heap}_{funcend\_724,1}.\text{p1}) \ / \ 30269.0)
[Take given term]
[88.0] asType<real>((double)0.0) < asType<real>(raux2)
\rightarrow [simplify]
[88.2] 0.0 < asType < real > (raux2)
\rightarrow [from term 85.10, raux2 is equal to real($heap_{funcend\_724,1}.p2) / 30307.0]
[88.3] 0.0 < asType<real>(real($heap_{funcend\_724,1}.p2) / 30307.0)
\rightarrow [simplify]
[88.4] 0.0 < (real(\$heap_{funcend\_724,1}.p2) / 30307.0)
[Take given term]
[89.0] asType<real>((double)0.0) < asType<real>(raux3)
\rightarrow [simplify]
[89.2] 0.0 < asType < real > (raux3)
\rightarrow [from term 86.10, raux3 is equal to real($heap_{funcend\_724,1}.p3) / 30323.0]
[89.3] 0.0 < asType<real>(real($heap_{funcend\_724,1}.p3) / 30323.0)
\rightarrow [simplify]
[89.4] 0.0 < (real($heap_{funcend\_724,1}.p3) / 30323.0)
[Create new term from terms 1.17, 89.4 using rule: transitivity 2b]
[209.0] (0.0 + 0.0) < (-(real($heap_{funcend\_724,1}.p2) / 30307.0) +
\rightarrow [simplify]
[209.1] 0.0 < (-(real(\$heap_{funcend\_724,1}.p2) / 30307.0) +
[Create new term from terms 209.1, 88.4 using rule: transitivity 2a]
[219.0] (0.0 + 0.0) < -(\text{real}(\text{\$heap}_{funcend\_724,1}.\text{p1}) / 30269.0)
\rightarrow [simplify]
[219.1] 0.0 < -(\text{real}(\text{\$heap}_{funcend\_724,1}.\text{p1}) / 30269.0)
\rightarrow [from term 87.4, literala < -(\text{real}(\text{\$heap}_{funcend\_724,1}.p1) / 30269.0) is false
whenever -0.0 < literala
   Proof of rule precondition:
   [219.1.0] -0.0 \le 0.0
   \rightarrow [simplify]
```

```
[219.2] false
Proof of verification condition: Precondition of 'fmod' satisfied
Condition generated at: C:\Escher\Customers\prang\prang.c (87,25)
Condition defined at: C:\Escher\ecv\standard\math.h (84,16)
To prove: !(asType<real>((double)1.0) ==
asType < real > ((double)0.0))
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta
heap_{init}.M2 == asType < short int > ((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta == asType<short int>((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
heap_{init}.b3 == asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart_{-724,1}})
div1 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724.1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}))~\%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))) ==
```

[219.1.1] true

asType<integer>(div1.rem)

```
(asType < integer > (\$heap_{funcstart\_724,1}.p1) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) ==
asType<integer>(div1.rem))
(asType < integer > (\$heap_{funcstart_{-724,1}}.a1) \le
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType < integer > (div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p2})) \ / \\
\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.quot)
(asType<int>(asType<int>($heap_{funcstart\_724,1}.p2)) %
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType < integer > (div2.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(asType < integer > (\$heap_{funcstart\_724,1}.p2) = =
asType<integer>(div2.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a2) \le
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p2})) => !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart_{-724.1}},
asType < int > (\$heap_{funcstart\_724,1}.p3),
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p3})) \ / \\
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}))~\%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a3}))) = =
asType<integer>(div3.rem)
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}) ==
asType<integer>(div3.rem))
```

```
(asType < integer > (\$heap_{funcstart\_724,1}.a3) \le
\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3})) = > !(0 = =
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
int>(div1.quot)) * asType< int>($heap_{funcstart\_724,1}.b1))))
-asType < integer const > (\$heap_{724.1:745.8}.M1) < 
asType<integer>($heap<sub>724,1:745,8</sub>.p1)
!(0 == asType < integer > (\$heap_{724,1:745.8}.p1))
asType<integer>($heap<sub>724,1:745,8</sub>.p1) <
asType<integer>($heap<sub>724,1:745,8</sub>.M1)
heap_{724,1;747,8} == heap_{724,1;745,8}.replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724.1:745.8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724,1:745,8</sub>.b2))))
-\mathbf{asType}{<}\mathbf{integer\ const}{>}(\$\mathrm{heap}_{724,1;747,8}.\mathrm{M2}) <
asType<integer>($heap<sub>724,1:747,8</sub>.p2)
!(0 == asType < integer > (\$heap_{724,1;747,8}.p2))
asType<integer>($heap<sub>724,1:747,8</sub>.p2) <
asType<integer>($heap<sub>724,1;747,8</sub>.M2)
\text{heap}_{724.1:749.8} == \text{heap}_{724.1:747.8}._replace(p3 \rightarrow asType<short)
int>((asType<int>(asType<short int>(div3.rem)) *
asType < int > (\$heap_{724,1;747,8}.r3)) - (asType < int > (asType < short)
int>(div3.quot)) * asType<int>($heap<sub>724.1:747.8</sub>.b3))))
-asType<integer const>($heap_{724,1:749.8}.M3) <
asType<integer>($heap<sub>724.1:749.8</sub>.p3)
!(0 == asType < integer > (\$heap_{724.1:749.8}.p3))
asType<integer>($heap<sub>724.1:749.8</sub>.p3) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;749,8}.\mathrm{M3})
heap_{724,1;752,8} == heap_{724,1;749,8}.replace(p1 \to asType<short
int>((asType< int>(\$heap_{724,1;749,8}.M1) *
asType<int>(static_cast<integer>(asType<int>($heap<sub>724.1:749.8</sub>.p1) <
(int)(0) + asType<int>($heap<sub>724.1:749.8</sub>.p1)))
$heap_{724,1;753,8} == $heap_{724,1;752,8}.replace(p2 \rightarrow asType < short)
int>((asType<int>($heap<sub>724,1;752,8</sub>.M2) *
asType<int>(static_cast<integer>(asType<int>($heap_{724,1:752,8}.p2) <
```

```
(int)(0) + asType<int>($heap<sub>724.1:752.8</sub>.p2)))
\theta_{124,1} == \theta_{124,1} == \theta_{124,1:753,8}. replace (p3 \to as Type < short
int>((asType< int>(\$heap_{724,1;753,8}.M3) *
asType<int>(static_cast<integer>(asType<int>($heap_{724.1:753.8}.p3) <
(int)(0) + asType<int>($heap<sub>724.1:753.8</sub>.p3)))
invariant1(heapIs heap_{funcend\_724,1})
raux1 == asType < double > (static\_cast < real > ($heap_{funcend\_724,1}.p1)) /
\mathbf{asType}{<}\mathbf{double}{>}(\mathbf{static\_cast}{<}\mathbf{real}{>}(\$\mathsf{heap}_{funcend\_724,1}.\mathsf{M1}))
asType<double>(static_cast<real>($heap_{funcend\_724.1}.M2))
raux3 == asType < double > (static\_cast < real > (\$heap_{funcend\_724,1}.p3)) / 
asType < double > (static\_cast < real > ($heap_{funcend\_724,1}.M3))
asType<real>((double)0.0) < asType<real>(raux1)
asType < real > ((double)0.0) < asType < real > (raux2)
asType<real>((double)0.0) < asType<real>(raux3)
asType < real > ((double)0.0) < ((asType < real > (raux2) + real > (raux
asType<real>(raux1)) + asType<real>(raux3))
Proof:
[Take goal term]
[1.0]!(asType<real>((double)1.0) == asType<real>((double)0.0))
\rightarrow [simplify]
[1.6] true
Proof of verification condition: Postcondition satisfied when function
'WHprang' returns
Condition generated at: C:\Escher\Customers\prang\prang.c (89,9)
Condition defined at: C:\Escher\Customers\prang\prang.c (43,25)
To prove: asType<real>(result) < asType<real>((double)1.0)
Given:
heap_{init}.LIMIT == (int)80
\theta
\theta_{init}.r1 == asType < short int > ((int)171)
\theta_{init}.a1 == asType<short int>((int)177)
\theta = asType < short int > ((int)2)
\theta = asType < short int > ((int)30307)
```

```
\rho_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta
heap_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart\_724,1})
div1 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p1)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(asType<int>(asType<int>($heap_{funcstart\_724,1}.p1)) %
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.rem)
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) <
asType < integer > (\$heap_{funcstart\_724,1}.a1)) = >
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1}) ==
asType<integer>(div1.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a1) \le
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p1})) => !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
(\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}))\ /
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2}))) ==
asType<integer>(div2.quot)
(asType<integer>(asType<int>($heap_{tuncstart\_724.1}.p2)) %
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{a2}))) = =
asType<integer>(div2.rem)
```

```
(asType < integer > (\$heap_{funcstart\_724,1}.p2) <
asType < integer > (\$heap_{funcstart\_724,1}.a2)) = >
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2}) ==
asType<integer>(div2.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a2) \le
asType < integer > (\$heap_{funcstart\_724,1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p3),
asType < int > (\$heap_{funcstart\_724.1}.a3))
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{p3})) \ / \\
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(asType<int>(asType<int>($heap_{funcstart\_724,1}.p3)) %
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p3}) <
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(asType < integer > (\$heap_{funcstart\ 724,1}.p3) = =
asType<integer>(div3.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a3) \le
asType < integer > (\$heap_{funcstart\_724,1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType<integer>(div3.quot))
heap_{724,1:745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
\mathbf{asType} \small{<} \mathbf{int} \small{>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{r1})) \\ - (\mathbf{asType} \small{<} \mathbf{int} \small{>} (\mathbf{asType} \small{<} \mathbf{short}
int>(div1.quot)) * asType< int>($heap_{tuncstart\_724.1}.b1))))
-asType<integer const>($heap<sub>724,1:745,8</sub>.M1) <
asType<integer>($heap<sub>724.1:745.8</sub>.p1)
!(0 == asType < integer > (\$heap_{724.1:745.8}.p1))
asType<integer>($heap<sub>724.1:745.8</sub>.p1) <
asType<integer>($heap<sub>724,1:745,8</sub>.M1)
heap_{724,1;747,8} == heap_{724,1;745,8}._replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
asType < int > (\$heap_{724.1:745.8}.r2)) - (asType < int > (asType < short)
int>(div2.quot)) * asType<int>($heap<sub>724.1:745.8</sub>.b2))))
```

```
-asType<integer const>($heap<sub>724.1:747.8</sub>.M2) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;747,8}.\mathrm{p2})
!(0 == asType < integer > (\$heap_{724,1;747,8}.p2))
asType<integer>($heap<sub>724,1;747,8</sub>.p2) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;747,8}.\mathrm{M2})
heap_{724,1:749,8} == heap_{724,1:747,8}.replace(p3 \rightarrow asType<short
int>((asType<int>(asType<short int>(div3.rem)) *
\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{724,1;747,8}.\mathrm{r3})) - (\mathbf{asType} < \mathbf{int} > (\mathbf{asType} < \mathbf{short}))
int>(div3.quot)) * asType<int>($heap<sub>724,1:747,8</sub>.b3))))
-asType<integer const>($heap<sub>724.1:749.8</sub>.M3) <
asType<integer>($heap<sub>724.1:749.8</sub>.p3)
!(0 == asType < integer > (\$heap_{724,1:749.8}.p3))
asType<integer>($heap<sub>724.1:749.8</sub>.p3) <
asType<integer>($heap<sub>724,1.749,8</sub>.M3)
heap_{724,1:752,8} == heap_{724,1:749,8}._replace(p1 \rightarrow asType<short
int>((asType<int>($heap<sub>724,1:749,8</sub>.M1) *
asType<int>(static_cast<integer>(asType<int>($heap<sub>724.1:749.8</sub>.p1) <
(int)(0) + asType<int>($heap_{724.1:749.8}.p1)))
\text{heap}_{724.1;753.8} == \text{heap}_{724.1;752.8}._replace(p2 \rightarrow asType<short)
int>((asType< int>(\$heap_{724,1;752,8}.M2) *
asType<int>(static_cast<integer>(asType<int>($heap_{724.1:752.8}.p2) <
(int)(0) + asType < int > (\$heap_{724,1:752.8}.p2))
\theta_{124,1} == \theta_{124,1} == \theta_{124,1:753,8}. replace(p3 \to asType < short
int>((asType<int>($heap<sub>724.1:753.8</sub>.M3) *
asType<int>(static_cast<integer>(asType<int>($heap_{724,1:753,8}.p3) <
(int)(0)) + asType < int > ($heap_{724,1;753,8}.p3)))
invariant1(heapIs heap_{funcend\_724,1})
raux1 == asType < double > (static\_cast < real > (\$heap_{funcend\_724,1}.p1)) /
asType<double>(static_cast<real>($heap_{tuncend_724,1}.M1))
raux2 == asType < double > (static\_cast < real > ($heap_{funcend\_724,1}.p2)) / 
\mathbf{asType} < \mathbf{double} > (\mathbf{static\_cast} < \mathbf{real} > (\$ \mathrm{heap}_{funcend\_724,1}.\mathrm{M2}))
raux3 == asType < double > (static\_cast < real > (\$heap_{funcend\_724,1}.p3)) /
\mathbf{asType}{<}\mathbf{double}{>}(\mathbf{static\_cast}{<}\mathbf{real}{>}(\$\mathbf{heap}_{funcend\_724,1}.\mathbf{M3}))
asType < real > ((double)0.0) < asType < real > (raux1)
asType < real > ((double)0.0) < asType < real > (raux2)
asType<real>((double)0.0) < asType<real>(raux3)
asType < real > ((double)0.0) < ((asType < real > (raux2) + real > (raux
asType < real > (raux1)) + asType < real > (raux3))
```

```
result == \operatorname{fmod}(\mathbf{heapIs} \$ \operatorname{heap}_{funcend\_724.1}, (\operatorname{raux}1 + \operatorname{raux}2) + \operatorname{raux}3,
(double)1.0)
((asType < real > ((double)0.0) \le asType < real > ((raux1 + raux2) + raux2))
raux3)) && (asType<real>((double)0.0) \leq asType<real>((double)1.0)))
=> ((asType < real > ((double)0.0) \le asType < real > (result)) \&\&
(asType<real>(result) < asType<real>((double)1.0)))
Proof:
[Take given term]
[84.0] (asType<double>(static_cast<real>(part = 1.00) /
asType < double > (static\_cast < real > (\$heap_{funcend\_724.1}.M1))) == raux1
\rightarrow [simplify]
[84.2] (\mathbf{real}(\hat{\mathbf{s}}_{heap_{funcend\_724,1}}.p1) /
asType < double > (static\_cast < real > (\$heap_{funcend\_724.1}.M1))) == raux1
\rightarrow [const static or extern object]
[84.3] (real($heap_{funcend_{-724,1}}.p1) /
asType < double > (static\_cast < real > (\$heap_{init}.M1))) == raux1
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[84.4]~(\mathbf{real}(\mathrm{\$heap}_{funcend\_724,1}.\mathrm{p1})~/
asType < double > (static\_cast < real > (asType < short int > ((int)30269))))
== raux1
\rightarrow [simplify]
[84.10] \ 0.0 == (-\text{raux1} + (\text{real}(\text{\$heap}_{funcend\_724,1}.\text{p1}) / 30269.0))
[Take given term]
[85.0] (asType<double>(static_cast<real>($heap_{funcend_{724,1}}.p2)) /
asType<double>(static_cast<real>($heap_{funcend,724,1}.M2))) == raux2
\rightarrow [simplify]
[85.2] (\mathbf{real}(\$heap_{funcend\_724,1}.p2) /
asType < double > (static\_cast < real > (\$heap_{funcend\_724,1}.M2))) == raux2
\rightarrow [const static or extern object]
[85.3] (\mathbf{real}(\$heap_{funcend\_724,1}.p2) /
asType < double > (static\_cast < real > (\$heap_{init}.M2))) = = raux2
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[85.4] (real(heap_{funcend\_724,1}.p2) /
asType<double>(static_cast<real>(asType<short int>((int)30307))))
== raux2
\rightarrow [simplify]
```

```
[85.10] \ 0.0 == (-\text{raux}2 + (\text{real}(\text{\$heap}_{funcend\_724.1.p2}) / 30307.0))
[Take given term]
[86.0] (asType<double>(static_cast<real>($heap_{funcend\_724.1}.p3)) /
asType < double > (static\_cast < real > (\$heap_{funcend\_724,1}.M3))) == raux3
\rightarrow [simplify]
[86.2] (real($heap_{funcend_724,1}.p3) /
asType < double > (static\_cast < real > (\$heap_{funcend\_724,1}.M3))) == raux3
\rightarrow [const static or extern object]
[86.3] (real($heap_{funcend\_724,1}.p3) /
asType < double > (static\_cast < real > (\$heap_{init}.M3))) = = raux3
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[86.4] (real($heap_{funcend_{-724,1}}.p3) /
asType<double>(static_cast<real>(asType<short int>((int)30323))))
== raux3
\rightarrow [simplify]
[86.10] \ 0.0 == (-\text{raux}3 + (\text{real}(\$\text{heap}_{funcend\_724,1}.\text{p3}) / 30323.0))
[Take given term]
[90.0] asType<real>((double)0.0) < ((asType<real>(raux2) + 
asType<real>(raux1)) + asType<real>(raux3))
\rightarrow [simplify]
[90.2] 0.0 < ((asType < real > (raux2) + asType < real > (raux1)) +
asType<real>(raux3))
\rightarrow [from term 85.10, raux2 is equal to real($heap_{funcend\_724,1}.p2) / 30307.0]
[90.3] \ 0.0 < ((asType < real > (real(\$heap_{funcend\_724,1}.p2) / 30307.0) + (real(\$heap_{funcend\_724,1}.p2)
asType<real>(raux1)) + asType<real>(raux3))
\rightarrow [simplify]
[90.4] \ 0.0 < (((real(\$heap_{funcend\_724.1}.p2) \ / \ 30307.0) +
asType<real>(raux1)) + asType<real>(raux3))
\rightarrow [from term 84.10, raux1 is equal to real($heap_{funcend\_724,1}.p1) / 30269.0]
asType < real > (real(\$heap_{funcend\_724,1}.p1) / 30269.0)) +
asType<real>(raux3))
\rightarrow [simplify]
[90.6] 0.0 < (((real(\$heap_{funcend\_724,1}.p2) / 30307.0) +
(real(\text{heap}_{funcend\_724,1}.p1) / 30269.0)) + asType < real > (raux3))
\rightarrow [from term 86.10, raux3 is equal to real($heap_{funcend\_724,1}.p3) / 30323.0]
```

```
[90.7] 0.0 < (((real(\$heap_{funcend\_724,1}.p1) / 30269.0) +
 (real($heap_{funcend\_724,1}.p2) / 30307.0)) +
asType < real > (real(\$heap_{funcend\_724,1}.p3) / 30323.0))
 \rightarrow [simplify]
 [90.9] \ 0.0 < ((real(\$heap_{funcend\_724,1}.p3) \ / \ 30323.0) +
 (real(\$heap_{funcend\_724,1}.p1) / 30269.0) + (real(\$heap_{funcend\_724,1}.p2) / (real(\$heap_{funcend\_724,1}.p2)) / (real
30307.0))
 [Take given term]
 [91.0] result == fmod(heapIs heap_{funcend\_724,1}, (raux1 + raux2) + raux3,
 (double)1.0)
 \rightarrow [from term 84.10, raux1 is equal to real($heap_{funcend\_724,1}.p1) / 30269.0]
 [91.1] result == fmod(heapIs $heap_{funcend\_724.1},
 ((\mathbf{real}(\$heap_{funcend\_724,1}.p1) / 30269.0) + raux2) + raux3, (\mathbf{double})1.0)
 \rightarrow [from term 85.10, raux2 is equal to real($heap_{funcend\_724,1}.p2) / 30307.0]
[91.2] \text{ result} == \text{fmod}(\mathbf{heapIs} \$ \text{heap}_{funcend\_724,1}, ((\mathbf{real}(\$ \text{heap}_{funcend\_724,1}.\text{p1})
 /30269.0) + (real(\text{$heap}_{funcend\_724,1}.p2) / 30307.0)) + raux3, (double)1.0)
 \rightarrow [from term 86.10, raux3 is equal to real($heap_{funcend\_724,1}.p3) / 30323.0]
 [91.3] result == fmod(heapIs heap_{funcend\_724,1},
 ((\mathbf{real}(\$heap_{funcend\_724,1}.p2) \ / \ 30307.0) + (\mathbf{real}(\$heap_{funcend\_724,1}.p1) \ / \ 30307.0) + (\mathbf{real}(\$heap_{funcend\_724,1}.p2) \ / \ 30307.0) + (\mathbf{real}(\$heap_
30269.0)) + (real($heap_{funcend\_724,1}.p3) / 30323.0), (double)1.0)
 \rightarrow [simplify]
 [91.6] 0.0 == (-\text{fmod}(\mathbf{heapIs} \$ \text{heap}_{funcend\_724,1}, (\mathbf{real}(\$ \text{heap}_{funcend\_724,1}.p3)))
 /30323.0) + (real(\text{$heap_{funcend\_724,1.p2}}) / 30307.0) +
 (real(\text{$heap}_{funcend\_724,1}.p1) / 30269.0), 1.0) + result)
 [Assume known post-assertion, class invariant or type constraint for term 91.6]
 [94.0] ((asType<real>((double)0.0) \leq
asType < real > ((real(\$heap_{funcend\_724,1}.p3) / 30323.0) +
(real(\$heap_{funcend\_724,1}.p2) / 30307.0) + (real(\$heap_{funcend\_724,1}.p1) / (real(\$heap_{funcend\_724,1}.p1)) / (real
30269.0))) && (asType<real>((double)0.0) \le asType<real>(1.0))) =>
 ((asType < real > ((double)0.0) \le asType < real > (fmod(heapIs)))
\theta_{funcend_{724,1}}, (real(\theta_{funcend_{724,1}}, g_3) / 30323.0) +
 (real(\$heap_{funcend\_724.1}.p2) / 30307.0) + (real(\$heap_{funcend\_724,1}.p1) / (real(\$heap_{funcend\_724,1}.p1)) / (real
30269.0, 1.0)) && (asType<real>(fmod(heapIs $heap_{funcend\_724,1},
 (real(\$heap_{funcend\_724,1}.p3) / 30323.0) + (real(\$heap_{funcend\_724,1}.p2) / (real(\$heap_{funcend\_724,1}.p3)) / (real
30307.0) + (real($heap_{funcend\_724,1}.p1) / 30269.0), 1.0)) <
asType < real > (1.0))
 \rightarrow [simplify]
 [94.3] ((0.0 \leq ((real($heap_{funcend_{724.1}}.p3) / 30323.0) +
 (\mathbf{real}(\$ heap_{funcend\_724,1}.p2) \; / \; 30307.0) \; + \; (\mathbf{real}(\$ heap_{funcend\_724,1}.p1) \; / \;
```

```
30269.0)) && (asType<real>((double)0.0) < asType<real>(1.0))) =>
 ((asType < real > ((double)0.0) \le asType < real > (fmod(heapIs)))
heap_{funcend\_724,1}, (real(heap_{funcend\_724,1}.p3) / 30323.0) +
 (real(\$heap_{funcend\_724,1}.p2) / 30307.0) + (real(\$heap_{funcend\_724,1}.p1) / (real(\$heap_{funcend\_724,1}.p1)) / (real
30269.0), 1.0))) && (asType<real>(fmod(heapIs heap_{funcend\_724,1},
 (real(\$heap_{funcend\_724,1}.p3) / 30323.0) + (real(\$heap_{funcend\_724,1}.p2) / (real(\$heap_{funcend\_724,1}.p3)) / (real
30307.0) + (real($heap_{funcend\_724,1}.p1) / 30269.0), 1.0)) <
asType < real > (1.0))
 \rightarrow [from term 90.9, literala \leq ((real($heap_{funcend\_724,1}.p3) / 30323.0) +
 (real(\$heap_{funcend\_724,1}.p1) / 30269.0) + (real(\$heap_{funcend\_724,1}.p2) / (real(\$heap_{funcend\_724,1}.p2)) / (real
 30307.0)) is true whenever literala \leq 0.0]
                      Proof of rule precondition:
                      [94.3.0] \ 0.0 \le 0.0
                      \rightarrow [simplify]
                      [94.3.1] true
 [94.4] (true && (asType<real>((double)0.0) \leq asType<real>(1.0))) =>
 ((asType < real > ((double)0.0) \le asType < real > (fmod(heapIs)))
 \text{Sheap}_{funcend\_724,1}, (\text{real}(\text{Sheap}_{funcend\_724,1}.\text{p3}) / 30323.0) +
 (real(\$heap_{funcend\_724,1}.p2) / 30307.0) + (real(\$heap_{funcend\_724,1}.p1) / (real(\$heap_{funcend\_724,1}.p1)) / (real
30269.0), 1.0))) && (asType<real>(fmod(heapIs heap_{funcend\_724,1},
 (real(\$heap_{funcend,724.1}.p3) / 30323.0) + (real(\$heap_{funcend,724.1}.p2) /
30307.0) + (real($heap_{funcend\_724,1}.p1) / 30269.0), 1.0)) <
asType < real > (1.0))
 \rightarrow [simplify]
 [94.21] \ (-1.0 < -\mathrm{fmod}(\mathbf{heapIs} \ \$ \mathrm{heap}_{funcend\_724,1}, \ (\mathbf{real}(\$ \mathrm{heap}_{funcend\_724,1}.\mathrm{p3}))))
  /30323.0) + (real(\text{$heap_{funcend\_724,1.p2}}) / 30307.0) +
 (real(heap_{funcend\_724,1}.p1) / 30269.0), 1.0)) \land (0.0 \le fmod(heapIs)
 heap_{funcend\_724,1}, (real(heap_{funcend\_724,1}.p3) / 30323.0) +
 (real(\$heap_{funcend\_724,1}.p2) / 30307.0) + (real(\$heap_{funcend\_724,1}.p1) / (real(\$heap_{funcend\_724,1}.p2)) / (real
30269.0), 1.0))
 \rightarrow [separate conjunction and work on first sub-term]
[94.22] -1.0 < -\text{fmod}(\text{heapIs } \text{$heap}_{funcend\_724.1}, (\text{real}(\text{$heap}_{funcend\_724.1}.\text{p3}))
 /30323.0) + (real(\$heap_{funcend,724.1}.p2) / 30307.0) +
 (real(\text{$heap}_{funcend\_724,1}.p1) / 30269.0), 1.0)
 [Take goal term]
 [1.0] asType<real>(result) < asType<real>((double)1.0)
 \rightarrow [from term 91.6, result is equal to fmod(heapIs $heap_{funcend\_724,1},
 (real(\$heap_{funcend\_724,1}.p3) / 30323.0) + (real(\$heap_{funcend\_724,1}.p2) / (real(\$heap_{funcend\_724,1}.p3)) / (real
 30307.0) + (real($heap_{funcend_{724,1}}.p1) / 30269.0), 1.0)]
 [1.1] asType<real>(fmod(heapIs $heap_{funcend\_724,1},
```

```
(real(\$heap_{funcend\_724,1}.p3) / 30323.0) + (real(\$heap_{funcend\_724,1}.p2) / (real(\$heap_{funcend\_724,1}.p3)) + (real(\$heap_{funcend\_724,1}.p3)) / (real(\$heap_{funcend\_724,1}.p3)) + (real(\$heap_{funcend\_724,1}.p3)) / (real
30307.0) + (real($heap_{funcend\_724,1}.p1) / 30269.0), 1.0)) <
asType < real > ((double)1.0)
\rightarrow [simplify]
[1.7] -1.0 < -\text{fmod}(\text{heapIs }\text{\$heap}_{funcend\_724,1}, (\text{real}(\text{\$heap}_{funcend\_724,1}.\text{p3}))
30323.0) + (real($heap_{funcend_724,1}.p2) / 30307.0) +
(real(\text{$heap}_{funcend\_724,1.p1}) / 30269.0), 1.0)
\rightarrow [from term 94.22, literala < -fmod(heapIs $heap_{funcend\_724,1},
 (real(\$heap_{funcend\_724,1}.p3) / 30323.0) + (real(\$heap_{funcend\_724,1}.p2) / (real(\$heap_{funcend\_724,1}.p3)) / (real
30307.0) + (real($heap_{funcend_{724,1}}.p1) / 30269.0), 1.0) is true whenever
literala \leq -1.0
            Proof of rule precondition:
            [1.7.0] - 1.0 \le -1.0
            \rightarrow [simplify]
            [1.7.1] true
[1.8] true
Proof of verification condition: Postcondition satisfied when function
'WHprang' returns
Condition generated at: C:\Escher\Customers\prang\prang.c (89,9)
Condition defined at: C:\Escher\Customers\prang\prang.c (43,44)
To prove: invariant1(heapIs $heap_{funcend\_724,1})
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
\theta_{init}.a1 == asType<short int>((int)177)
\theta = asType < short int > ((int)2)
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
\theta
\theta
heap_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
```

```
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
invariant1(heapIs heap_{funcstart\_724,1})
\operatorname{div1} == \operatorname{div}(\mathbf{heapIs} \ \operatorname{\$heap}_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p1),
asType < int > (\$heap_{funcstart\_724,1}.a1))
(asType < int > (asType < int > (\$heap_{funcstart\_724,1}.p1)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a1))) = =
asType<integer>(div1.quot)
(\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p1}))\ \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a1}))) = =
asType<integer>(div1.rem)
(asType<integer>($heap_{tuncstart\_724.1}.p1) <
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{a1})) = >
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p1}) = =
asType<integer>(div1.rem))
(asType < integer > (\$heap_{funcstart\_724,1}.a1) \le
asType < integer > (\$heap_{funcstart\_724,1}.p1)) = > !(0 ==
asType<integer>(div1.quot))
!(0 == asType < integer > (div1.rem)) || !(0 ==
asType<integer>(div1.quot))
div2 == div(\mathbf{heapIs} \$heap_{funcstart\_724,1},
asType < int > (\$heap_{funcstart\_724,1}.p2),
asType < int > (\$heap_{funcstart\_724,1}.a2))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p2)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.quot)
(\mathbf{asType} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p2})) \ \%
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a2))) = =
asType<integer>(div2.rem)
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{p2}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a2})) =>
(asType < integer > (\$heap_{funcstart\_724,1}.p2) = =
asType<integer>(div2.rem))
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcstart\_724,1}.\mathsf{a2}) \leq
asType < integer > (\$heap_{funcstart\_724,1}.p2)) = > !(0 ==
asType<integer>(div2.quot))
```

```
!(0 == asType < integer > (div2.rem)) || !(0 ==
asType<integer>(div2.quot))
div3 == div(\mathbf{heapIs} \$ heap_{funcstart\_724,1},
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{p3}),
asType < int > (\$heap_{funcstart\_724.1}.a3))
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) /
asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.a3))) = =
asType<integer>(div3.quot)
(asType < integer > (asType < int > (\$heap_{funcstart\_724,1}.p3)) \%
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{funcstart\_724,1}.\mathrm{a3}))) ==
asType<integer>(div3.rem)
(asType<integer>($heap_funcstart_724.1.p3) <
asType < integer > (\$heap_{funcstart\_724,1}.a3)) = >
(\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcstart\_724,1}.\mathbf{p3}) ==
asType<integer>(div3.rem))
(asType < integer > (\$heap_{funcstart_{724,1}}.a3) \le
asType < integer > (\$heap_{funcstart\_724.1}.p3)) = > !(0 ==
asType<integer>(div3.quot))
!(0 == asType < integer > (div3.rem)) || !(0 ==
asType < integer > (div3.quot))
heap_{724,1;745,8} == heap_{funcstart\_724,1}._replace(p1 \rightarrow asType<short
int>((asType<int>(asType<short int>(div1.rem)) *
asType < int > (\$heap_{funcstart\_724,1}.r1)) - (asType < int > (asType < short)
\mathbf{int}{>}(\mathbf{div1}.\mathbf{quot})) \ * \ \mathbf{asType}{<} \mathbf{int}{>} (\$\mathbf{heap}_{funcstart\_724,1}.\mathbf{b1}))))
-asType<integer const>($heap<sub>724,1:745,8</sub>.M1) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{724,1;745,8}.\mathrm{p1})
!(0 == asType < integer > (\$heap_{724,1;745,8}.p1))
asType<integer>($heap<sub>724.1:745.8</sub>.p1) <
asType<integer>($heap<sub>724,1;745,8</sub>.M1)
heap_{724,1:747,8} == heap_{724,1:745,8}.replace(p2 \rightarrow asType<short
int>((asType<int>(asType<short int>(div2.rem)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\text{heap}_{724,1;745,8}.\mathbf{r2})) - (\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{short}
int>(div2.quot)) * asType< int>($heap_{724.1:745.8}.b2))))
-asType<integer const>($heap<sub>724.1:747.8</sub>.M2) <
asType<integer>($heap<sub>724,1:747,8</sub>.p2)
!(0 == asType < integer > (\$heap_{724,1;747,8}.p2))
asType<integer>($heap<sub>724.1:747.8</sub>.p2) <
asType<integer>($heap<sub>724.1:747.8</sub>.M2)
\text{$heap}_{724,1;749,8} == \text{$heap}_{724,1;747,8}.\_\textbf{replace}(p3 \to \textbf{asType} < \textbf{short}
```

```
int>((asType<int>(asType<short int>(div3.rem)) *
\mathbf{asType}{<}\mathbf{int}{>}(\$\mathrm{heap}_{724,1;747,8}.\mathrm{r3})) - (\mathbf{asType}{<}\mathbf{int}{>}(\mathbf{asType}{<}\mathbf{short}
int>(div3.quot)) * asType<int>($heap<sub>724,1:747,8</sub>.b3))))
-asType<integer const>($heap<sub>724.1:749.8</sub>.M3) <
asType < integer > ($heap_{724,1;749,8}.p3)
!(0 == asType < integer > (\$heap_{724,1:749.8}.p3))
asType<integer>($heap<sub>724,1:749,8</sub>.p3) <
asType<integer>($heap<sub>724.1:749.8</sub>.M3)
\text{heap}_{724.1;752.8} == \text{heap}_{724.1;749.8}._replace(p1 \rightarrow asType<short)
int>((asType<int>($heap<sub>724.1:749.8</sub>.M1) *
asType<int>(static_cast<integer>(asType<int>($heap_{724.1:749.8}.p1) <
(int)(0)) + asType < int > (\$heap_{724,1;749,8}.p1)))
heap_{724,1:753.8} == heap_{724,1:752.8}.replace(p2 \rightarrow asType<short
int>((asType<int>($heap<sub>724,1:752,8</sub>.M2) *
asType<int>(static_cast<integer>(asType<int>($heap_{724.1:752.8}.p2) <
(int)(0)) + asType < int > (\$heap_{724,1;752,8}.p2)))
\text{Sheap}_{funcend\_724.1} == \text{Sheap}_{724.1:753.8}._replace(p3 \rightarrow asType<short
int>((asType<int>($heap<sub>724,1:753,8</sub>.M3) *
\mathbf{asType} < \mathbf{int} > (\mathbf{static\_cast} < \mathbf{integer} > (\mathbf{asType} < \mathbf{int} > (\$ \mathrm{heap}_{724,1;753,8}.\mathrm{p3}) < \mathsf{nt})
(int)(0)) + asType < int > (\$heap_{724,1:753,8}.p3)))
invariant1(heapIs $heap_{funcend_724.1})
raux1 == asType < double > (static\_cast < real > ($heap_{funcend\_724,1}.p1)) /
asType<double>(static_cast<real>($heap_{tuncend,724,1}.M1))
raux2 == asType < double > (static\_cast < real > ($heap_{funcend\_724,1}.p2)) /
\mathbf{asType}{<}\mathbf{double}{>}(\mathbf{static\_cast}{<}\mathbf{real}{>}(\$\mathbf{heap}_{funcend\_724,1}.\mathbf{M2}))
\mathbf{asType} \small{<} \mathbf{double} \small{>} (\mathbf{static\_cast} \small{<} \mathbf{real} \small{>} (\$ \mathbf{heap}_{funcend\_724,1}.\mathbf{M3}))
asType<real>((double)0.0) < asType<real>(raux1)
asType<real>((double)0.0) < asType<real>(raux2)
asType<real>((double)0.0) < asType<real>(raux3)
asType < real > ((double)0.0) < ((asType < real > (raux2) + real > (raux
asType < real > (raux1)) + asType < real > (raux3))
result == fmod(\mathbf{heapIs} \$heap_{funcend\_724,1}, (raux1 + raux2) + raux3,
(double)1.0)
((asType < real > ((double)0.0) \le asType < real > ((raux1 + raux2) + raux2))
raux3)) && (asType<real>((double)0.0) \leq asType<real>((double)1.0)))
=> ((asType < real > ((double)0.0) \le asType < real > (result)) \&\&
(asType<real>(result) < asType<real>((double)1.0)))
```

Proof:

```
[Take given term]
[78.0] invariant1(heapIs heap_{funcend\_724.1})
\rightarrow [expand definition of function 'invariant1' at prang.c (34.1)]
[78.1] (((((0 < asType < integer > ($heap_{funcend\_724,1}.p1)) &&
(asType < integer > (\$heap_{funcend\_724,1}.p1) < 
asType < integer > (\$heap_{funcend\_724,1}.M1))) \&\& (0 <
asType < integer > (\$heap_{funcend\_724,1}.p2))) \&\&
(asType < integer > (\$heap_{funcend\_724,1}.p2) <
asType<integer>(\theta_{13}) && (0 <
asType < integer > (\$heap_{funcend\_724,1}.p3))) \&\&
(asType<integer>($heap_{funcend_724.1}.p3) <
asType < integer > (\$heap_{funcend\_724,1}.M3))
\rightarrow [simplify]
[78.3] (((((0 < $heap_{funcend\_724,1}.p1) && ($heap_{funcend\_724,1}.p1 < ])
asType<integer>(\theta_{13}) && (0 <
asType < integer > (\$heap_{funcend\_724,1}.p2))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcend\_724,1}.\mathrm{p2}) <
asType < integer > (\$heap_{funcend\_724,1}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathtt{heap}_{funcend\_724,1}.\mathtt{p3})))\ \&\&
(asType<integer>($heap_{funcend,724,1}.p3) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcend\_724,1}.\mathrm{M3}))
\rightarrow [const static or extern object]
[78.4] (((((0 < $heap_{funcend\_724,1}.p1) && ($heap_{funcend\_724,1}.p1 < 
asType < integer > (\$heap_{init}.M1))) \&\& (0 <
asType < integer > (\$heap_{funcend\_724,1}.p2))) \&\&
(asType < integer > (\$heap_{funcend\_724,1}.p2) < 
asType < integer > (\$heap_{funcend\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcend\_724,1}.p3))) \&\&
(asType < integer > (\$heap_{funcend\_724,1}.p3) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcend\_724,1}.\mathrm{M3}))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[78.5] (((((0 < $heap_{funcend_{724,1}}.p1) && ($heap_{funcend_{724,1}}.p1 < ]
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType < integer > (\$heap_{funcend\_724,1}.p2))) \&\&
(asType < integer > (\$heap_{funcend\_724,1}.p2) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcend\_724,1}.\mathrm{M2})))~\&\&~(0<
asType < integer > (\$heap_{funcend\_724,1}.p3))) \&\&
(asType < integer > (\$heap_{funcend\_724,1}.p3) < 
asType < integer > (\$heap_{funcend\_724.1}.M3))
\rightarrow [simplify]
```

```
[78.16] ((((-30269 < -$heap<sub>funcend-724,1</sub>.p1) \wedge (0 < $heap<sub>funcend-724,1</sub>.p1) \wedge
(0 < \text{\$heap}_{funcend\_724,1}.p2)) \&\& (\text{\$heap}_{funcend\_724,1}.p2 <
asType < integer > (\$heap_{funcend\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcend\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcend\_724,1}.\mathrm{p3}) <
asType < integer > (\$heap_{funcend\_724,1}.M3))
\rightarrow [const static or extern object]
[78.17] \; ((((-30269 < -\$ heap_{funcend\_724,1}.p1) \; \land \; (0 < \$ heap_{funcend\_724,1}.p2) \; \land \; (0 < \$ heap
(0 < \text{$heap}_{funcend\_724,1}.p2)) \&\& (\text{$heap}_{funcend\_724,1}.p2 <
asType < integer > (\$heap_{init}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcend\_724,1}.p3))) \&\&
(asType<integer>($heap_funcend_724,1.p3) <
asType < integer > (\$heap_{funcend\_724,1}.M3))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[78.18] ((((-30269 < -\$heap_{funcend\_724,1}.p1) \land (0 < \$heap_{funcend\_724,1}.p1) \land (0 < \$heap_{funcend\_724,1}.p2) \land (0 < \$heap_{fu
(0 < \text{\$heap}_{funcend\_724,1}.\text{p2})) \&\& (\text{\$heap}_{funcend\_724,1}.\text{p2} <
asType<integer>(asType<short int>((int)30307)))) && (0 <
asType < integer > (\$heap_{funcend\_724,1}.p3))) \&\&
(asType < integer > (\$heap_{funcend_{-724,1}}.p3) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcend\_724,1}.\mathrm{M3}))
\rightarrow [simplify]
[78.30] ((-30307 < -$heap_{funcend\_724,1}.p2) \land (-30269 <
-\$heap_{funcend\_724,1}.p1) \land (0 < \$heap_{funcend\_724,1}.p1) \land (0 <
\text{Sheap}_{funcend\_724,1.p2} \land (0 < \text{Sheap}_{funcend\_724,1.p3})) \&\&
(\text{\$heap}_{funcend\_724,1}.p3 < asType < integer > (\text{\$heap}_{funcend\_724,1}.M3))
\rightarrow [const static or extern object]
[78.31] ((-30307 < -$heap<sub>funcend_724,1.</sub>p2) \land (-30269 <
-\$heap_{funcend\_724,1}.p1) \land (0 < \$heap_{funcend\_724,1}.p1) \land (0 < \$heap_{funcend\_724,1}.p1)
\text{Sheap}_{funcend\_724,1}.\text{p2}) \land (0 < \text{Sheap}_{funcend\_724,1}.\text{p3})) \&\&
(\text{\$heap}_{funcend\_724,1}.\text{p3} < \text{asType} < \text{integer} > (\text{\$heap}_{init}.\text{M3}))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[78.32] ((-30307 < -$heap<sub>funcend_724,1.</sub>p2) \wedge (-30269 <
-\$heap_{funcend\_724,1}.p1) \land (0 < \$heap_{funcend\_724,1}.p1) \land (0 < \$heap_{funcend\_724,1}.p1)
\text{Sheap}_{funcend\_724,1}.\text{p2}) \land (0 < \text{Sheap}_{funcend\_724,1}.\text{p3})) \&\&
(\$heap_{funcend\_724,1}.p3 < \textbf{asType} < \textbf{integer} > (\textbf{asType} < \textbf{short})
int > ((int)30323)))
\rightarrow [simplify]
[78.40] (-30323 < -\$heap_{funcend\_724,1}.p3) \land (-30307 < -\$heap_{funcend\_724,1}.p2)
\land (-30269 < -\$heap_{funcend\_724,1}.p1) \land (0 < \$heap_{funcend\_724,1}.p1) \land (0 < \$heap_{funcend\_724,1}.p1)
\text{Sheap}_{funcend\_724,1}.\text{p2}) \land (0 < \text{Sheap}_{funcend\_724,1}.\text{p3})
```

```
\rightarrow [separate conjunction and work on first sub-term]
[78.41] \ \hbox{-}30323 < -\$ heap_{funcend\_724,1}.p3
[Work on sub-term 2 of conjunction in term 78.40]
[79.0] -30307 < -$heap<sub>funcend_724,1</sub>.p2
[Work on sub-term 3 of conjunction in term 78.40]
[80.0] \ \hbox{--}30269 < -\$ \mathrm{heap}_{funcend\_724,1}.\mathrm{p1}
[Work on sub-term 4 of conjunction in term 78.40]
[81.0] 0 < $\text{heap}_{funcend_{-724,1}}.p1$
[Work on sub-term 5 of conjunction in term 78.40]
[82.0] 0 < heap_{funcend\_724,1}.p2
[Work on sub-term 6 of conjunction in term 78.40]
\textit{[83.0]}~0 < \$ heap_{funcend\_724,1}.p3
[Take goal term]
[1.0] invariant1(heapIs heap_{funcend\_724,1})
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
[1.1] ((((((0 < asType<integer>(heap_{funcend\_724,1}.p1)) &&
(asType < integer > (\$heap_{funcend\_724,1}.p1) <
asType<integer>($heap<sub>funcend_724,1</sub>.M1))) && (0 <
asType < integer > (\$heap_{funcend\_724,1}.p2))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcend\_724,1}.p2) <
asType<integer>($heap<sub>funcend_724,1</sub>.M2))) && (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathtt{heap}_{funcend\_724,1}.\mathtt{p3})))\ \&\&
(asType<integer>($heap_funcend_724,1.p3) <
asType < integer > (\$heap_{funcend\_724,1}.M3))
\rightarrow [simplify]
[1.2] (((((0 < $heap_{funcend_{-724,1}}.p1) &&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcend\_724,1}.\mathrm{p1}) <
asType < integer > (\$heap_{funcend\_724,1}.M1))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcend\_724,1}.\mathrm{p2})))\ \&\&
(asType < integer > (\$heap_{funcend\_724,1}.p2) <
asType<integer>(heap_{funcend\_724.1}.M2))) && (0 <
asType < integer > (\$heap_{funcend\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcend\_724,1}.\mathrm{p3}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcend\_724,1}.\mathrm{M3}))
\rightarrow [from term 81.0, literala < $heap_{funcend\_724,1}.p1 is true whenever (-1 +
literala) < 0
```

Proof of rule precondition:

```
[1.2.0](-1+0)<0
   \rightarrow [simplify]
   [1.2.2] true
[1.3] ((((true && (asType<integer>(protect{sheap}_{funcend\_724,1.p1}) <
asType < integer > (\$heap_{funcend\_724,1}.p2))) \&\&
(asType < integer > (\$heap_{funcend\_724,1}.p2) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcend\_724,1}.\mathrm{M2})))~\&\&~(0<
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathtt{heap}_{funcend\_724,1}.\mathtt{p3})))\ \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{funcend\_724,1}.\mathrm{p3}) <
asType < integer > (\$heap_{funcend\_724,1}.M3))
\rightarrow [simplify]
[1.4] ((((true && ($heap_{funcend\_724,1}.p1 <
asType < integer > (\$heap_{funcend\_724,1}.M1))) \&\& (0 <
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcend\_724,1}.\mathbf{p2}))) \ \&\& \\
(asType<integer>($heap_{funcend_724.1}.p2) <
asType < integer > (\$heap_{funcend\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcend\_724,1}.p3))) \&\&
(asType < integer > (\$heap_{funcend\_724,1}.p3) < 
asType<integer>($heap_{tuncend\_724.1}.M3))
\rightarrow [const static or extern object]
[1.5] ((((true && ($heap_{funcend\_724,1}.p1 <
asType < integer > (heap_{init}.M1))) && (0 < order )
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathtt{heap}_{funcend\_724,1}.\mathtt{p2})))\ \&\&
(asType < integer > (\$heap_{funcend\_724,1}.p2) <
asType < integer > (\$heap_{funcend\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcend\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcend\_724,1}.\mathsf{p3}) <
asType<integer>($heap_{tuncend_724.1}.M3))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[1.6] ((((true && ($heap_{funcend_{724.1}}.p1 < ))))
asType<integer>(asType<short int>((int)30269)))) && (0 <
asType < integer > (\$heap_{funcend\_724,1}.p2))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcend\_724,1}.\mathrm{p2}) <
asType < integer > (\$heap_{funcend\_724,1}.M2))) \&\& (0 <
asType < integer > (\$heap_{funcend\_724,1}.p3))) \&\&
(asType<integer>($heap_funcend_724,1.p3) <
asType < integer > (\$heap_{funcend\_724,1}.M3))
\rightarrow [simplify]
[1.12] ((((true && (-30269 < -$heap_{funcend\_724,1}.p1)) && (0 <
asType < integer > (\$heap_{funcend\_724,1}.p2))) \&\&
```

```
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcend\_724,1}.\mathrm{p2}) <
asType < integer > (\$heap_{funcend\_724,1}.M2))) \&\& (0 <
\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcend\_724,1}.p3))) \&\&
(asType < integer > (\$heap_{funcend\_724,1}.p3) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcend\_724,1}.\mathrm{M3}))
\rightarrow [from term 80.0, literala < –$heap_{funcend\_724,1}.p1 is true whenever (-1 +
literala) < -30269
    Proof of rule precondition:
    [1.12.0](-30269 + -1) < -30269
    \rightarrow [simplify]
    [1.12.2] true
[1.13] ((((true && true) && (0 <
asType < integer > (\$heap_{funcend\_724,1}.p2))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcend\_724,1}.\mathrm{p2}) <
asType < integer > (\$heap_{funcend\_724,1}.M2))) \&\& (0 <
\mathbf{asType} {<} \mathbf{integer} {>} (\$ \mathbf{heap}_{funcend\_724,1}.\mathbf{p3}))) \ \&\& \\
(asType < integer > (\$heap_{funcend\_724,1}.p3) < 
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcend\_724,1}.\mathrm{M3}))
\rightarrow [simplify]
[1.15] (((true && (0 < p_{funcend_{-724,1}.p2})) &&
(asType < integer > (\$heap_{funcend\_724,1}.p2) < 
asType<integer>($heap<sub>funcend_724.1</sub>.M2))) && (0 <
asType < integer > (\$heap_{funcend\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcend\_724,1}.\mathsf{p3}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcend\_724,1}.\mathrm{M3}))
\rightarrow [from term 82.0, literala < $heap_{funcend\_724,1}.p2 is true whenever (-1 +
literala) < 0
    Proof of rule precondition:
    [1.15.0](-1+0)<0
    \rightarrow [simplify]
    [1.15.2] true
[1.16] (((true && true) && (asType<integer>($heap_{funcend\_724,1}.p2) <
asType < integer > (\$heap_{funcend\_724,1}.M2))) \&\& (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathtt{heap}_{funcend\_724,1}.\mathtt{p3})))\ \&\&
(asType<integer>($heap_{funcend\_724.1}.p3) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcend\_724,1}.\mathrm{M3}))
\rightarrow [simplify]
[1.18] ((true && ($heap_{funcend_{724.1}}.p2 <
asType < integer > (\$heap_{funcend\_724,1}.M2))) \&\& (0 <
```

```
asType < integer > (\$heap_{funcend\_724,1}.p3))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathbf{heap}_{funcend\_724,1}.\mathbf{p3}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcend\_724,1}.\mathrm{M3}))
\rightarrow [const static or extern object]
[1.19] ((true && (\theta_{init}.M2)))
&& (0 < asType < integer > (\$heap_{funcend\_724,1}.p3))) &&
(asType < integer > ($heap_{funcend\_724,1}.p3) < 
asType < integer > (\$heap_{funcend\_724,1}.M3))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[1.20] ((true && ($heap_{funcend\_724,1}.p2 <
\mathbf{asType} \small{<} \mathbf{integer} \small{>} (\mathbf{asType} \small{<} \mathbf{short} \ \mathbf{int} \small{>} ((\mathbf{int})30307)))) \ \&\& \ (0 <
asType < integer > (\$heap_{funcend\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathsf{heap}_{funcend\_724,1}.\mathsf{p3}) <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcend\_724,1}.\mathrm{M3}))
\rightarrow [simplify]
[1.26] ((true && (-30307 < -$heap_{funcend\_724,1}.p2)) && (0 <
asType < integer > (\$heap_{funcend\_724,1}.p3))) \&\&
(\mathbf{asType}{<}\mathbf{integer}{>}(\$\mathrm{heap}_{funcend\_724,1}.\mathrm{p3}) <
asType < integer > (\$heap_{funcend\_724,1}.M3))
\rightarrow [from term 79.0, literala < -$heap<sub>funcend_724,1</sub>.p2 is true whenever (-1 +
literala) < -30307
    Proof of rule precondition:
    [1.26.0](-30307 + -1) < -30307
    \rightarrow [simplify]
    [1.26.2] true
[1.27] ((true && true) && (0 < asType<integer>(\ensuremath{\text{heap}}_{funcend\_724,1}.p3)))
&& (asType<integer>($heap<sub>funcend_724,1</sub>.p3) <
asType < integer > (\$heap_{funcend\_724,1}.M3))
\rightarrow [simplify]
[1.29] (true && (0 < \rho_{1.29}) (true && (0 < \rho_{1.29})) &&
(asType < integer > (\$heap_{funcend\_724,1}.p3) < 
asType < integer > (\$heap_{funcend\_724,1}.M3))
\rightarrow [from term 83.0, literala < $heap_{funcend\_724,1}.p3 is true whenever (-1 +
literala) < 0
    Proof of rule precondition:
    [1.29.0](-1+0)<0
    \rightarrow [simplify]
    [1.29.2] true
```

```
[1.30] (true && true) && (asType<integer>($heap_{tuncend\_724.1}.p3) <
asType < integer > (\$heap_{funcend\_724,1}.M3))
\rightarrow [simplify]
[1.32] true && ($heap_{funcend\_724,1}.p3 <
asType < integer > (\$heap_{funcend\_724,1}.M3))
\rightarrow [const\ static\ or\ extern\ object]
[1.33] true && (\theta_{1.33}) true && (\theta_{1.33}) true && (\theta_{1.33})
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[1.34] true && ($heap_{funcend\_724,1}.p3 < asType<integer>(asType<short)
int > ((int)30323)))
\rightarrow [simplify]
[1.40] true && (-30323 < -$heap_{tuncend\_724,1}.p3)
\rightarrow [from term 78.41, literala < –$heap_{uncend\_724,1}.p3 is true whenever (-1 +
literala) < -30323
   Proof of rule precondition:
   [1.40.0](-30323 + -1) < -30323
   \rightarrow [simplify]
   [1.40.2] true
[1.41] true && true
\rightarrow [simplify]
[1.42] true
Proof of verification condition: Type constraint satisfied in implicit
conversion from 'int' to 'short int'
Condition generated at: C:\Escher\Customers\prang\prang.c (102,10)
Condition defined at:
To prove: minof(short int) \le (int)1
Given:
heap_{init}.LIMIT == (int)80
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
```

```
\theta_{init}.r2 == asType<short int>((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
Proof:
[Take goal term]
[1.0] minof(short int) \leq (int)1
\rightarrow [simplify]
[1.3] true
Proof of verification condition: Type constraint satisfied in implicit
conversion from 'int' to 'short int'
Condition generated at: C:\Escher\Customers\prang\prang.c (102,10)
Condition defined at:
To prove: (int)1 \le maxof(short\ int)
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
\theta
\theta = asType < short int > ((int)2)
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\theta
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
```

```
heap_{init}.a3 == asType < short int > ((int)178)
heap_{init}.b3 == asType < short int > ((int)63)
\theta
\theta
\theta = asType < short int > ((int)3)
Proof:
[Take goal term]
[1.0] (int)1 \leq maxof(short int)
\rightarrow [simplify]
[1.3] true
Proof of verification condition: Type constraint satisfied in implicit
conversion from 'int' to 'short int'
Condition generated at: C:\Escher\Customers\prang\prang.c (103,10)
Condition defined at:
To prove: minof(short int) \le (int)2
Given:
heap_{init}.LIMIT == (int)80
\theta
\theta_{init}.r1 == asType < short int > ((int)171)
\theta
\theta
heap_{init}.M2 == asType < short int > ((int)30307)
\rho_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
\theta sheap<sub>init</sub>.M3 == asType<short int>((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
\theta == asType<short int>((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\rho = asType < short int > ((int)3)
```

```
\text{Sheap}_{780,1;783,8} == \text{Sheap}_{funcstart\_780,1}.\_\mathbf{replace}(\text{p1} \to \mathbf{asType} < \mathbf{short})
int>((int)1))
Proof:
[Take goal term]
[1.0] minof(short int) \leq (int)2
\rightarrow [simplify]
[1.3] true
Proof of verification condition: Type constraint satisfied in implicit
conversion from 'int' to 'short int'
Condition generated at: C:\Escher\Customers\prang\prang.c (103,10)
Condition defined at:
To prove: (int)2 \leq maxof(short\ int)
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
\theta
heap_{init}.a1 == asType < short int > ((int)177)
\theta
heap_{init}.M2 == asType < short int > ((int)30307)
heap_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
\theta = asType < short int > ((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
\text{Sheap}_{780,1:783,8} == \text{Sheap}_{funcstart\_780,1}.\_\mathbf{replace}(\text{p1} \to \mathbf{asType} < \mathbf{short})
int>((int)1)
Proof:
```

```
[Take goal term]
[1.0] (int)2 \leq maxof(short int)
\rightarrow [simplify]
[1.3] true
Proof of verification condition: Type constraint satisfied in implicit
conversion from 'int' to 'short int'
Condition generated at: C:\Escher\Customers\prang\prang.c (104,10)
Condition defined at:
To prove: minof(short int) \le (int)3
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta
heap_{init}.M2 == asType < short int > ((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta sheap<sub>init</sub>.b2 == asType<short int>((int)35)
\theta = asType < short int > ((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
\$heap_{780,1;783,8} == \$heap_{funcstart\_780,1}.\_\textbf{replace}(p1 \rightarrow \textbf{asType} < \textbf{short}
int>((int)1)
heap_{780,1:784.8} == heap_{780,1:783.8}.replace(p2 \rightarrow asType<short
int>((int)2)
Proof:
[Take goal term]
```

```
[1.0] minof(short int) \leq (int)3
\rightarrow [simplify]
[1.3] true
Proof of verification condition: Type constraint satisfied in implicit
conversion from 'int' to 'short int'
Condition generated at: C:\Escher\Customers\prang\prang.c (104,10)
Condition defined at:
To prove: (int)3 \le maxof(short\ int)
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
heap_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta = asType < short int > ((int)2)
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\theta
\theta sheap<sub>init</sub>.a2 == asType<short int>((int)176)
\theta
\theta sheap<sub>init</sub>.M3 == asType<short int>((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
heap_{init}.a3 == asType<short int>((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
heap_{780,1;783,8} == heap_{funcstart\_780,1}. replace(p1 \rightarrow asType<short
int>((int)1)
\$ heap_{780,1;784,8} == \$ heap_{780,1;783,8}. \textbf{\_replace} (p2 \rightarrow \textbf{asType} < \textbf{short}
int>((int)2)
Proof:
[Take goal term]
[1.0] (int)3 \leq maxof(short int)
```

```
[1.3] true
Proof of verification condition: Loop initialisation establishes end
condition or a valid variant
Condition generated at: C:\Escher\Customers\prang\prang.c (111,5)
Condition defined at: C:\Escher\Customers\prang\prang.c (114,20)
To prove: 0 \le (asType < integer const > (limit) - limit)
asType<integer>(count))
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
heap_{init}.M2 == asType < short int > ((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta sheap<sub>init</sub>.b2 == asType<short int>((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
heap_{780,1;783,8} == heap_{funcstart\_780,1}.\_replace(p1 \rightarrow asType < short)
int>((int)1)
\text{heap}_{780,1;784,8} == \text{heap}_{780,1;783,8}.\text{replace}(p2 \to asType < short)
int>((int)2))
\$heap_{780,1;785,8} == \$heap_{780,1;784,8}. \textbf{\_replace}(p3 \rightarrow \textbf{asType} < \textbf{short}
int>((int)3))
limit == \$heap_{780,1;785,8}.LIMIT
minof(int const) \le limit
```

 \rightarrow [simplify]

```
limit \leq maxof(int const)
count == (int)0
minof(int) \le count
count \leq maxof(int)
heap_{780,1;790,5} == heap_{780,1;785,8}.replace((&heap_{780,1;785,8}.ecv_files[1]).$r
\rightarrow writes_790_5)
count < limit
Proof:
[Take given term]
[5.0] \text{sheap}_{780.1;783.8} == \text{sheap}_{funcstart\_780.1}. \text{replace}(\text{p1} \rightarrow \text{asType} < \text{short})
int > ((int)1)
\rightarrow [simplify]
[5.2] $heap<sub>780,1;783,8</sub> == $heap<sub>funcstart_780,1</sub>._replace(p1 \rightarrow 1)
[Take given term]
[6.0] $heap<sub>780.1:784.8</sub> == $heap<sub>780.1:783.8</sub>._replace(p2 \rightarrow asType<short
int>((int)2))
\rightarrow [from term 5.2, $heap<sub>780,1;783,8</sub> is equal to $heap<sub>funcstart_780,1</sub>._replace(p1
\rightarrow 1)
[6.1] heap_{780,1;784,8} == heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
asType<short int>((int)2))
\rightarrow [simplify]
\textit{[6.3]} \$ heap_{780,1;784,8} == \$ heap_{funcstart\_780,1}.\_\textbf{replace}(p1 \rightarrow 1).\_\textbf{replace}(p2 \rightarrow 1).\_\textbf{replace}(p2 \rightarrow 1).\_\textbf{replace}(p3 \rightarrow 1).
2)
[Take given term]
[7.0] $\text{heap}_{780,1;785,8} == $\text{heap}_{780,1;784,8}.$_{\text{replace}}(p3 \rightarrow asType < short)
int>((int)3))
\rightarrow [from term 6.3, $heap<sub>780,1;784,8</sub> is equal to $heap<sub>funcstart_780,1</sub>._replace(p1
\rightarrow 1)._replace(p2 \rightarrow 2)]
[7.1] heap_{780,1:785,8} == heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow asType<short int>((int)3))
\rightarrow [simplify]
[7.3] heap_{780,1;785,8} == heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)
[Take given term]
[8.0] $heap<sub>780,1;785,8</sub>.LIMIT == limit
```

```
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)]
[8.1] \text{heap}_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow
3).LIMIT == limit
\rightarrow [const member of object with modified fields]
[8.4] $heap<sub>funcstart_780,1</sub>.LIMIT == limit
\rightarrow [const static or extern object]
[8.5] $heap<sub>init</sub>.LIMIT == limit
\rightarrow [expand definition of constant 'LIMIT' at prang.c (12,18)]
[8.6] (int)80 == limit
\rightarrow [simplify]
[8.7] 80 == limit
[Take given term]
[9.0] (int)0 == count
\rightarrow [simplify]
[9.1] 0 == count
[Take goal term]
[1.0] 0 \leq (asType<integer const>(limit) - asType<integer>(count))
\rightarrow [from term 8.7, limit is equal to 80]
[1.1] 0 \le (asType < integer const > (80) - asType < integer > (count))
\rightarrow [simplify]
[1.2] 0 \le (80 - asType < integer > (count))
\rightarrow [from term 9.1, count is equal to 0]
[1.3]\ 0 \le (80 - asType < integer > (0))
\rightarrow [simplify]
[1.6] true
Proof of verification condition: Loop body establishes end condition or
decreases variant
Condition generated at: C:\Escher\Customers\prang\prang.c (115,5)
Condition defined at: C:\Escher\Customers\prang\prang.c (114,5)
To prove: (asType<integer const>(limit) -
asType < integer > (count_{loopend})) < (asType < integer const > (limit) - (limit) > (limit) = (limit) 
asType < integer > (count_{loopstart\_792,5}))
```

 \rightarrow [from term 7.3, \$heap_{780,1;785,8} is equal to \$heap_{funcstart_780,1}._replace(p1)

Given:

```
heap_{init}.LIMIT == (int)80
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta = asType < short int > ((int)2)
heap_{init}.M2 == asType < short int > ((int)30307)
\rho_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
heap_{init}.a3 == asType<short int>((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
\text{Sheap}_{780,1;783,8} == \text{Sheap}_{funcstart\_780,1}.\text{-replace}(\text{p1} \rightarrow \text{asType} < \text{short})
int>((int)1))
heap_{780,1:784,8} == heap_{780,1:783,8}.replace(p2 \rightarrow asType<short
int>((int)2))
\$ heap_{780,1;785,8} == \$ heap_{780,1;784,8}. \textbf{\_replace} (p3 \rightarrow \textbf{asType} < \textbf{short}
int>((int)3)
limit == \$heap_{780,1;785,8}.LIMIT
minof(int const) \leq limit
limit \leq maxof(int const)
count == (int)0
minof(int) \le count
count \leq maxof(int)
\text{sheap}_{780.1;790.5} == \text{sheap}_{780.1;785.8}. \mathbf{replace}((\&\text{sheap}_{780.1;785.8}. \mathbf{ecv\_files}[1]). \mathbf{sr}
\rightarrow writes_790_5)
heap_{loopstart\_792,5} == heap_{780,1;790,5}._replace(p1 \rightarrow
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow
writes_793_12)._replace(\_ecv\_files \rightarrow writes\_793\_12)
```

```
\#\text{writes}_{793\_12} == \#\text{heap}_{780.1:790.5}.\text{ecv}_{\text{files}}
minof(int) \leq count_{loopstart\_792,5}
count_{loopstart\_792,5} \le maxof(int)
invariant1(heapIs $heap_loopstart_792,5)
\operatorname{count}_{loopstart\_792,5} < \operatorname{limit}
0 \le (asType < integer const > (limit) -
asType < integer > (count_{loopstart\_792.5}))
(\mathbf{asType} < \mathbf{integer} \ \mathbf{const} > (\mathbf{limit}) \ - \ \mathbf{asType} < \mathbf{integer} > (\mathbf{count}_{loopstart\_792,5}))
\leq (asType < integer const > (limit) - asType < integer > (count))
(++\text{count}_{loopstart\_792,5} == \text{count}_{loopend}) \land (\$\text{heap}_{797,16} ==
\text{Sheap}_{loopstart\_792.5}.\_\mathbf{replace}(p1 \rightarrow writes\_797\_25).\_\mathbf{replace}(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)) \land ($heap<sub>loopend</sub> ==
\rho_{797,16}.\_replace((\&\rho_{797,16}.\_ecv\_files[1]).$r \rightarrow writes\_797\_9)) \land \rho_{797,16}.\_ecv\_files[1]
(asType < real > ((double)0.0) < asType < real > (\$result_797_25)) \land
(asType < real > (\$result\_797\_25) < asType < real > ((double)1.0)) \land
invariant1(heapIs $heap<sub>797.16</sub>)
\operatorname{count}_{loopend} < \operatorname{limit}
Proof:
[Take given term]
[5.0] \text{sheap}_{780,1;783,8} == \text{sheap}_{funcstart\_780,1}. \text{replace}(\text{p1} \rightarrow \text{asType} < \text{short})
int>((int)1))
\rightarrow [simplify]
[5.2] $\text{heap}_{780,1;783,8} == $\text{heap}_{funcstart_780,1}._\text{replace}(p1 \rightarrow 1)$
[Take given term]
[6.0] $\text{heap}_{780,1;784,8} == \text{$heap}_{780,1;783,8}._\text{replace}(p2 \rightarrow \text{asType} < \text{short}
int>((int)2))
\rightarrow [from term 5.2, $heap<sub>780,1:783,8</sub> is equal to $heap<sub>funcstart_780,1</sub>._replace(p1
\rightarrow 1)
[6.1] heap_{780,1;784,8} == heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
\mathbf{asType}{<}\mathbf{short}\ \mathbf{int}{>}((\mathbf{int})2))
\rightarrow [simplify]
[6.3] \text{heap}_{780,1;784,8} == \text{heap}_{funcstart\_780,1}.\mathbf{replace}(p1 \rightarrow 1).\mathbf{replace}(p2 \rightarrow
2)
[Take given term]
[7.0] $\text{heap}_{780,1:785,8} == \text{$heap}_{780,1:784,8}._\text{$replace}(p3 \to \text{asType} < \text{short}
int>((int)3))
```

```
\rightarrow [from term 6.3, $heap_{780,1:784,8}$ is equal to $heap_{funcstart\_780,1}._replace(p1
\rightarrow 1)._replace(p2 \rightarrow 2)]
[7.1] heap_{780,1;785,8} == heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow asType<short int>((int)3))
\rightarrow [simplify]
[7.3] \text{heap}_{780,1;785,8} == \text{heap}_{funcstart\_780,1}.\mathbf{replace}(p1 \rightarrow 1).\mathbf{replace}(p2 \rightarrow
2)._replace(p3 \rightarrow 3)
[Take given term]
[8.0] $heap<sub>780,1:785,8</sub>.LIMIT == limit
\rightarrow [from term 7.3, $heap<sub>780,1;785,8</sub> is equal to $heap<sub>funcstart_780,1</sub>._replace(p1
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)]
[8.1] \text{Sheap}_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow
3).LIMIT == limit
\rightarrow [const member of object with modified fields]
[8.4] $heap<sub>funcstart_780,1</sub>.LIMIT == limit
\rightarrow [const static or extern object]
[8.5] $heap<sub>init</sub>.LIMIT == limit
\rightarrow [expand definition of constant 'LIMIT' at prang.c (12,18)]
[8.6] (int)80 == limit
\rightarrow [simplify]
[8.7] 80 == limit
[Take given term]
[10.0] $heap<sub>780,1;790,5</sub> ==
\rho_{780,1;785,8}.=\rho_{80,1;785,8}.=\rho_{80,1;785,8}.=\rho_{80,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785,8}.=\rho_{10,1;785
\rightarrow [from term 7.3, $heap<sub>780,1;785,8</sub> is equal to $heap<sub>funcstart_780,1</sub>._replace(p1)
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)]
[10.1] \text{$heap}_{780,1;790,5} == \text{$heap}_{funcstart\_780,1}.\_replace(p1 \to 1).\_replace(p2)
\rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap_{780,1:785,8}._ecv_files[1]).$r \rightarrow
writes_790_5)
\rightarrow [simplify]
[10.2] heap_{780,1;790,5} == heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2
\rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]).$r \rightarrow writes_790_5)
→ [attribute value is known from postcondition]
[10.3] \text{sheap}_{780,1;790,5} == \text{sheap}_{funcstart\_780,1}.\_replace(p1 \to 1).\_replace(p2 \to 1)
\rightarrow 2)._replace(p3 \rightarrow 3)._replace(&\text{heap._ecv_files}[1] \rightarrow writes_790_5)
[Take given term]
```

```
[11.0] $\text{heap}_{loopstart_792,5} == $\text{heap}_{780,1;790,5}._\text{replace}(p1 \rightarrow 1.0]$
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow
writes_793_12)._replace(\_ecv\_files \rightarrow writes\_793\_12)
\rightarrow [from term 10.3, $heap<sub>780,1;790,5</sub> is equal to $heap<sub>funcstart_780,1</sub>._replace(p1
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace(&$heap._ecv_files[1] \rightarrow
writes_790_5)]
[11.1] heap_{loopstart\_792,5} == heap_{funcstart\_780,1}._replace(p1 \rightarrow
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)
[Take given term]
[29.0] (++\text{count}_{loopstart\_792,5} == \text{count}_{loopend}) \land (\$\text{heap}_{797,16} ==
\theta_{loopstart\_792.5}._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)) \land ($heap<sub>loopend</sub> ==
\text{sheap}_{797,16}.\text{-replace}((\&\text{sheap}_{797,16}.\text{-ecv\_files}[1]).\text{sr} \rightarrow \text{writes}\_797\_9)) \land
(asType < real > ((double)0.0) < asType < real > (\$result_797.25)) \land
(\mathbf{asType} < \mathbf{real} > (\$result\_797\_25) < \mathbf{asType} < \mathbf{real} > ((\mathbf{double})1.0)) \land \\
invariant1(heapIs $heap<sub>797,16</sub>)
\rightarrow [simplify]
[29.8] (1 == (count_{loopend} + -count_{loopstart\_792.5})) \land (sheap_{797.16} ==
\text{Sheap}_{loopstart\_792.5}._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)) \land ($heap<sub>loopend</sub> ==
\text{sheap}_{797,16}.\text{-replace}((\&\text{sheap}_{797,16}.\text{-ecv\_files}[1]).\text{sr} \rightarrow \text{writes}_{-797,9})) \land
(asType < real > ((double)0.0) < asType < real > (\$result_797_25)) \land
(asType < real > (\$result\_797\_25) < asType < real > ((double)1.0)) \land
invariant1(heapIs $heap<sub>797,16</sub>)
\rightarrow [from term 11.1, \rho_{loopstart\_792,5} is equal to
heap_{funcstart\_780.1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 1)._replace(p3 \rightarrow 1)._repla
3)._replace((&\$heap._ecv_files[1]) \rightarrow writes_790_5)._replace(p1 \rightarrow
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow 
writes_793_12)._replace(_ecv_files \rightarrow writes_793_12)]
[29.9] (1 == (-\text{count}_{loopstart\_792,5} + \text{count}_{loopend})) \land (\$\text{heap}_{797,16} ==
heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow
3)._replace((&\$heap._ecv_files[1]) \rightarrow writes_790_5)._replace(p1 \rightarrow
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow
writes_793_12)._replace(_ecv_files \rightarrow writes_793_12)._replace(p1 \rightarrow
writes_797_25)._replace(p2 \rightarrow writes_797_25)._replace(p3 \rightarrow writes_797_25))
\land (\$ heap_{loopend} == \$ heap_{797,16}.\_\mathbf{replace}((\&\$ heap_{797,16}.\_\mathbf{ecv\_files}[1]).\$ r \rightarrow
writes\_797\_9)) \, \wedge \, (\mathbf{asType}{<}\mathbf{real}{>}((\mathbf{double})0.0) <
asType < real > (\$result\_797\_25)) \land (asType < real > (\$result\_797\_25) < result\_797\_25) < result\_797\_25)
asType < real > ((double)1.0)) \land invariant1(heapIs $heap_{797,16})
```

```
\rightarrow [simplify]
[29.10] (1 == (-\text{count}_{loopstart\_792,5} + \text{count}_{loopend})) \land (\$\text{heap}_{797,16} ==
\theta_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow
3)._replace((&$heap._ecv_files[1]) \rightarrow writes_790_5)._replace(p1 \rightarrow
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow
writes_793_12)._replace(\_ecv\_files \rightarrow writes\_793\_12)._replace(p1 \rightarrow
writes_797_25)._replace(p2 \rightarrow writes_797_25)._replace(p3 \rightarrow writes_797_25))
\land \ (\$ heap_{loopend} == \$ heap_{797,16}.\_\mathbf{replace}((\&\$ heap.\_ecv\_files[1]).\$ r \rightarrow 0
writes_797_9)) \land (asType<real>((double)0.0) <
asType < real > (\$result_797.25)) \land (asType < real > (\$result_797.25) < real > (\$result_797.25
asType < real > ((double)1.0)) \land invariant1(heapIs $heap_{797.16})
\rightarrow [attribute value is known from postcondition]
[29.11] (1 == (-\text{count}_{loopstart\_792,5} + \text{count}_{loopend})) \land (\$\text{heap}_{797,16} ==
\theta_{funcstart\_780.1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow
3)._replace((&\$heap._ecv_files[1]) \rightarrow writes_790_5)._replace(p1 \rightarrow
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow
writes_793_12)._replace(_ecv_files \rightarrow writes_793_12)._replace(p1 \rightarrow
writes_797_25)._replace(p2 \rightarrow writes_797_25)._replace(p3 \rightarrow writes_797_25))
\land ($heap<sub>loopend</sub> == $heap<sub>797,16</sub>._replace(&$heap._ecv_files[1] \rightarrow
writes_797_9) \land (asType < real > ((double)0.0) <
asType < real > (\$result\_797\_25)) \land (asType < real > (\$result\_797\_25) < real > (\$result\_797\_25
asType < real > ((double)1.0)) \land invariant1(heapIs $heap_{797,16})
\rightarrow [simplify]
 [29.20] (1 == (-\text{count}_{loopstart\_792,5} + \text{count}_{loopend})) \land (\$\text{heap}_{797,16} ==
{\rm Sheap}_{funcstart\_780,1}.{\tt replace}({\rm p1} \to 1).{\tt replace}({\rm p2} \to 2).{\tt replace}({\rm p3} \to 1).{\tt replace}({\rm p2} \to 2).{\tt replace}({\rm p3} \to 1).{\tt replace}({\rm p3} \to 1).
3)._replace((&\text{heap._ecv_files}[1]) \rightarrow writes_790_5)._replace(p1 \rightarrow
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow
writes_793_12)._replace(_ecv_files \rightarrow writes_793_12)._replace(p1 \rightarrow
writes_797_25)._replace(p2 \rightarrow writes_797_25)._replace(p3 \rightarrow writes_797_25))
\land ($heap<sub>loopend</sub> == $heap<sub>797,16</sub>._replace(&$heap._ecv_files[1] \rightarrow
writes_797_9)) \land (0.0 < $result_797_25) \land (-1.0 < -$result_797_25) \land
invariant1(heapIs $heap<sub>797,16</sub>)
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
[29.21] (1 == (-\text{count}_{loopstart\_792,5} + \text{count}_{loopend})) \land (\$\text{heap}_{797,16} ==
{\rm Sheap}_{funcstart\_780,1}.{\bf replace}({\rm p1} \rightarrow 1).{\bf replace}({\rm p2} \rightarrow 2).{\bf replace}({\rm p3} \rightarrow 1).{\bf replace}({\rm p2} \rightarrow 2).{\bf replace}({\rm p3} \rightarrow 1).{\bf replace}({\rm p3} \rightarrow 1).
3)._replace((&\text{heap._ecv_files}[1]) \rightarrow writes_790_5)._replace(p1 \rightarrow
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow
writes_793_12)._replace(_ecv_files \rightarrow writes_793_12)._replace(p1 \rightarrow
writes_797_25)._replace(p2 \rightarrow writes_797_25)._replace(p3 \rightarrow writes_797_25))
\land \ (\$ heap_{loopend} == \$ heap_{797,16}.\_\mathbf{replace} (\&\$ heap.\_ecv\_files[1] \rightarrow \\
writes_797_9)) \land (0.0 < $result_797_25) \land (-1.0 < -$result_797_25) \land ((((((0 <
asType<integer>($heap<sub>797.16</sub>.p1)) && (asType<integer>($heap<sub>797.16</sub>.p1)
< asType < integer > ($heap_{797,16}.M1))) && (0 < 1)
```

```
asType < integer > (\$heap_{797,16}.p2))) \&\& (asType < integer > (\$heap_{797,16}.p2))
< asType < integer > ($heap_{797,16}.M2))) \&\& (0 <
asType < integer > (\$heap_{797,16}.p3))) \&\& (asType < integer > (\$heap_{797,16}.p3))
< asType<integer>($heap<sub>797,16</sub>.M3)))
\rightarrow [simplify]
[29.23] (1 == (-\text{count}_{loopstart\_792,5} + \text{count}_{loopend})) \land (\$\text{heap}_{797,16} ==
\theta_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow
3)._replace((&\$heap._ecv_files[1]) \rightarrow writes_790_5)._replace(p1 \rightarrow
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow
writes_793_12)._replace(_ecv_files \rightarrow writes_793_12)._replace(p1 \rightarrow
writes_797_25)._replace(p2 \rightarrow writes_797_25)._replace(p3 \rightarrow writes_797_25))
\land ($heap<sub>loopend</sub> == $heap<sub>797,16</sub>._replace(&$heap._ecv_files[1] \rightarrow
writes_797_9)) \land (0.0 < $result_797_25) \land (-1.0 < -$result_797_25) \land ((((((0 <
\rho_{797,16} $\psi_1$ $\psi_4$ $\psi_1$ $\psi_2$ $\psi_2$ $\psi_1$ $\psi_2$ $\psi_1$ $\psi_2$ $\psi_1$ $\psi_2$ $\psi_2$ $\psi_1$ $\psi_2$ $\psi_1$ $\psi_2$ $\psi_2$ $\psi_2$ $\psi_1$ $\psi_2$ $\psi_2$ $\psi_2$ $\psi_1$ $\psi_2$ $\psi_2$ $\psi_2$ $\psi_1$ $\psi_2$ $\psi_2$ $\psi_2$ $\psi_2$ $\psi_1$ $\psi_2$ $\psi_2
&& (0 < asType < integer > (\$heap_{797,16}.p2))) &&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{797,16}.\mathrm{p2}) < \mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{797,16}.\mathrm{M2})))
&& (0 < asType < integer > (\$heap_{797,16}.p3))) &&
(asType < integer > ($heap_{797.16}.p3) < asType < integer > ($heap_{797.16}.M3)))
\rightarrow [const static or extern object]
[29.24] (1 == (-\text{count}_{loopstart\_792,5} + \text{count}_{loopend})) \land (\$\text{heap}_{797,16} ==
\theta_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow
3)._replace((&$heap._ecv_files[1]) \rightarrow writes_790_5)._replace(p1 \rightarrow
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow
writes_793_12)._replace(\_ecv\_files \rightarrow writes\_793\_12)._replace(p1 \rightarrow
writes_797_25)._replace(p2 \rightarrow writes_797_25)._replace(p3 \rightarrow writes_797_25))
\land \ (\$ heap_{loopend} == \$ heap_{797,16}.\_\mathbf{replace} (\&\$ heap.\_ecv\_files[1] \rightarrow \\
writes_797_9)) \land (0.0 < $result_797_25) \land (-1.0 < -$result_797_25) \land ((((((0 <
\rho_{797,16} (heap<sub>797,16</sub>.p1 < asType<integer>(\rho_{797,16}.p1) &&
(0 < asType < integer > (\$heap_{797,16}.p2))) \&\&
(asType < integer > (\$heap_{797,16}.p2) < asType < integer > (\$heap_{797,16}.M2)))
&& (0 < asType < integer > (\$heap_{797,16},p_3))) &&
(asType < integer > (\$heap_{797,16}.p3) < asType < integer > (\$heap_{797,16}.M3)))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[29.25] (1 == (-\text{count}_{loopstart\_792,5} + \text{count}_{loopend})) \land (\$\text{heap}_{797,16} ==
{\bf p}_{funcstart\_780,1}.{\bf place}({\bf p}1 \to 1).{\bf place}({\bf p}2 \to 2).{\bf place}({\bf p}3 \to 1).{\bf place}({\bf p}3 \to
3)._replace((&\$heap._ecv_files[1]) \rightarrow writes_790_5)._replace(p1 \rightarrow
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow
writes_793_12)._replace(_ecv_files \rightarrow writes_793_12)._replace(p1 \rightarrow
writes_797_25)._replace(p2 \rightarrow writes_797_25)._replace(p3 \rightarrow writes_797_25))
\land ($heap<sub>loopend</sub> == $heap<sub>797,16</sub>._replace(&$heap._ecv_files[1] \rightarrow
writes_797_9)) \land (0.0 < $result_797_25) \land (-1.0 < -$result_797_25) \land ((((((0 <
\rho_{797,16}.p1 && (\rho_{797,16}.p1 < asType < integer > (asType < short)
int>((int)30269))) && (0 < asType < integer>($heap_{797.16}.p2))) &&
```

```
(asType < integer > (\$heap_{797.16}.p2) < asType < integer > (\$heap_{797.16}.M2)))
&& (0 < asType < integer > (\$heap_{797,16}.p3))) &&
(asType < integer > (\$heap_{797,16}.p3) < asType < integer > (\$heap_{797,16}.M3)))
\rightarrow [simplify]
[29.36] (1 == (-\text{count}_{loopstart\_792,5} + \text{count}_{loopend})) \land (\$\text{heap}_{797,16} ==
heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow
3)._replace((&$heap._ecv_files[1]) \rightarrow writes_790_5)._replace(p1 \rightarrow
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow
writes_793_12)._replace(_ecv_files \rightarrow writes_793_12)._replace(p1 \rightarrow
writes_797_25)._replace(p2 \rightarrow writes_797_25)._replace(p3 \rightarrow writes_797_25))
\land ($heap<sub>loopend</sub> == $heap<sub>797,16</sub>._replace(&$heap._ecv_files[1] \rightarrow
writes_797_9)) \land (0.0 < $result_797_25) \land (-1.0 < -$result_797_25) \land
(((((-30269 < -\$heap_{797,16}.p1) \land (0 < \$heap_{797,16}.p1) \land (0 < \$heap_{797,16}.p2)))
&& (\theta = p_{797,16}.p2 < asType < integer > (\theta = p_{797,16}.M2)) && (0 <
asType < integer > (\$heap_{797,16}.p3))) \&\& (asType < integer > (\$heap_{797,16}.p3))
< asType < integer > ($heap_{797,16}.M3)))
\rightarrow [const static or extern object]
[29.37] (1 == (-\text{count}_{loopstart\_792,5} + \text{count}_{loopend})) \land (\$\text{heap}_{797,16} ==
heap_{funcstart_{-780,1}}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow
3)._replace((&\$heap._ecv_files[1]) \rightarrow writes_790_5)._replace(p1 \rightarrow
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow
writes_793_12)._replace(_ecv_files \rightarrow writes_793_12)._replace(p1 \rightarrow
writes_797_25)._replace(p2 \rightarrow writes_797_25)._replace(p3 \rightarrow writes_797_25))
\land ($heap<sub>loopend</sub> == $heap<sub>797.16</sub>._replace(&$heap._ecv_files[1] \rightarrow
writes_797_9)) \land (0.0 < $result_797_25) \land (-1.0 < -$result_797_25) \land
(((((-30269 < -\$heap_{797,16}.p1) \land (0 < \$heap_{797,16}.p1) \land (0 < \$heap_{797,16}.p2)))
&& (\theta_{init}.M2))) && (0 <
asType<integer>($heap<sub>797,16</sub>.p3))) && (asType<integer>($heap<sub>797,16</sub>.p3)
< asType < integer > ($heap_{797,16}.M3)))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[29.38] (1 == (-\text{count}_{loopstart\_792,5} + \text{count}_{loopend})) \land (\$\text{heap}_{797,16} ==
heap_{funcstart\_780.1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow
3)._replace((&\$heap._ecv_files[1]) \rightarrow writes_790_5)._replace(p1 \rightarrow
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow
writes_793_12)._replace(_ecv_files \rightarrow writes_793_12)._replace(p1 \rightarrow
writes_797_25)._replace(p2 \rightarrow writes_797_25)._replace(p3 \rightarrow writes_797_25))
\land ($heap<sub>loopend</sub> == $heap<sub>797,16</sub>._replace(&$heap._ecv_files[1] \rightarrow
writes_797_9)) \land (0.0 < $result_797_25) \land (-1.0 < -$result_797_25) \land
(((((-30269 < -\$heap_{797,16}.p1) \land (0 < \$heap_{797,16}.p1) \land (0 < \$heap_{797,16}.p2)))
&& (heap_{797,16}.p2 < asType < integer > (asType < short)
int>((int)30307))) && (0 < asType < integer>($heap_{797,16}.p3))) &&
(asType < integer > (\$heap_{797.16}.p3) < asType < integer > (\$heap_{797.16}.M3)))
\rightarrow [simplify]
```

```
[29.50] (1 == (-\text{count}_{loopstart\_792,5} + \text{count}_{loopend})) \land (\$\text{heap}_{797,16} ==
heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow
3)._replace((&\text{heap._ecv_files}[1]) \rightarrow writes_790_5)._replace(p1 \rightarrow
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow
writes_793_12)._replace(_ecv_files \rightarrow writes_793_12)._replace(p1 \rightarrow
writes_797_25)._replace(p2 \rightarrow writes_797_25)._replace(p3 \rightarrow writes_797_25))
\land (\$ heap_{loopend} == \$ heap_{797,16}.\_\mathbf{replace} (\&\$ heap.\_ecv\_files[1] \rightarrow
writes_797_9)) \land (0.0 < $result_797_25) \land (-1.0 < -$result_797_25) \land (((-30307))
< -\$heap_{797,16}.p2) \land (-30269 < -\$heap_{797,16}.p1) \land (0 < \$heap_{797,16}.p1) \land (0
< $heap<sub>797,16</sub>.p2) \land (0 < $heap<sub>797,16</sub>.p3)) && ($heap<sub>797,16</sub>.p3 <
asType<integer>($heap<sub>797.16</sub>.M3)))
\rightarrow [const static or extern object]
[29.51] (1 == (-\text{count}_{loopstart\_792,5} + \text{count}_{loopend})) \land (\$\text{heap}_{797,16} ==
\$heap_{funcstart\_780,1}.\_\mathbf{replace}(p1 \to 1).\_\mathbf{replace}(p2 \to 2).\_\mathbf{replace}(p3 \to 1)
3)._replace((&$heap._ecv_files[1]) \rightarrow writes_790_5)._replace(p1 \rightarrow
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow
writes_793_12)._replace(_ecv_files \rightarrow writes_793_12)._replace(p1 \rightarrow
writes_797_25)._replace(p2 \rightarrow writes_797_25)._replace(p3 \rightarrow writes_797_25))
\land \ (\$ heap_{loopend} == \$ heap_{797,16}.\_\mathbf{replace} (\&\$ heap.\_ecv\_files[1] \rightarrow \\
writes_797_9)) \land (0.0 < $result_797_25) \land (-1.0 < -$result_797_25) \land (((-30307))
<-$heap<sub>797,16</sub>.p2) \land (-30269 <-$heap<sub>797,16</sub>.p1) \land (0 <$heap<sub>797,16</sub>.p1) \land (0
< $heap<sub>797,16</sub>.p2) \land (0 < $heap<sub>797,16</sub>.p3)) && ($heap<sub>797,16</sub>.p3 <
asType < integer > (\$heap_{init}.M3)))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[29.52] (1 == (-\text{count}_{loopstart\_792,5} + \text{count}_{loopend})) \land (\$\text{heap}_{797,16} ==
heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow
3)._replace((&\$heap._ecv_files[1]) \rightarrow writes_790_5)._replace(p1 \rightarrow
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow
writes_793_12)._replace(_ecv_files \rightarrow writes_793_12)._replace(p1 \rightarrow
writes_797_25)._replace(p2 \rightarrow writes_797_25)._replace(p3 \rightarrow writes_797_25))
\land ($heap<sub>loopend</sub> == $heap<sub>797,16</sub>._replace(&$heap._ecv_files[1] \rightarrow
writes_797_9)) \land (0.0 < $result_797_25) \land (-1.0 < -$result_797_25) \land (((-30307))
<-$heap<sub>797,16</sub>.p2) \land (-30269 <-$heap<sub>797,16</sub>.p1) \land (0 <$heap<sub>797,16</sub>.p1) \land (0
< $heap<sub>797,16</sub>.p2) \land (0 < $heap<sub>797,16</sub>.p3)) && ($heap<sub>797,16</sub>.p3 <
asType<integer>(asType<short int>((int)30323))))
\rightarrow [simplify]
[29.61] (1 == (-\text{count}_{loopstart\_792,5} + \text{count}_{loopend})) \land (\$\text{heap}_{797,16} ==
heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow
3)._replace((&\$heap._ecv_files[1]) \rightarrow writes_790_5)._replace(p1 \rightarrow
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow
writes_793_12)._replace(_ecv_files \rightarrow writes_793_12)._replace(p1 \rightarrow
writes_797_25)._replace(p2 \rightarrow writes_797_25)._replace(p3 \rightarrow writes_797_25))
\land (\$ heap_{loopend} == \$ heap_{797,16}. \mathbf{replace} (\$ \$ heap. \underline{ecv\_files}[1] \rightarrow writes\underline{-797\_9}))
```

```
\land (0.0 < \text{\$result\_797\_25}) \land (-1.0 < -\text{\$result\_797\_25}) \land (-30323 < -\text{\$result\_797\_25})
-\$heap_{797,16}.p3) \land (-30307 < -\$heap_{797,16}.p2) \land (-30269 < -\$heap_{797,16}.p1)
\land (0 < \text{$heap}_{797,16}.\text{p1}) \land (0 < \text{$heap}_{797,16}.\text{p2}) \land (0 < \text{$heap}_{797,16}.\text{p3})
\rightarrow [separate conjunction and work on first sub-term]
[29.62] 1 == (-\operatorname{count}_{loopstart\_792,5} + \operatorname{count}_{loopend})
[Take goal term]
[1.0] (asType<integer const>(limit) - asType<integer>(count_loopend)) <
(asType < integer const > (limit) - asType < integer > (count_{loopstart\_792.5}))
\rightarrow [from term 8.7, limit is equal to 80]
[1.1] (asType<integer const>(80) - asType<integer>(count_loopend)) <
(asType<integer const>(limit) - asType<integer>(count_loopstart_792.5))
\rightarrow [simplify]
[1.2] \; (80 - \mathbf{asType} < \mathbf{integer} > (\mathbf{count}_{loopend})) < (\mathbf{asType} < \mathbf{integer})
const>(limit) - asType<integer>(count<sub>loopstart_792,5</sub>))
\rightarrow [from term 29.62, count<sub>loopend</sub> is equal to 1 + count<sub>loopstart_792,5</sub>]
[1.3] (80 - asType<integer>(1 + count<sub>loopstart_792.5</sub>)) < (asType<integer)
const>(limit) - asType < integer>(count_{loopstart\_792.5}))
\rightarrow [simplify]
[1.9] (79 + -\text{count}_{loopstart\_792,5}) < (asType < integer const > (limit) - 
asType < integer > (count_{loopstart\_792,5}))
\rightarrow [from term 8.7, limit is equal to 80]
[1.10] (79 + -count<sub>loopstart_792,5</sub>) < (asType<integer const>(80) -
asType < integer > (count_{loopstart\_792,5}))
\rightarrow [simplify]
[1.22] true
Proof of verification condition: Loop body establishes end condition or
preserves validity of variant
Condition generated at: C:\Escher\Customers\prang\prang.c (115,5)
Condition defined at: C:\Escher\Customers\prang\prang.c (114,20)
To prove: 0 \le (asType < integer const > (limit) - limit)
\mathbf{asType}{<}\mathbf{integer}{>}(\mathbf{count}_{loopend}))
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
```

```
heap_{init}.a1 == asType < short int > ((int)177)
\theta = asType < short int > ((int)2)
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
\theta_{init}.a2 == asType<short int>((int)176)
heap_{init}.b2 == asType<short int>((int)35)
\theta = asType < short int > ((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
heap_{init}.b3 == asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
\text{Sheap}_{780,1;783,8} == \text{Sheap}_{funcstart\_780,1}.\_\mathbf{replace}(\text{p1} \to \mathbf{asType} < \mathbf{short})
int>((int)1)
heap_{780,1:784.8} == heap_{780,1:783.8}.replace(p2 \rightarrow asType<short
int>((int)2))
\text{$heap}_{780,1;785,8} == \text{$heap}_{780,1;784,8}.\_\textbf{replace}(p3 \to \textbf{asType} < \textbf{short}
int>((int)3))
limit == \$heap_{780,1;785,8}.LIMIT
minof(int const) \le limit
limit \leq maxof(int const)
count == (int)0
minof(int) \le count
count \le maxof(int)
\text{Sheap}_{780,1;790,5} == \text{Sheap}_{780,1;785,8}.\mathbf{replace}((\&\text{Sheap}_{780,1;785,8}.\mathbf{ecv}_{files}[1]).\text{Sr}
\rightarrow writes_790_5)
heap_{loopstart\_792,5} == heap_{780,1;790,5}._replace(p1 \rightarrow
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow
writes_793_12)._replace(\_ecv\_files \rightarrow writes\_793\_12)
\#writes_793_12 == \#$heap<sub>780,1:790,5</sub>._ecv_files
minof(int) \leq count_{loopstart\_792,5}
count_{loopstart\_792,5} \le maxof(int)
invariant1(heapIs heap_{loopstart\_792,5})
```

```
\operatorname{count}_{loopstart\_792,5} < \operatorname{limit}
0 \le (asType < integer const > (limit) -
asType < integer > (count_{loopstart\_792.5}))
(asType < integer const > (limit) - asType < integer > (count_{loopstart\_792,5}))
\leq (asType < integer const > (limit) - asType < integer > (count))
(++count_{loopstart\_792,5} == count_{loopend}) \land (\$heap_{797,16} ==
heap_{loopstart\_792.5}._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)) \land ($heap<sub>loopend</sub> ==
\rho_{797,16}.\_replace((\&\rho_{797,16}.\_ecv\_files[1]).$r \rightarrow writes\_797\_9)) \land \rho_{797,16}.\_ecv\_files[1]
(asType < real > ((double)0.0) < asType < real > (\$result_797_25)) \land
(asType < real > (\$result\_797\_25) < asType < real > ((double)1.0)) \land
invariant1(heapIs $heap<sub>797.16</sub>)
count_{loopend} < limit
Proof:
[Take given term]
[5.0] \text{sheap}_{780.1;783.8} == \text{sheap}_{funcstart\_780.1}. \text{replace}(\text{p1} \rightarrow \text{asType} < \text{short})
int > ((int)1)
\rightarrow [simplify]
[5.2] $\text{heap}_{780,1;783,8} == $\text{heap}_{funcstart_780,1}._\text{replace}(p1 \rightarrow 1)$
[Take given term]
[6.0] $heap<sub>780.1:784.8</sub> == $heap<sub>780.1:783.8</sub>._replace(p2 \rightarrow asType<short
int>((int)2))
\rightarrow [from term 5.2, $heap<sub>780,1;783,8</sub> is equal to $heap<sub>funcstart_780,1</sub>._replace(p1
\rightarrow 1)
[6.1] heap_{780,1;784,8} == heap_{funcstart\_780,1}. replace(p1 \rightarrow 1). replace(p2 \rightarrow 1)
asType<short int>((int)2))
\rightarrow [simplify]
[6.3] heap_{780,1;784,8} == heap_{funcstart\_780,1}. replace(p1 \rightarrow 1). replace(p2 \rightarrow 1)
2)
[Take given term]
[7.0] $\text{heap}_{780.1:785.8} == \text{$heap}_{780.1:784.8}._\text{replace}(p3 \rightarrow \text{asType} < \text{short}
int > ((int)3))
\rightarrow [from term 6.3, $heap_{780,1;784,8}$ is equal to $heap_{funcstart\_780,1}._replace(p1
\rightarrow 1)._replace(p2 \rightarrow 2)]
\label{eq:funcstart_780,1.replace} \mbox{[7.1] $$heap_{780,1;785,8} == $$heap_{funcstart\_780,1}.$\_{\bf replace}(p1 \rightarrow 1).$\_{\bf replace}(p2 \rightarrow 1).$$
2)._replace(p3 \rightarrow asType<short int>((int)3))
\rightarrow [simplify]
```

```
[7.3] \text{sheap}_{780,1;785,8} == \text{sheap}_{funcstart\_780,1}.\text{replace}(p1 \rightarrow 1).\text{replace}(p2 \rightarrow
2)._replace(p3 \rightarrow 3)
[Take given term]
[8.0] $heap<sub>780,1;785,8</sub>.LIMIT == limit
\rightarrow [from term 7.3, $heap<sub>780,1:785,8</sub> is equal to $heap<sub>funcstart_780,1</sub>._replace(p1)
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)]
[8.1] \text{heap}_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow
3).LIMIT == limit
\rightarrow [const member of object with modified fields]
[8.4] $heap<sub>funcstart_780.1</sub>.LIMIT == limit
\rightarrow [const static or extern object]
[8.5] $heap<sub>init</sub>.LIMIT == limit
\rightarrow [expand definition of constant 'LIMIT' at prang.c (12,18)]
[8.6] (int)80 == limit
\rightarrow [simplify]
[8.7] 80 == limit
[Take given term]
[10.0] $heap<sub>780,1;790,5</sub> ==
\$heap_{780,1;785,8}.\_\mathbf{replace}((\&\$heap_{780,1;785,8}.\_ecv\_files[1]).\$r \to writes\_790\_5)
\rightarrow [from term 7.3, $heap<sub>780,1:785,8</sub> is equal to $heap<sub>funcstart_780,1</sub>._replace(p1
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)]
[10.1] $\text{heap}_{780,1;790,5} == $\text{heap}_{funcstart\_780,1}._\text{replace}(p1 \to 1)._\text{replace}(p2)
\rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap_{780,1;785,8}.ecv_files[1]).$r \rightarrow
writes_790_5)
\rightarrow [simplify]
[10.2] \; \$ heap_{780,1;790,5} == \; \$ heap_{funcstart\_780,1}.\_\mathbf{replace}(p1 \to 1).\_\mathbf{replace}(p2 \to 1).\_\mathbf{replace}(p2 \to 1).
\rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]).$r \rightarrow writes_790_5)
\rightarrow [attribute value is known from postcondition]
[10.3] $\text{heap}_{780.1:790.5} == \text{$heap}_{funcstart\_780.1}._{\text{replace}}(p1 \rightarrow 1)._{\text{replace}}(p2)
\rightarrow 2)._replace(p3 \rightarrow 3)._replace(&\text{heap._ecv_files}[1] \rightarrow writes_790_5)
[Take given term]
[11.0] $\text{heap}_{loopstart_792,5} == $\text{heap}_{780,1;790,5}._\text{replace}(p1 \rightarrow 1.0]$
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow
writes_793_12)._replace(\_ecv\_files \rightarrow writes\_793\_12)
\rightarrow [from term 10.3, $heap<sub>780.1:790.5</sub> is equal to $heap<sub>funcstart_780.1</sub>._replace(p1
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace(&\$heap._ecv_files[1] \rightarrow
```

```
writes_790_5)]
[11.1] \text{heap}_{loopstart\_792,5} == \text{heap}_{funcstart\_780,1}._replace(p1 \rightarrow
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)
[Take given term]
 [29.0] (++\text{count}_{loopstart\_792,5} == \text{count}_{loopend}) \land (\$\text{heap}_{797,16} ==
\theta_{loopstart\_792,5}.\_\mathbf{replace}(p1 \rightarrow writes\_797\_25).\_\mathbf{replace}(p2 \rightarrow writes\_797\_25).
writes_797_25)._replace(p3 \rightarrow writes_797_25)) \land ($heap<sub>loopend</sub> ==
\text{sheap}_{797.16}.\text{-replace}((\&\text{sheap}_{797.16}.\text{-ecv\_files}[1]).\text{sr} \rightarrow \text{writes}\_797\_9)) \land
(asType < real > ((double)0.0) < asType < real > (\$result_797_25)) \land
(asType < real > (\$result\_797\_25) < asType < real > ((double)1.0)) \land
invariant1(heapIs $heap<sub>797,16</sub>)
\rightarrow [simplify]
[29.8] (1 == (count_{loopend} + -count_{loopstart\_792,5})) \land (\$heap_{797,16} ==
\theta_{loopstart\_792.5}._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)) \land ($heap<sub>loopend</sub> ==
\$heap_{797,16}.\_\mathbf{replace}((\&\$heap_{797,16}.\_ecv\_files[1]).\$r \rightarrow writes\_797\_9)) \land \\
(asType < real > ((double)0.0) < asType < real > (\$result_797_25)) \land
(asType < real > (\$result_797_25) < asType < real > ((double)1.0)) \land
invariant1(heapIs $heap<sub>797.16</sub>)
\rightarrow [from term 11.1, \rho_{loopstart\_792,5} is equal to
heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 1)._replace(p3 \rightarrow 1)._repla
3)._replace((&\$heap._ecv_files[1]) \rightarrow writes_790_5)._replace(p1 \rightarrow
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow 
writes_793_12)._replace(_ecv_files \rightarrow writes_793_12)]
[29.9] (1 == (-\text{count}_{loopstart\_792,5} + \text{count}_{loopend})) \land (\$\text{heap}_{797,16} ==
heap_{funcstart_{-780,1}}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow
3)._replace((&\$heap._ecv_files[1]) \rightarrow writes_790_5)._replace(p1 \rightarrow
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow
writes_793_12)._replace(_ecv_files \rightarrow writes_793_12)._replace(p1 \rightarrow
writes_797_25)._replace(p2 \rightarrow writes_797_25)._replace(p3 \rightarrow writes_797_25))
\land ($heap<sub>loopend</sub> == $heap<sub>797,16</sub>._replace((&$heap<sub>797,16</sub>._ecv_files[1]).$r \rightarrow
writes\_797\_9)) \, \wedge \, (\mathbf{asType}{<}\mathbf{real}{>}((\mathbf{double})0.0) <
asType < real > (\$result\_797\_25)) \land (asType < real > (\$result\_797\_25) < real > (\$result\_797\_25
asType < real > ((double)1.0)) \land invariant1(heapIs $heap_{797.16})
\rightarrow [simplify]
[29.10] (1 == (-\text{count}_{loopstart\_792.5} + \text{count}_{loopend})) \land (\$\text{heap}_{797.16} ==
\$heap_{funcstart\_780,1}.\_\textbf{replace}(p1 \rightarrow 1).\_\textbf{replace}(p2 \rightarrow 2).\_\textbf{replace}(p3 \rightarrow
3)._replace((&\$heap._ecv_files[1]) \rightarrow writes_790_5)._replace(p1 \rightarrow
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow
```

```
writes_793_12)._replace(_ecv_files \rightarrow writes_793_12)._replace(p1 \rightarrow
writes_797_25)._replace(p2 \rightarrow writes_797_25)._replace(p3 \rightarrow writes_797_25))
\land ($heap<sub>loopend</sub> == $heap<sub>797,16</sub>._replace((&$heap._ecv_files[1]).$r \rightarrow
writes_797_9) \land (asType < real > ((double)0.0) <
asType < real > (\$result_797_25)) \land (asType < real > (\$result_797_25) < real > (\$result_797_25
asType < real > ((double)1.0)) \land invariant1(heapIs $heap_{797,16})
→ [attribute value is known from postcondition]
[29.11] (1 == (-\text{count}_{loopstart\_792,5} + \text{count}_{loopend})) \land (\$\text{heap}_{797,16} ==
\text{Sheap}_{funcstart\_780,1}.\_\mathbf{replace}(p1 \to 1).\_\mathbf{replace}(p2 \to 2).\_\mathbf{replace}(p3 \to 1)
3)._replace((&\$heap._ecv_files[1]) \rightarrow writes_790_5)._replace(p1 \rightarrow
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow
writes_793_12)._replace(_ecv_files \rightarrow writes_793_12)._replace(p1 \rightarrow
writes_797_25)._replace(p2 \rightarrow writes_797_25)._replace(p3 \rightarrow writes_797_25))
\land ($heap_{loopend} == $heap_{797,16}._replace(&$heap._ecv_files[1] \rightarrow
writes_797_9) \land (asType < real > ((double)0.0) <
asType < real > (\$result\_797\_25)) \land (asType < real > (\$result\_797\_25) < real > (\$result\_797\_25
asType < real > ((double)1.0)) \land invariant1(heapIs $heap_{797.16})
\rightarrow [simplify]
[29.20] (1 == (-\text{count}_{loopstart\_792,5} + \text{count}_{loopend})) \land (\$\text{heap}_{797,16} ==
{\rm Sheap}_{funcstart\_780,1}.{\bf replace}({\rm p1} \rightarrow 1).{\bf replace}({\rm p2} \rightarrow 2).{\bf replace}({\rm p3} \rightarrow 1).{\bf replace}({\rm p3} \rightarrow 1).
3)._replace((&\$heap._ecv_files[1]) \rightarrow writes_790_5)._replace(p1 \rightarrow
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow
writes_793_12)._replace(_ecv_files \rightarrow writes_793_12)._replace(p1 \rightarrow
writes_797_25)._replace(p2 \rightarrow writes_797_25)._replace(p3 \rightarrow writes_797_25))
\land ($heap<sub>loopend</sub> == $heap<sub>797,16</sub>._replace(&$heap._ecv_files[1] \rightarrow
writes_797_9)) \land (0.0 < $result_797_25) \land (-1.0 < -$result_797_25) \land
invariant1(heapIs $heap<sub>797.16</sub>)
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
[29.21] (1 == (-\text{count}_{loopstart\_792,5} + \text{count}_{loopend})) \land (\$\text{heap}_{797,16} ==
\theta_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow
3)._replace((&\text{$heap._ecv_files}[1]) \rightarrow writes_790_5)._replace(p1 \rightarrow
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow
writes_793_12)._replace(\_ecv\_files \rightarrow writes\_793\_12)._replace(p1 \rightarrow
writes_797_25)._replace(p2 \rightarrow writes_797_25)._replace(p3 \rightarrow writes_797_25))
\land ($heap<sub>loopend</sub> == $heap<sub>797,16</sub>._replace(&$heap._ecv_files[1] \rightarrow
writes_797_9)) \land (0.0 < $result_797_25) \land (-1.0 < -$result_797_25) \land ((((((0 <
asType<integer>($heap<sub>797,16</sub>.p1)) && (asType<integer>($heap<sub>797,16</sub>.p1)
< asType < integer > ($heap_{797,16}.M1))) && (0 < 1)
asType < integer > (\$heap_{797,16}.p2))) \&\& (asType < integer > (\$heap_{797,16}.p2))
< asType < integer > ($heap_{797,16}.M2))) \&\& (0 <
asType<integer>($heap<sub>797,16</sub>.p3))) && (asType<integer>($heap<sub>797,16</sub>.p3)
 < asType < integer > ($heap_{797.16}.M3)))
\rightarrow [simplify]
```

```
[29.23] (1 == (-\text{count}_{loopstart\_792,5} + \text{count}_{loopend})) \land (\$\text{heap}_{797,16} ==
{\rm Sheap}_{funcstart\_780,1}.{\tt replace}({\rm p1} \to 1).{\tt replace}({\rm p2} \to 2).{\tt replace}({\rm p3} \to 1).{\tt replace}({\rm p3} \to 1).
3)._replace((&\text{heap._ecv_files}[1]) \rightarrow writes_790_5)._replace(p1 \rightarrow
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow
writes_793_12)._replace(_ecv_files \rightarrow writes_793_12)._replace(p1 \rightarrow
writes_797_25)._replace(p2 \rightarrow writes_797_25)._replace(p3 \rightarrow writes_797_25))
\land (\$ heap_{loopend} == \$ heap_{797,16}.\_\mathbf{replace} (\&\$ heap.\_ecv\_files[1] \rightarrow
writes_797_9)) \land (0.0 < $result_797_25) \land (-1.0 < -$result_797_25) \land ((((((0 <
\rho_{797,16} $\text{p1} \&\delta (\parallel{p1}_{797,16}.p1 < asType < integer > (\parallel{p1}_{16}.M1)))
&& (0 < asType < integer > (\$heap_{797,16}.p2))) &&
(\mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{797,16}.\mathrm{p2}) < \mathbf{asType} < \mathbf{integer} > (\$ \mathrm{heap}_{797,16}.\mathrm{M2})))
&& (0 < asType < integer > (\$heap_{797,16}.p3))) &&
(asType < integer > ($heap_{797.16}.p3) < asType < integer > ($heap_{797.16}.M3)))
\rightarrow [const static or extern object]
[29.24] (1 == (-\text{count}_{loopstart\_792,5} + \text{count}_{loopend})) \land (\$\text{heap}_{797,16} ==
{\rm Sheap}_{funcstart\_780,1}.{\bf replace}({\rm p1} \rightarrow 1).{\bf replace}({\rm p2} \rightarrow 2).{\bf replace}({\rm p3} \rightarrow 1).{\bf replace}({\rm p2} \rightarrow 2).{\bf replace}({\rm p3} \rightarrow 1).{\bf replace}({\rm p3} \rightarrow 1).
3)._replace((&\$heap._ecv_files[1]) \rightarrow writes_790_5)._replace(p1 \rightarrow
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow
writes_793_12)._replace(_ecv_files \rightarrow writes_793_12)._replace(p1 \rightarrow
writes_797_25)._replace(p2 \rightarrow writes_797_25)._replace(p3 \rightarrow writes_797_25))
\land ($heap<sub>loopend</sub> == $heap<sub>797.16</sub>._replace(&$heap._ecv_files[1] \rightarrow
writes_797_9)) \land (0.0 < $result_797_25) \land (-1.0 < -$result_797_25) \land ((((((0 <
\rho_{797,16}.p1 && (\rho_{797,16}.p1 < asType < integer > (\rho_{init}.M1)) &&
(0 < asType < integer > (\$heap_{797,16}.p2))) \&\&
(asType < integer > (\$heap_{797,16}.p2) < asType < integer > (\$heap_{797,16}.M2)))
&& (0 < asType < integer > (\$heap_{797,16}.p3))) &&
(asType < integer > (\$heap_{797,16}.p3) < asType < integer > (\$heap_{797,16}.M3)))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[29.25] (1 == (-\text{count}_{loopstart\_792,5} + \text{count}_{loopend})) \land (\$\text{heap}_{797,16} ==
heap_{funcstart\_780.1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow
3)._replace((&\$heap._ecv_files[1]) \rightarrow writes_790_5)._replace(p1 \rightarrow
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow
writes_793_12)._replace(_ecv_files \rightarrow writes_793_12)._replace(p1 \rightarrow
writes_797_25)._replace(p2 \rightarrow writes_797_25)._replace(p3 \rightarrow writes_797_25))
\land ($heap<sub>loopend</sub> == $heap<sub>797,16</sub>._replace(&$heap._ecv_files[1] \rightarrow
writes_797_9)) \land (0.0 < $result_797_25) \land (-1.0 < -$result_797_25) \land ((((((0 <
\rho_{797,16} $\text{pl} & \& (\partial_{10} \partial_{10} \partial_{10}
int>((int)30269)))) && (0 < asType < integer>($heap_{797,16}.p2))) &&
(asType < integer > (\$heap_{797.16}.p2) < asType < integer > (\$heap_{797.16}.M2)))
&& (0 < asType < integer > (\text{$heap}_{797,16}.p3))) &&
(asType < integer > ($heap_{797.16}.p3) < asType < integer > ($heap_{797.16}.M3)))
\rightarrow [simplify]
[29.36] (1 == (-\text{count}_{loopstart\_792,5} + \text{count}_{loopend})) \land (\$\text{heap}_{797,16} ==
```

```
{\rm heap}_{funcstart\_780,1}.{\tt replace}({\rm p1} \to 1).{\tt replace}({\rm p2} \to 2).{\tt replace}({\rm p3} \to 1).{\tt replace}({\rm p2} \to 2).{\tt replace}({\rm p3} \to 1).{\tt replace}({\rm p3} \to 1).{
3)._replace((&$heap._ecv_files[1]) \rightarrow writes_790_5)._replace(p1 \rightarrow
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow
writes_793_12)._replace(_ecv_files \rightarrow writes_793_12)._replace(p1 \rightarrow
writes_797_25)._replace(p2 \rightarrow writes_797_25)._replace(p3 \rightarrow writes_797_25))
\land ($heap<sub>loopend</sub> == $heap<sub>797,16</sub>._replace(&$heap._ecv_files[1] \rightarrow
writes_797_9)) \land (0.0 < $result_797_25) \land (-1.0 < -$result_797_25) \land
(((((-30269 < -\$heap_{797.16}.p1) \land (0 < \$heap_{797.16}.p1) \land (0 < \$heap_{797.16}.p2))
&& ($heap<sub>797,16</sub>.p2 < asType<integer>($heap<sub>797,16</sub>.M2))) && (0 <
asType<integer>($heap<sub>797,16</sub>.p3))) && (asType<integer>($heap<sub>797,16</sub>.p3)
< asType<integer>($heap<sub>797.16</sub>.M3)))
\rightarrow [const static or extern object]
[29.37] (1 == (-\text{count}_{loopstart\_792,5} + \text{count}_{loopend})) \land (\$\text{heap}_{797,16} ==
\$heap_{funcstart\_780,1}.\_\mathbf{replace}(p1 \to 1).\_\mathbf{replace}(p2 \to 2).\_\mathbf{replace}(p3 \to 1)
3)._replace((&$heap._ecv_files[1]) \rightarrow writes_790_5)._replace(p1 \rightarrow
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow
writes_793_12)._replace(_ecv_files \rightarrow writes_793_12)._replace(p1 \rightarrow
writes_797_25)._replace(p2 \rightarrow writes_797_25)._replace(p3 \rightarrow writes_797_25))
\land \ (\$ heap_{loopend} == \$ heap_{797,16}.\_\mathbf{replace} (\$\$ heap.\_ecv\_files[1] \rightarrow \$ heap_{100pend} == \$ heap_{100pend} = \$ heap_{
writes_797_9)) \land (0.0 < $result_797_25) \land (-1.0 < -$result_797_25) \land
(((((-30269 < -\$heap_{797,16}.p1) \land (0 < \$heap_{797,16}.p1) \land (0 < \$heap_{797,16}.p2))
&& (\theta_{init}.M2)) && (0 <
asType<integer>($heap<sub>797,16</sub>.p3))) && (asType<integer>($heap<sub>797,16</sub>.p3)
< asType < integer > (\$heap_{797.16}.M3)))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[29.38] (1 == (-\text{count}_{loopstart\_792,5} + \text{count}_{loopend})) \land (\$\text{heap}_{797,16} ==
heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow
3)._replace((&\$heap._ecv_files[1]) \rightarrow writes_790_5)._replace(p1 \rightarrow
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow
writes_793_12)._replace(_ecv_files \rightarrow writes_793_12)._replace(p1 \rightarrow
writes_797_25)._replace(p2 \rightarrow writes_797_25)._replace(p3 \rightarrow writes_797_25))
\land (\$ heap_{loopend} == \$ heap_{797,16}.\_\mathbf{replace}(\&\$ heap.\_ecv\_files[1] \rightarrow
writes_797_9)) \land (0.0 < $result_797_25) \land (-1.0 < -$result_797_25) \land
(((((-30269 < -\$heap_{797,16}.p1) \land (0 < \$heap_{797,16}.p1) \land (0 < \$heap_{797,16}.p2)))
&& (heap_{797,16}.p2 < asType < integer > (asType < short)
int>((int)30307))) && (0 < asType < integer>($heap_{797,16}.p3))) &&
(asType < integer > (\$heap_{797,16}.p3) < asType < integer > (\$heap_{797,16}.M3)))
\rightarrow [simplify]
[29.50] (1 == (-\text{count}_{loopstart\_792,5} + \text{count}_{loopend})) \land (\$\text{heap}_{797,16} ==
\text{Sheap}_{funcstart\_780,1}.\_\mathbf{replace}(p1 \to 1).\_\mathbf{replace}(p2 \to 2).\_\mathbf{replace}(p3 \to 1)
3)._replace((&\text{heap._ecv_files}[1]) \rightarrow writes_790_5)._replace(p1 \rightarrow
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow
writes_793_12)._replace(_ecv_files \rightarrow writes_793_12)._replace(p1 \rightarrow
```

```
writes_797_25)._replace(p2 \rightarrow writes_797_25)._replace(p3 \rightarrow writes_797_25))
\land \ (\$ heap_{loopend} == \$ heap_{797,16}.\_\mathbf{replace} (\&\$ heap.\_ecv\_files[1] \rightarrow \\
writes_797_9)) \land (0.0 < $result_797_25) \land (-1.0 < -$result_797_25) \land (((-30307))
<-$heap<sub>797,16</sub>.p2) \land (-30269 <-$heap<sub>797,16</sub>.p1) \land (0 <$heap<sub>797,16</sub>.p1) \land (0
< $heap<sub>797,16</sub>.p2) \land (0 < $heap<sub>797,16</sub>.p3)) && ($heap<sub>797,16</sub>.p3 <
asType<integer>($heap<sub>797,16</sub>.M3)))
\rightarrow [const static or extern object]
[29.51] (1 == (-\text{count}_{loopstart\_792,5} + \text{count}_{loopend})) \land (\$\text{heap}_{797,16} ==
{\rm Sheap}_{funcstart\_780,1}.{\bf replace}({\rm p1} \rightarrow 1).{\bf replace}({\rm p2} \rightarrow 2).{\bf replace}({\rm p3} \rightarrow 1).{\bf replace}({\rm p3} \rightarrow 1).
3)._replace((&\$heap._ecv_files[1]) \rightarrow writes_790_5)._replace(p1 \rightarrow
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow
writes_793_12)._replace(_ecv_files \rightarrow writes_793_12)._replace(p1 \rightarrow
writes_797_25)._replace(p2 \rightarrow writes_797_25)._replace(p3 \rightarrow writes_797_25))
\land ($heap_{loopend} == $heap_{797,16}._replace(&$heap._ecv_files[1] \rightarrow
writes_797_9)) \land (0.0 < $result_797_25) \land (-1.0 < -$result_797_25) \land (((-30307))
<-\$heap_{797,16}.p2) \land (-30269 < -\$heap_{797,16}.p1) \land (0 < \$heap_{797,16}.p1) \land (0
< $heap<sub>797,16</sub>.p2) \land (0 < $heap<sub>797,16</sub>.p3)) && ($heap<sub>797,16</sub>.p3 <
asType < integer > (\$heap_{init}.M3)))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[29.52] (1 == (-\text{count}_{loopstart\_792,5} + \text{count}_{loopend})) \land (\$\text{heap}_{797,16} ==
\theta_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow
3)._replace((&$heap._ecv_files[1]) \rightarrow writes_790_5)._replace(p1 \rightarrow
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow
writes_793_12)._replace(\_ecv\_files \rightarrow writes\_793\_12)._replace(p1 \rightarrow
writes_797_25)._replace(p2 \rightarrow writes_797_25)._replace(p3 \rightarrow writes_797_25))
\land \ (\$ heap_{loopend} == \$ heap_{797,16}.\_\mathbf{replace} (\&\$ heap.\_ecv\_files[1] \rightarrow \\
writes_797_9)) \land (0.0 < $result_797_25) \land (-1.0 < -$result_797_25) \land (((-30307))
<-$heap<sub>797,16</sub>.p2) \land (-30269 <-$heap<sub>797,16</sub>.p1) \land (0 <$heap<sub>797,16</sub>.p1) \land (0
< $heap<sub>797,16</sub>.p2) \land (0 < $heap<sub>797,16</sub>.p3)) && ($heap<sub>797,16</sub>.p3 <
asType<integer>(asType<short int>((int)30323))))
\rightarrow [simplify]
[29.61] (1 == (-\text{count}_{loopstart\_792,5} + \text{count}_{loopend})) \land (\$\text{heap}_{797,16} ==
\$heap_{funcstart\_780,1}.\_\mathbf{replace}(p1 \to 1).\_\mathbf{replace}(p2 \to 2).\_\mathbf{replace}(p3 \to 1)
3)._replace((&\$heap._ecv_files[1]) \rightarrow writes_790_5)._replace(p1 \rightarrow
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow
writes_793_12)._replace(_ecv_files \rightarrow writes_793_12)._replace(p1 \rightarrow
writes_797_25)._replace(p2 \rightarrow writes_797_25)._replace(p3 \rightarrow writes_797_25))
\land ($heap_{loopend} == $heap_{797,16}._replace(&$heap._ecv_files[1] \rightarrow writes_797_9))
\land (0.0 < \text{\$result\_797\_25}) \land (-1.0 < -\text{\$result\_797\_25}) \land (-30323 < -\text{\$result\_797\_25})
-\$heap_{797,16}.p3) \land (-30307 < -\$heap_{797,16}.p2) \land (-30269 < -\$heap_{797,16}.p1)
\land (0 < \text{$heap}_{797,16}.\text{p1}) \land (0 < \text{$heap}_{797,16}.\text{p2}) \land (0 < \text{$heap}_{797,16}.\text{p3})
\rightarrow [separate conjunction and work on first sub-term]
```

```
[29.62] 1 == (-\text{count}_{loopstart\_792,5} + \text{count}_{loopend})
[Take given term]
[48.0] count<sub>loopend</sub> < limit
\rightarrow [from term 29.62, count_{loopend} is equal to 1 + count_{loopstart\_792,5}]
[48.1] (1 + count_{loopstart\_792,5}) < limit
\rightarrow [from term 8.7, limit is equal to 80]
[48.2] (1 + count_{loopstart\_792,5}) < 80
\rightarrow [simplify]
\textit{[48.9]} \; \text{--} 79 < -\text{count}_{loopstart\_792,5}
[Take goal term]
[1.0] 0 \leq (asType<integer const>(limit) -
asType < integer > (count_{loopend}))
\rightarrow [from term 8.7, limit is equal to 80]
[1.1] 0 \le (asType < integer const > (80) - asType < integer > (count_{loopend}))
\rightarrow [simplify]
[1.2] 0 \le (80 - \mathbf{asType} < \mathbf{integer} > (\mathbf{count}_{loopend}))
\rightarrow [from term 29.62, count<sub>loopend</sub> is equal to 1 + count<sub>loopstart_792,5</sub>]
[1.3] 0 \le (80 - \mathbf{asType} < \mathbf{integer} > (1 + \mathbf{count}_{loopstart\_792,5}))
\rightarrow [simplify]
\textit{[1.13]} \text{ -80} < -\text{count}_{loopstart\_792,5}
\rightarrow [from term 48.9, literala < -count_{loopstart\_792.5} is true whenever (-1 +
literala) < -79
    Proof of rule precondition:
    [1.13.0](-80 + -1) < -79
    \rightarrow [simplify]
    [1.13.2] true
[1.14] true
Proof of verification condition: Loop body preserves loop invariant
Condition generated at: C:\Escher\Customers\prang\prang.c (115,5)
Condition defined at: C:\Escher\Customers\prang\prang.c (113,10)
To prove: invariant1(heapIs $heap_loopend)
Given:
```

```
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
heap_{init}.M2 == asType < short int > ((int)30307)
\theta_{init}.r2 == asType<short int>((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
heap_{780,1;783,8} == heap_{funcstart\_780,1}.\_replace(p1 \rightarrow asType < short)
int>((int)1)
heap_{780,1;784,8} == heap_{780,1;783,8}.replace(p2 \rightarrow asType<short
int>((int)2))
\$ heap_{780,1;785,8} == \$ heap_{780,1;784,8}. \textbf{\_replace} (p3 \rightarrow \textbf{asType} < \textbf{short}
int>((int)3)
limit == $heap_{780,1:785.8}.LIMIT
minof(int const) \leq limit
limit \leq maxof(int const)
count == (int)0
minof(int) \le count
count \leq maxof(int)
\text{Sheap}_{780,1;790,5} == \text{Sheap}_{780,1;785,8}.\mathbf{replace}((\&\text{Sheap}_{780,1;785,8}.\mathbf{ecv\_files}[1]).\$r
\rightarrow writes_790_5)
\$heap_{loopstart\_792,5} == \$heap_{780,1;790,5}.\_\mathbf{replace}(p1 \rightarrow
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow
writes_793_12)._replace(\_ecv\_files \rightarrow writes\_793\_12)
\#writes_793_12 == \#$heap<sub>780,1;790,5</sub>._ecv_files
```

```
minof(int) \leq count_{loopstart\_792,5}
count_{loopstart\_792,5} \le maxof(int)
invariant
1<br/>({\bf heapIs}\ \${\rm heap}_{loopstart\_792,5})
\operatorname{count}_{loopstart\_792,5} < \operatorname{limit}
0 \le (asType < integer const > (limit) -
asType < integer > (count_{loopstart\_792,5}))
(\mathbf{asType} {<} \mathbf{integer} \ \mathbf{const} {>} (\mathbf{limit}) \ - \ \mathbf{asType} {<} \mathbf{integer} {>} (\mathbf{count}_{loopstart\_792,5}))
\leq (asType < integer const > (limit) - asType < integer > (count))
(++\text{count}_{loopstart\_792,5} == \text{count}_{loopend}) \land (\$\text{heap}_{797,16} ==
heap_{loopstart.792.5}._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)) \land ($heap<sub>loopend</sub> ==
\rho_{797.16}.\_replace((\&\rho_{797.16}.\_ecv\_files[1]).$r \rightarrow writes\_797\_9)) \land \rho_{797.16}.\_replace((\&\rho_{797.16}.\_ecv\_files[1]).$r \rightarrow writes\_797\_9))
(asType < real > ((double)0.0) < asType < real > (\$result_797_25)) \land
(asType < real > (\$result\_797\_25) < asType < real > ((double)1.0)) \land
invariant1(heapIs $heap<sub>797.16</sub>)
Proof:
[Take given term]
[5.0] $\text{heap}_{780.1:783.8} == $\text{heap}_{funcstart\_780.1}.$\text{replace}(p1 \rightarrow \text{asType} < \text{short}
int > ((int)1)
\rightarrow [simplify]
[5.2] $\text{heap}_{780.1:783.8} == $\text{heap}_{tuncstart_780.1}._\text{replace}(p1 \rightarrow 1)$
[Take given term]
[6.0] $heap<sub>780.1:784.8</sub> == $heap<sub>780.1:783.8</sub>._replace(p2 \rightarrow asType<short
int>((int)2))
\rightarrow [from term 5.2, $heap<sub>780,1;783,8</sub> is equal to $heap<sub>funcstart_780,1</sub>._replace(p1
\rightarrow 1)
[6.1] heap_{780,1;784,8} == heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
asType < short int > ((int)2))
\rightarrow [simplify]
[6.3] \theta == \theta
[Take given term]
[7.0] $\text{heap}_{780,1:785,8} == $\text{heap}_{780,1:784,8}._\text{replace}(p3 \rightarrow \text{asType} < \text{short}
int > ((int)3))
\rightarrow [from term 6.3, $heap<sub>780,1;784,8</sub> is equal to $heap<sub>funcstart_780,1</sub>._replace(p1)
\rightarrow 1)._replace(p2 \rightarrow 2)]
[7.1] heap_{780,1:785,8} == heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
```

```
2)._replace(p3 \rightarrow asType<short int>((int)3))
\rightarrow [simplify]
[7.3] heap_{780,1;785,8} == heap_{funcstart\_780,1}.\_replace(p1 \rightarrow 1).\_replace(p2 \rightarrow 1)
2)._replace(p3 \rightarrow 3)
[Take given term]
[10.0] $heap<sub>780,1;790,5</sub> ==
\rho_{80,1;785,8}.replace((&$heap_{780,1;785,8}.-ecv_files[1]).$r \rightarrow writes_790_5)
\rightarrow [from term 7.3, $heap<sub>780,1:785,8</sub> is equal to $heap<sub>funcstart_780,1</sub>._replace(p1
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)]
[10.1] $\text{heap}_{780.1:790.5} == \text{$heap}_{funcstart\_780.1}._{\text{replace}}(p1 \to 1)._{\text{replace}}(p2)
\rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap_{780,1;785,8}.ecv_files[1]).$r \rightarrow
writes_790_5)
\rightarrow [simplify]
[10.2] $\text{heap}_{780,1;790,5} == $\text{heap}_{funcstart\_780,1}.$_{-}\text{replace}(p1 \rightarrow 1).$_{-}\text{replace}(p2)
\rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]).$r \rightarrow writes_790_5)
→ [attribute value is known from postcondition]
[10.3] $\text{heap}_{780,1:790.5} == $\text{heap}_{funcstart\_780,1}._\text{replace}(p1 \to 1)._\text{replace}(p2)
\rightarrow 2)._replace(p3 \rightarrow 3)._replace(&\text{heap._ecv_files}[1] \rightarrow writes_790_5)
[Take given term]
[11.0] $\text{heap}_{loopstart_792,5} == $\text{heap}_{780,1;790,5}._\text{replace}(p1 \rightarrow)$
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow
writes_793_12)._replace(_ecv_files \rightarrow writes_793_12)
\rightarrow [from term 10.3, $heap<sub>780,1:790.5</sub> is equal to $heap<sub>funcstart_780,1</sub>._replace(p1
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace(&$heap._ecv_files[1] \rightarrow
writes_790_5)]
[11.1] \theta_{loopstart\_792,5} == \theta_{loopstart\_780,1}._replace(p1 \rightarrow
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)
[Take given term]
[29.0] (++count<sub>loopstart_792,5</sub> == count<sub>loopend</sub>) \land ($heap<sub>797,16</sub> ==
heap_{loopstart\_792.5}._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)) \land ($heap<sub>loopend</sub> ==
\theta_{797,16}. replace((&\text{heap}_{797,16}. ecv_files[1]). r \to \text{writes}_797.9)) \land
(asType < real > ((double)0.0) < asType < real > (\$result_797_25)) \land
(asType < real > (\$result\_797\_25) < asType < real > ((double)1.0)) \land
invariant1(heapIs $heap<sub>797,16</sub>)
```

```
\rightarrow [simplify]
[29.8] (1 == (count_{loopend} + -count_{loopstart\_792,5})) \land (\$heap_{797,16} ==
\theta_{loopstart\_792.5}._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)) \land ($heap<sub>loopend</sub> ==
\rho_{797,16}.\mathbf{replace}((\&\rho_{797,16}.\mathbf{ecv}_{files}[1]).\r \rightarrow \text{writes}_{797,9})) \land \rho_{797,16}.\mathbf{replace}((\&\rho_{797,16}.\mathbf{ecv}_{files}[1]).\
(asType < real > ((double)0.0) < asType < real > (\$result_797_25)) \land
(asType < real > (\$result\_797\_25) < asType < real > ((double)1.0)) \land
invariant1(heapIs $heap<sub>797.16</sub>)
\rightarrow [from term 11.1, \rho_{loopstart\_792,5} is equal to
heap_{funcstart\ 780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 1)._replace(p3 \rightarrow 1)._repl
3)._replace((&\$heap._ecv_files[1]) \rightarrow writes_790_5)._replace(p1 \rightarrow
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow 
 writes_793_12)._replace(_ecv_files \rightarrow writes_793_12)]
 [29.9] (1 == (-\text{count}_{loopstart\_792,5} + \text{count}_{loopend})) \land (\$\text{heap}_{797,16} ==
heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow
3)._replace((&\$heap._ecv_files[1]) \rightarrow writes_790_5)._replace(p1 \rightarrow
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow
writes_793_12)._replace(_ecv_files \rightarrow writes_793_12)._replace(p1 \rightarrow
writes_797_25)._replace(p2 \rightarrow writes_797_25)._replace(p3 \rightarrow writes_797_25))
\land ($heap<sub>loopend</sub> == $heap<sub>797,16</sub>._replace((&$heap<sub>797,16</sub>._ecv_files[1]).$r \rightarrow
writes_797_9) \land (asType < real > ((double)0.0) <
asType < real > (\$result\_797\_25)) \land (asType < real > (\$result\_797\_25) < real > (\$result\_797\_25
asType < real > ((double)1.0)) \land invariant1(heapIs $heap_{797.16})
\rightarrow [simplify]
[29.10] (1 == (-\text{count}_{loopstart\_792,5} + \text{count}_{loopend})) \land (\$\text{heap}_{797,16} ==
\theta_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow
3)._replace((&\$heap._ecv_files[1]) \rightarrow writes_790_5)._replace(p1 \rightarrow
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow
writes_793_12)._replace(_ecv_files \rightarrow writes_793_12)._replace(p1 \rightarrow
writes_797_25)._replace(p2 \rightarrow writes_797_25)._replace(p3 \rightarrow writes_797_25))
\land ($heap_{loopend} == $heap_{797,16}._replace((&$heap._ecv_files[1]).$r \rightarrow
writes_797_9) \land (asType < real > ((double)0.0) <
asType < real > (\$result_797.25)) \land (asType < real > (\$result_797.25) < real > (\$result_797.25
asType < real > ((double)1.0)) \land invariant1(heapIs $heap_{797,16})
→ [attribute value is known from postcondition]
[29.11] (1 == (-\text{count}_{loopstart\_792,5} + \text{count}_{loopend})) \land (\$\text{heap}_{797,16} ==
heap_{funcstart_{-780,1}}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow
3)._replace((&\$heap._ecv_files[1]) \rightarrow writes_790_5)._replace(p1 \rightarrow
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow
writes_793_12)._replace(_ecv_files \rightarrow writes_793_12)._replace(p1 \rightarrow
writes_797_25)._replace(p2 \rightarrow writes_797_25)._replace(p3 \rightarrow writes_797_25))
\land ($heap<sub>loopend</sub> == $heap<sub>797.16</sub>._replace(&$heap._ecv_files[1] \rightarrow
writes_797_9) \land (asType < real > ((double)0.0) <
```

```
asType < real > (\$result_797.25)) \land (asType < real > (\$result_797.25) < real > (\$result_797.25
asType < real > ((double)1.0)) \land invariant1(heapIs $heap_{797,16})
\rightarrow [simplify]
[29.20] (1 == (-count_{loopstart\_792,5} + count_{loopend})) \land ($heap<sub>797,16</sub> ==
heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow
3)._replace((&\$heap._ecv_files[1]) \rightarrow writes_790_5)._replace(p1 \rightarrow
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow
writes_793_12)._replace(_ecv_files \rightarrow writes_793_12)._replace(p1 \rightarrow
writes_797_25)._replace(p2 \rightarrow writes_797_25)._replace(p3 \rightarrow writes_797_25))
\land ($heap<sub>loopend</sub> == $heap<sub>797,16</sub>._replace(&$heap._ecv_files[1] \rightarrow
writes_797_9)) \land (0.0 < $result_797_25) \land (-1.0 < -$result_797_25) \land
invariant1(heapIs $heap<sub>797,16</sub>)
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
[29.21] (1 == (-\text{count}_{loopstart\_792,5} + \text{count}_{loopend})) \land (\$\text{heap}_{797,16} ==
\text{Sheap}_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 1).
3)._replace((&\$heap._ecv_files[1]) \rightarrow writes_790_5)._replace(p1 \rightarrow
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow
writes_793_12)._replace(_ecv_files \rightarrow writes_793_12)._replace(p1 \rightarrow
writes_797_25)._replace(p2 \rightarrow writes_797_25)._replace(p3 \rightarrow writes_797_25))
\land ($heap<sub>loopend</sub> == $heap<sub>797,16</sub>._replace(&$heap._ecv_files[1] \rightarrow
writes_797_9)) \land (0.0 < $result_797_25) \land (-1.0 < -$result_797_25) \land ((((((0 <
asType<integer>($heap<sub>797.16</sub>.p1)) && (asType<integer>($heap<sub>797.16</sub>.p1)
< asType < integer > ($heap_{797.16}.M1))) && (0 < 1)
asType < integer > (\$heap_{797,16}.p2))) \&\& (asType < integer > (\$heap_{797,16}.p2))
< asType < integer > ($heap_{797,16}.M2))) && (0 < 1)
asType < integer > (\$heap_{797.16}.p3)) && (asType < integer > (\$heap_{797.16}.p3))
< asType < integer > (\$heap_{797.16}.M3)))
\rightarrow [simplify]
[29.23] (1 == (-\text{count}_{loopstart\_792,5} + \text{count}_{loopend})) \land (\$\text{heap}_{797,16} ==
heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow
3)._replace((&\text{$heap._ecv_files}[1]) \rightarrow writes_790_5)._replace(p1 \rightarrow
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow
writes_793_12)._replace(\_ecv\_files \rightarrow writes\_793\_12)._replace(p1 \rightarrow
writes_797_25)._replace(p2 \rightarrow writes_797_25)._replace(p3 \rightarrow writes_797_25))
\land ($heap<sub>loopend</sub> == $heap<sub>797,16</sub>._replace(&$heap._ecv_files[1] \rightarrow
writes_797_9)) \land (0.0 < $result_797_25) \land (-1.0 < -$result_797_25) \land ((((((0 <
\text{sheap}_{797,16}.\text{p1} && (\text{sheap}_{797,16}.\text{p1} < \text{asType} < \text{integer} > (\text{sheap}_{797,16}.\text{M1}))
&& (0 < asType < integer > (\$heap_{797,16}.p2))) &&
(asType < integer > (\$heap_{797,16}.p2) < asType < integer > (\$heap_{797,16}.M2)))
&& (0 < asType < integer > (\$heap_{797,16}.p3))) &&
(\mathbf{asType} < \mathbf{integer} > (\$ \text{heap}_{797,16}.\text{p3}) < \mathbf{asType} < \mathbf{integer} > (\$ \text{heap}_{797,16}.\text{M3})))
\rightarrow [const static or extern object]
```

```
[29.24] (1 == (-\text{count}_{loopstart\_792,5} + \text{count}_{loopend})) \land (\$\text{heap}_{797,16} ==
{\rm Sheap}_{funcstart\_780,1}.{\tt replace}({\rm p1} \to 1).{\tt replace}({\rm p2} \to 2).{\tt replace}({\rm p3} \to 1).{\tt replace}({\rm p3} \to 1).
3)._replace((&\text{heap._ecv_files}[1]) \rightarrow writes_790_5)._replace(p1 \rightarrow
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow
writes_793_12)._replace(_ecv_files \rightarrow writes_793_12)._replace(p1 \rightarrow
writes_797_25)._replace(p2 \rightarrow writes_797_25)._replace(p3 \rightarrow writes_797_25))
\land (\$ heap_{loopend} == \$ heap_{797,16}.\_\mathbf{replace} (\&\$ heap.\_ecv\_files[1] \rightarrow
writes_797_9)) \land (0.0 < $result_797_25) \land (-1.0 < -$result_797_25) \land ((((((0 <
\rho_{797,16} ($heap<sub>797,16</sub>.p1 < asType<integer>($heap<sub>init</sub>.M1))) &&
(0 < \mathbf{asType} < \mathbf{integer} > (\$heap_{797,16}.p2))) \&\&
(asType < integer > (\$heap_{797,16}.p2) < asType < integer > (\$heap_{797,16}.M2)))
&& (0 < asType < integer > (\$heap_{797,16}.p3))) &&
(asType < integer > ($heap_{797.16}.p3) < asType < integer > ($heap_{797.16}.M3)))
\rightarrow [expand definition of constant 'M1' at prang.c (14.20)]
[29.25] (1 == (-\text{count}_{loopstart\_792,5} + \text{count}_{loopend})) \land (\$\text{heap}_{797,16} ==
{\rm Sheap}_{funcstart\_780,1}.{\bf replace}({\rm p1} \rightarrow 1).{\bf replace}({\rm p2} \rightarrow 2).{\bf replace}({\rm p3} \rightarrow 1).{\bf replace}({\rm p2} \rightarrow 2).{\bf replace}({\rm p3} \rightarrow 1).{\bf replace}({\rm p3} \rightarrow 1).
3)._replace((&$heap._ecv_files[1]) \rightarrow writes_790_5)._replace(p1 \rightarrow
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow
writes_793_12)._replace(_ecv_files \rightarrow writes_793_12)._replace(p1 \rightarrow
writes_797_25)._replace(p2 \rightarrow writes_797_25)._replace(p3 \rightarrow writes_797_25))
\land ($heap<sub>loopend</sub> == $heap<sub>797.16</sub>._replace(&$heap._ecv_files[1] \rightarrow
writes_797_9)) \land (0.0 < $result_797_25) \land (-1.0 < -$result_797_25) \land ((((((0 <
\rho_{797,16}.p1 && (\rho_{797,16}.p1 < asType < integer > (asType < short)
int>((int)30269))) && (0 < asType < integer>($heap_{797.16}.p2))) &&
(asType < integer > (\$heap_{797,16}.p2) < asType < integer > (\$heap_{797,16}.M2)))
&& (0 < asType < integer > (\$heap_{797,16}.p3))) &&
(asType < integer > (\$heap_{797.16}.p3) < asType < integer > (\$heap_{797.16}.M3)))
\rightarrow [simplify]
[29.36] (1 == (-\text{count}_{loopstart\_792,5} + \text{count}_{loopend})) \land (\$\text{heap}_{797,16} ==
heap_{funcstart\_780.1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow
3)._replace((&\$heap._ecv_files[1]) \rightarrow writes_790_5)._replace(p1 \rightarrow
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow
writes_793_12)._replace(_ecv_files \rightarrow writes_793_12)._replace(p1 \rightarrow
writes_797_25)._replace(p2 \rightarrow writes_797_25)._replace(p3 \rightarrow writes_797_25))
\land ($heap<sub>loopend</sub> == $heap<sub>797,16</sub>._replace(&$heap._ecv_files[1] \rightarrow
writes_797_9)) \land (0.0 < $result_797_25) \land (-1.0 < -$result_797_25) \land
(((((-30269 < -\$heap_{797,16}.p1) \land (0 < \$heap_{797,16}.p1) \land (0 < \$heap_{797,16}.p2)))
&& (\theta = p_{797,16}.p2 < asType < integer > (\theta = p_{797,16}.M2)) && (0 <
asType<integer>($heap<sub>797,16</sub>.p3))) && (asType<integer>($heap<sub>797,16</sub>.p3)
< asType<integer>($heap_{797,16}.M3)))
\rightarrow [const static or extern object]
[29.37] (1 == (-\text{count}_{loopstart\_792,5} + \text{count}_{loopend})) \land (\$\text{heap}_{797,16} ==
{\rm Sheap}_{funcstart\_780,1}.{\bf replace}({\rm p1} \rightarrow 1).{\bf replace}({\rm p2} \rightarrow 2).{\bf replace}({\rm p3} \rightarrow 1).{\bf replace}({\rm p2} \rightarrow 2).{\bf replace}({\rm p3} \rightarrow 1).{\bf replace}({\rm p3} \rightarrow 1).
```

```
3)._replace((&\$heap._ecv_files[1]) \rightarrow writes_790_5)._replace(p1 \rightarrow
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow
writes_793_12)._replace(_ecv_files \rightarrow writes_793_12)._replace(p1 \rightarrow
writes_797_25)._replace(p2 \rightarrow writes_797_25)._replace(p3 \rightarrow writes_797_25))
\land ($heap<sub>loopend</sub> == $heap<sub>797,16</sub>._replace(&$heap._ecv_files[1] \rightarrow
writes_797_9)) \land (0.0 < $result_797_25) \land (-1.0 < -$result_797_25) \land
(((((-30269 < -\$heap_{797,16}.p1) \land (0 < \$heap_{797,16}.p1) \land (0 < \$heap_{797,16}.p2)))
&& (heap_{797,16}.p2 < asType < integer > (heap_{init}.M2)) && (0 <
asType<integer>($heap<sub>797,16</sub>.p3))) && (asType<integer>($heap<sub>797,16</sub>.p3)
< asType < integer > ($heap_{797,16}.M3)))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[29.38] (1 == (-\text{count}_{loopstart\_792,5} + \text{count}_{loopend})) \land (\$\text{heap}_{797,16} ==
heap_{funcstart\_780,1}._replace(p1 
ightarrow 1)._replace(p2 
ightarrow 2)._replace(p3 
ightarrow
3)._replace((&$heap._ecv_files[1]) \rightarrow writes_790_5)._replace(p1 \rightarrow
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow
writes_793_12)._replace(_ecv_files \rightarrow writes_793_12)._replace(p1 \rightarrow
writes_797_25)._replace(p2 \rightarrow writes_797_25)._replace(p3 \rightarrow writes_797_25))
\land (\$ heap_{loopend} == \$ heap_{797.16}.\_replace(\&\$ heap.\_ecv\_files[1] \rightarrow
writes_797_9)) \land (0.0 < $result_797_25) \land (-1.0 < -$result_797_25) \land
(((((-30269 < -\$heap_{797,16}.p1) \land (0 < \$heap_{797,16}.p1) \land (0 < \$heap_{797,16}.p2))
&& (heap_{797,16}.p2 < asType < integer > (asType < short)
int>((int)30307))) && (0 < asType < integer>($heap_{797,16}.p3))) &&
(asType < integer > ($heap_{797.16}.p3) < asType < integer > ($heap_{797.16}.M3)))
\rightarrow [simplify]
[29.50] (1 == (-\text{count}_{loopstart\_792,5} + \text{count}_{loopend})) \land (\$\text{heap}_{797,16} ==
\text{Sheap}_{funcstart\_780,1}.\_\mathbf{replace}(p1 \to 1).\_\mathbf{replace}(p2 \to 2).\_\mathbf{replace}(p3 \to 1)
3)._replace((&\$heap._ecv_files[1]) \rightarrow writes_790_5)._replace(p1 \rightarrow
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow
writes_793_12)._replace(_ecv_files \rightarrow writes_793_12)._replace(p1 \rightarrow
writes_797_25)._replace(p2 \rightarrow writes_797_25)._replace(p3 \rightarrow writes_797_25))
\land ($heap<sub>loopend</sub> == $heap<sub>797,16</sub>._replace(&$heap._ecv_files[1] \rightarrow
writes_797_9)) \land (0.0 < $result_797_25) \land (-1.0 < -$result_797_25) \land (((-30307))
<-$heap<sub>797,16</sub>.p2) \land (-30269 <-$heap<sub>797,16</sub>.p1) \land (0 <$heap<sub>797,16</sub>.p1) \land (0
< \$ heap_{797,16}.p2) \land (0 < \$ heap_{797,16}.p3)) \&\& (\$ heap_{797,16}.p3 <
asType < integer > (\$heap_{797,16}.M3)))
\rightarrow [const static or extern object]
[29.51] (1 == (-\text{count}_{loopstart\_792,5} + \text{count}_{loopend})) \land (\$\text{heap}_{797,16} ==
heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow
3)._replace((&\$heap._ecv_files[1]) \rightarrow writes_790_5)._replace(p1 \rightarrow
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow
writes_793_12)._replace(_ecv_files \rightarrow writes_793_12)._replace(p1 \rightarrow
writes_797_25)._replace(p2 \rightarrow writes_797_25)._replace(p3 \rightarrow writes_797_25))
\land ($heap<sub>loopend</sub> == $heap<sub>797,16</sub>._replace(&$heap._ecv_files[1] \rightarrow
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writes_797_9) \wedge (0.0 < $result_797_25) \wedge (-1.0 < -$result_797_25) \wedge (((-30307)
<-$heap<sub>797,16</sub>.p2) \land (-30269 <-$heap<sub>797,16</sub>.p1) \land (0 <$heap<sub>797,16</sub>.p1) \land (0
< $heap<sub>797,16</sub>.p2) \land (0 < $heap<sub>797,16</sub>.p3)) && ($heap<sub>797,16</sub>.p3 <
asType < integer > (\$heap_{init}.M3)))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[29.52] (1 == (-\text{count}_{loopstart\_792,5} + \text{count}_{loopend})) \land (\$\text{heap}_{797,16} ==
\theta_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow
3)._replace((&\text{heap._ecv_files}[1]) \rightarrow writes_790_5)._replace(p1 \rightarrow
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow
writes_793_12)._replace(_ecv_files \rightarrow writes_793_12)._replace(p1 \rightarrow
writes_797_25)._replace(p2 \rightarrow writes_797_25)._replace(p3 \rightarrow writes_797_25))
\land ($heap<sub>loopend</sub> == $heap<sub>797,16</sub>._replace(&$heap._ecv_files[1] \rightarrow
writes_797_9)) 
 \land (0.0 < $result_797_25) 
 \land (-1.0 < -$result_797_25) 
 \land (((-30307))  
<-$heap<sub>797,16</sub>.p2) \land (-30269 <-$heap<sub>797,16</sub>.p1) \land (0 <$heap<sub>797,16</sub>.p1) \land (0
< $heap<sub>797,16</sub>.p2) \land (0 < $heap<sub>797,16</sub>.p3)) && ($heap<sub>797,16</sub>.p3 <
asType<integer>(asType<short int>((int)30323))))
\rightarrow [simplify]
[29.61] (1 == (-\text{count}_{loopstart\_792,5} + \text{count}_{loopend})) \land (\$\text{heap}_{797,16} ==
heap_{funcstart_{-780,1}}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow
3)._replace((&\$heap._ecv_files[1]) \rightarrow writes_790_5)._replace(p1 \rightarrow
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow
writes_793_12)._replace(_ecv_files \rightarrow writes_793_12)._replace(p1 \rightarrow
writes_797_25)._replace(p2 \rightarrow writes_797_25)._replace(p3 \rightarrow writes_797_25))
\land ($heap<sub>loopend</sub> == $heap<sub>797.16</sub>._replace(&$heap._ecv_files[1] \rightarrow writes_797_9))
\land (0.0 < \text{\$result\_797\_25}) \land (-1.0 < -\text{\$result\_797\_25}) \land (-30323 < -\text{\$result\_797\_25}) \land (-30323 < -\text{\$result\_797\_25})
-\$heap_{797,16}.p3) \land (-30307 < -\$heap_{797,16}.p2) \land (-30269 < -\$heap_{797,16}.p1)
\land (0 < \text{\$heap}_{797,16}.\text{p1}) \land (0 < \text{\$heap}_{797,16}.\text{p2}) \land (0 < \text{\$heap}_{797,16}.\text{p3})
[Work on sub-term 2 of conjunction in term 29.61]
[30.0] heap_{797,16} == heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\hat{heap._ecv_files}[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)
[Work on sub-term 3 of conjunction in term 29.61]
writes_797_9)
\rightarrow [from term 30.0, $heap<sub>797,16</sub> is equal to $heap<sub>funcstart_780,1</sub>._replace(p1 \rightarrow
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((\&\$heap.\_ecv\_files[1]) \rightarrow
writes_790_5)._{\mathbf{replace}}(p1 \rightarrow writes_793\_12)._{\mathbf{replace}}(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow writes_797_25
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writes_797_25)._replace(p3 \rightarrow writes_797_25)]
 [31.1] \theta == 
2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
 writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
 writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace(&\$heap._ecv_files[1] \rightarrow
 writes_797_9)
 [Work on sub-term 4 of conjunction in term 29.61]
 [32.0] -30323 < -$heap<sub>797.16</sub>.p3
 \rightarrow [from term 30.0, $heap<sub>797,16</sub> is equal to $heap<sub>funcstart_780,1</sub>._replace(p1 \rightarrow
 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((\&\$heap.\_ecv\_files[1]) \rightarrow
 writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow w
 writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
 writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow writes_79_25
 writes_797_25)._replace(p3 \rightarrow writes_797_25)]
 [32.1] -30323 < -\$heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25).p3
 \rightarrow [simplify]
 [32.2] - 30323 < -writes_797_25
 [Work on sub-term 5 of conjunction in term 29.61]
 [33.0] -30307 < -$heap<sub>797.16</sub>.p2
 \rightarrow [from term 30.0, $heap<sub>797,16</sub> is equal to $heap<sub>funcstart_780,1</sub>._replace(p1 \rightarrow
 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((\&\$heap.\_ecv\_files[1]) \rightarrow
 writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow w
 writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
 writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow writes_797_25)._replace(p2 \rightarrow writes_797_25)
 writes_797_25)._replace(p3 \rightarrow writes_797_25)]
 [33.1] -30307 < -\$heap_{funcstart\_780.1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes\_793\_12).\_\mathbf{replace}(p3 \to writes\_793\_12).\_\mathbf{replace}(\_ecv\_files \to 0.0000)
 writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
 writes_797_25)._replace(p3 \rightarrow writes_797_25).p2
 \rightarrow [simplify]
 [33.3] - 30307 < -writes_797_25
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[Work on sub-term 6 of conjunction in term 29.61]
 [34.0] - 30269 < -\$heap_{797.16}.p1
 \rightarrow [from term 30.0, $heap<sub>797,16</sub> is equal to $heap<sub>funcstart_780,1</sub>._replace(p1 \rightarrow
 1). replace(p2 \rightarrow 2). replace(p3 \rightarrow 3). replace((&$heap.\_ecv\_files[1]) \rightarrow
 writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow w
 writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
 writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow writes_797_25)._replace(p2 \rightarrow writes_797_25)
  writes_797_25)._replace(p3 \rightarrow writes_797_25)]
 [34.1] -30269 < -$heap_{tuncstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25).p1
 \rightarrow [simplify]
 [34.4] -30269 < -writes_797_25
 [Work on sub-term 7 of conjunction in term 29.61]
 [35.0] 0 < $heap<sub>797,16</sub>.p1
 \rightarrow [from term 30.0, $heap<sub>797,16</sub> is equal to $heap<sub>funcstart_780,1</sub>._replace(p1 \rightarrow
 1). replace(p2 \rightarrow 2). replace(p3 \rightarrow 3). replace((& heap. ecv_files[1]) \rightarrow
 writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
 writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
 writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow writes_797_25).
 writes_797_25)._replace(p3 \rightarrow writes_797_25)]
 [35.1] 0 < \text{$heap}_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
 writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25).p1
 \rightarrow [simplify]
[35.4] 0 < writes_797_25
 [Work on sub-term 8 of conjunction in term 29.61]
 [36.0] 0 < \text{heap}_{797,16}.p2
 \rightarrow [from term 30.0, $heap<sub>797,16</sub> is equal to $heap<sub>funcstart_780,1</sub>._replace(p1 \rightarrow
 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((\&\$heap.\_ecv\_files[1]) \rightarrow
 writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow w
 writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
 writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow writes_797_25
  writes_797_25)._replace(p3 \rightarrow writes_797_25)]
```

```
[36.1] 0 < \text{heap}_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25).p2
\rightarrow [simplify]
[36.3] 0 < writes_797_25
[Work on sub-term 9 of conjunction in term 29.61]
[37.0] 0 < $heap<sub>797,16</sub>.p3
\rightarrow [from term 30.0, $heap_{797,16}$ is equal to $heap_{funcstart\_780,1}._replace(p1 \rightarrow
1). replace(p2 \rightarrow 2). replace(p3 \rightarrow 3). replace((\&\$heap.\_ecv\_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow w
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow writes_79_25)._replace(p2 \rightarrow writes_79_25)._replace(p2 \rightarrow writes_79_25)._replace(p2 \rightarrow writes_79_25
writes_797_25)._replace(p3 \rightarrow writes_797_25)]
[37.1] 0 < \text{$heap}_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25).p3
\rightarrow [simplify]
[37.2] 0 < writes_{797}25
[Take goal term]
[1.0] invariant1(heapIs $heap_{loopend})
\rightarrow [from term 31.1, $heap_{loopend}$ is equal to $heap_{funcstart\_780,1}._replace(p1
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow w
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_{-}793_{-}12)._replace(p1 \rightarrow writes_{-}797_{-}25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace(&$heap._ecv_files[1] \rightarrow
writes_797_9)]
[1.1] invariant1(heapIs heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes\_790\_5).\_\mathbf{replace}(p1 \rightarrow writes\_793\_12).\_\mathbf{replace}(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace(&\$heap._ecv_files[1] \rightarrow
writes_797_9))
```

```
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
[1.2] (((((0 < asType < integer > ($heap_{funcstart\_780,1}.\_replace(p1 \rightarrow
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow writes_797_9).p1)) &&
(asType<integer>(heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow writes_797_9).p1) < asType<integer>($heap_{tuncstart\_780,1}._replace(p1
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow writes_797_9).M1))) && (0 <
\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_780,1}.\_\mathbf{replace}(p1 \rightarrow 1).\_\mathbf{replace}(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow writes_797_9).p2))) &&
(asType<integer>(\$heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow \text{writes\_797\_9}).\text{p2}) < \mathbf{asType} < \mathbf{integer} > (\$ \text{heap}_{funcstart\_780,1}. \_\mathbf{replace} (\text{p1}
\rightarrow 1).replace(p2 \rightarrow 2).replace(p3 \rightarrow 3).replace((&$heap.ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&$heap._ecv_files[1])
\rightarrow writes_797_9).M2))) && (0 <
asType < integer > (\$heap_{funcstart\_780,1}.\_replace(p1 \rightarrow 1).\_replace(p2 \rightarrow 1))
2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
```

```
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&$heap._ecv_files[1])
\rightarrow writes_797_9).p3))) &&
(asType < integer > (\$heap_{funcstart\_780,1}.\_replace(p1 \rightarrow 1).\_replace(p2 \rightarrow 1))
2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow \text{writes\_797\_9}).\text{p3}) < \mathbf{asType} < \mathbf{integer} > (\$ \text{heap}_{funcstart\_780,1}. \_\mathbf{replace} (\text{p1}
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow writes_797_9).M3))
\rightarrow [simplify]
[1.7] (((((0 < writes_797_25) &&
(asType<integer>(\$heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow writes_797_9).p1) < asType<integer>($heap_{tuncstart_780.1}._replace(p1
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow writes_797_9).M1))) && (0 <
asType<integer>($heap<sub>funcstart_780,1</sub>._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow writes_797_9).p2))) &&
(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_780,1}.\_\mathbf{replace} (\mathtt{p1} \to 1).\_\mathbf{replace} (\mathtt{p2} \to 1))
2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow writes_797_9).p2) < asType<integer>($heap_{tuncstart\_780.1}._replace(p1
```

```
\rightarrow 1)..replace(p2 \rightarrow 2)..replace(p3 \rightarrow 3)..replace((&$heap..ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&$heap._ecv_files[1])
\rightarrow writes_797_9).M2))) && (0 <
asType < integer > (\$heap_{tuncstart\_780,1}.\_replace(p1 \rightarrow 1).\_replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow writes_797_9).p3))) &&
(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_780,1}.\_\mathbf{replace} (\mathtt{p1} \to \mathtt{1}).\_\mathbf{replace} (\mathtt{p2} \to \mathtt{p1}))
2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow writes_797_9).p3) < asType<integer>($heap_{funcstart_780,1}._replace(p1
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow writes_797_9).M3))
\rightarrow [from term 35.4, literala < writes_797_25 is true whenever (-1 + literala) <
        Proof of rule precondition:
        [1.7.0](-1+0)<0
        \rightarrow [simplify]
        [1.7.2] true
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&$heap._ecv_files[1])
\rightarrow \text{writes\_797\_9}).\text{p1}) < \mathbf{asType} < \mathbf{integer} > (\$ \text{heap}_{funcstart\_780,1}. \_\mathbf{replace} (\text{p1})) + (\texttt{p1}) + (\texttt{p2}) 
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
```

```
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&$heap._ecv_files[1])
\rightarrow writes_797_9).M1))) && (0 <
asType<integer>(heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._{\mathbf{replace}}(p1 \rightarrow writes_793_12)._{\mathbf{replace}}(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow \text{writes}_{797_{-9},p2})) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_780,1}.\_\mathbf{replace} (\mathtt{p1} \to \mathtt{1}).\_\mathbf{replace} (\mathtt{p2} \to \mathtt{p1}))
2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow writes_797_9).p2) < asType<integer>($heap_{funcstart\_780,1}._replace(p1
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow writes_797_9).M2))) && (0 <
asType < integer > (\$heap_{funcstart\_780,1}.\_replace(p1 \rightarrow 1).\_replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow \text{writes}_{797_{-9},p3})) \&\&
(asType<integer>(\$heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&$heap._ecv_files[1])
\rightarrow writes_797_9).p3) < asType<integer>($heap_{funcstart\_780,1}._replace(p1))
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow writes_797_9).M3))
\rightarrow [simplify]
[1.13] ((((true && (writes_797_25 <
asType < integer > (\$heap_{funcstart\_780,1}.\_replace(p1 \rightarrow 1).\_replace(p2 \rightarrow
```

```
2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow writes_797_9).M1))) && (0 <
asType < integer > (\$heap_{tuncstart\_780,1}.\_replace(p1 \rightarrow 1).\_replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow writes_797_9).p2))) &&
(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_780,1}.\_\mathbf{replace} (\mathtt{p1} \to \mathtt{1}).\_\mathbf{replace} (\mathtt{p2} \to \mathtt{p1}))
2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow writes_797_9).p2) < asType<integer>($heap_{funcstart\_780,1}._replace(p1
\rightarrow 1). \texttt{\_replace}(p2 \rightarrow 2). \texttt{\_replace}(p3 \rightarrow 3). \texttt{\_replace}((\&\$heap.\_ecv\_files[1]) \rightarrow 1). \texttt{\_replace}(p2 \rightarrow 2). \texttt{\_replace}(p3 \rightarrow 3). \texttt{\_replace}((\&\$heap.\_ecv\_files[1])) \rightarrow 1). \texttt{\_replace}(p3 \rightarrow 3). \texttt{
writes_790_5)._{\mathbf{replace}}(p1 \rightarrow writes_793_12)._{\mathbf{replace}}(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow writes_797_9).M2))) && (0 <
\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_780,1}.\_\mathbf{replace}(p1 \rightarrow 1).\_\mathbf{replace}(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&$heap._ecv_files[1])
\rightarrow writes_797_9).p3))) &&
(asType<integer>(\$heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow \text{writes\_797\_9}).\text{p3}) < \mathbf{asType} < \mathbf{integer} > (\$ \text{heap}_{funcstart\_780,1}. \_\mathbf{replace} (\text{p1}))
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow writes_797_9).M3))
```

```
\rightarrow [const member of object with modified fields]
[1.25] ((((true && (writes_797_25 <
asType < integer > (\$heap_{funcstart\_780,1}.M1))) \&\& (0 <
asType<integer>(heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow writes_797_9).p2))) &&
(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_780,1}.\_\mathbf{replace}(p1 \rightarrow 1).\_\mathbf{replace}(p2 \rightarrow 1))
2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._\mathbf{replace}(p3 \rightarrow writes_793_12)._\mathbf{replace}(ecv\_files \rightarrow writes_793_12)._\mathbf{replace}(p3 \rightarrow writes_793_12)._\mathbf{rep}(p3 \rightarrow writes_793_12)._\mathbf{replace}(p3 \rightarrow writes_793_12)._\mathbf{replace
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow writes_797_9).p2) < asType<integer>($heap_{tuncstart\_780.1}._replace(p1
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow writes_797_9).M2))) && (0 <
asType<integer>(heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow writes_797_9).p3))) &&
(asType < integer > (\$heap_{funcstart\_780,1}.\_replace(p1 \rightarrow 1).\_replace(p2 \rightarrow 1))
2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow
writes_790_5)._{\mathbf{replace}}(p1 \rightarrow writes_793_12)._{\mathbf{replace}}(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow writes_797_9).p3) < asType<integer>($heap_{funcstart\_780,1}._replace(p1
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&$heap._ecv_files[1])
\rightarrow writes_797_9).M3))
\rightarrow [const static or extern object]
```

```
[1.26] ((((true && (writes_797_25 < asType < integer > ($heap_{init}.M1))) &&
(0 < asType < integer > (\$heap_{funcstart\_780,1}.\_replace(p1 \rightarrow 1).\_replace(p2))
\rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow writes_797_9).p2))) &&
(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_780,1}.\_\mathbf{replace} (\mathtt{p1} \to \mathtt{1}).\_\mathbf{replace} (\mathtt{p2} \to \mathtt{p1}))
2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&$heap._ecv_files[1])
\rightarrow writes_797_9).p2) < asType<integer>($heap_{funcstart\_780,1}._replace(p1
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow writes_797_9).M2))) && (0 <
\mathbf{asType} \small{<} \mathbf{integer} \small{>} (\$ \mathbf{heap}_{funcstart\_780,1}. \_\mathbf{replace} (\mathtt{p1} \rightarrow 1). \_\mathbf{replace} (\mathtt{p2} \rightarrow 1). \_\mathbf{repla
2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&$heap._ecv_files[1])
\rightarrow \text{writes}_{797_{-}9}, \text{p3}))) \&\&
(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_780,1}.\_\mathbf{replace} (\mathtt{p1} \to \mathtt{1}).\_\mathbf{replace} (\mathtt{p2} \to \mathtt{p1}))
2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow writes_797_9).p3) < asType<integer>($heap_{tuncstart_780.1}._replace(p1
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow writes_797_9).M3))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[1.27] ((((true && (writes_797_25 < asType < integer > (asType < short
int > ((int)30269)))) \&\& (0 <
asType < integer > (\$heap_{funcstart\_780,1}.\_replace(p1 \rightarrow 1).\_replace(p2 \rightarrow
```

```
2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow writes_797_9).p2))) &&
(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_780,1}.\_\mathbf{replace} (\mathtt{p1} \to \mathtt{1}).\_\mathbf{replace} (\mathtt{p2} \to \mathtt{p1}))
2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow \text{writes\_797\_9}).\text{p2}) < \mathbf{asType} < \mathbf{integer} > (\$ \text{heap}_{funcstart\_780,1}. \_\mathbf{replace} (\text{p1})) + (\$ \text{p2}) + (\$ \text{p
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes\_797\_25).\_\mathbf{replace}(p3 \rightarrow writes\_797\_25).\_\mathbf{replace}((\&\$heap.\_ecv\_files[1])
\rightarrow \text{writes}_{797_{-}9}.\text{M2}))) \&\& (0 <
asType<integer>($heap<sub>funcstart_780,1</sub>._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._{\mathbf{replace}}(p1 \rightarrow writes_793_12)._{\mathbf{replace}}(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow writes_797_9).p3))) &&
(asType < integer > (\$heap_{funcstart\_780,1}.\_replace(p1 \rightarrow 1).\_replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow \text{writes\_797\_9}).\text{p3}) < \mathbf{asType} < \mathbf{integer} > (\$ \text{heap}_{funcstart\_780,1}. \_\mathbf{replace} (\text{p1}
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow writes_797_9).M3))
\rightarrow [simplify]
[1.33] ((((true && (-30269 < -writes_797_25)) && (0 <
asType<integer>(place(p1 \rightarrow 1))._replace(p1 \rightarrow 1)._replace(p2 \rightarrow 1
2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
```

```
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&$heap._ecv_files[1])
\rightarrow writes_797_9).p2))) &&
(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_780,1}.\_\mathbf{replace} (\mathtt{p1} \to \mathtt{1}).\_\mathbf{replace} (\mathtt{p2} \to \mathtt{p1}))
2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow \text{writes\_797\_9}).\text{p2}) < \mathbf{asType} < \mathbf{integer} > (\$ \text{heap}_{funcstart\_780,1}. \_\mathbf{replace} (\text{p1}
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow writes_797_9).M2))) && (0 <
\mathbf{asType} \small{<} \mathbf{integer} \small{>} (\$ heap_{funcstart\_780,1}. \underline{\hspace{0.1cm}} \mathbf{replace} (p1 \rightarrow 1). \underline{\hspace{0.1cm}} \mathbf{replace} (p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&$heap._ecv_files[1])
\rightarrow writes_797_9).p3))) &&
(asType < integer > (\$heap_{funcstart\_780,1}.\_replace(p1 \rightarrow 1).\_replace(p2 \rightarrow 1))
2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow \text{writes\_797\_9}).\text{p3}) < \mathbf{asType} < \mathbf{integer} > (\$ \text{heap}_{funcstart\_780,1}. \_\mathbf{replace} (\text{p1}
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow writes_797_9).M3))
\rightarrow [from term 34.4, literala < -writes_797_25 is true whenever (-1 + literala)
< -30269]
    Proof of rule precondition:
    [1.33.0] (-30269 + -1) < -30269
    \rightarrow [simplify]
    [1.33.2] true
[1.34] ((((true && true) && (0 <
```

```
asType<integer>(place(p1 \rightarrow 1))._replace(p1 \rightarrow 1)._replace(p2 \rightarrow 1
2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow \text{writes}_{797_{-}9}, \text{p2}))) \&\&
(asType < integer > (\$heap_{funcstart\_780,1}.\_replace(p1 \rightarrow 1).\_replace(p2 \rightarrow 1))
2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow \text{writes\_797\_9}).\text{p2}) < \mathbf{asType} < \mathbf{integer} > (\$ \text{heap}_{funcstart\_780,1}. \_\mathbf{replace} (\text{p1}
\rightarrow 1). \textbf{\_replace}(p2 \rightarrow 2). \textbf{\_replace}(p3 \rightarrow 3). \textbf{\_replace}((\&\$heap.\_ecv\_files[1]) \rightarrow 1). \textbf{\_replace}(p2 \rightarrow 2). \textbf{\_replace}(p3 \rightarrow 3). \textbf{
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&$heap._ecv_files[1])
\rightarrow writes_797_9).M2))) && (0 <
\mathbf{asType} \small{<} \mathbf{integer} \small{>} (\$ heap_{funcstart\_780,1}. \_\mathbf{replace} (p1 \rightarrow 1). \_\mathbf{replace} (p2 \rightarrow 1). \_\mathbf{replace} (p2 \rightarrow 1). \_\mathbf{replace} (p3 \rightarrow 1). \_\mathbf{rep
2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow writes_797_9).p3))) &&
(asType<integer>(\$heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow writes_797_9).p3) < asType<integer>($heap_{funcstart\_780,1}._replace(p1
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow writes_797_9).M3))
\rightarrow [simplify]
[1.39] (((true && (0 < writes_797_25)) &&
(asType<integer>(\$heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
```

```
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow writes_797_9).p2) < asType<integer>($heap_{funcstart\_780,1}._replace(p1
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow \text{writes}_{797_{-}9}.\text{M2}))) \&\& (0 <
asType<integer>(heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow \text{writes}_{797_{-9},p3})) \&\&
(asType<integer>(\$heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow writes_797_9).p3) < asType<integer>($heap_{tuncstart\_780.1}._replace(p1
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow writes_797_9).M3))
\rightarrow [from term 36.3, literala < writes_797_25 is true whenever (-1 + literala) <
0
    Proof of rule precondition:
    [1.39.0](-1+0)<0
    \rightarrow [simplify]
    [1.39.2] true
[1.40] (((true && true) &&
(asType < integer > (\$heap_{funcstart\_780,1}.\_replace(p1 \rightarrow 1).\_replace(p2 \rightarrow 1))
2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
```

```
\rightarrow \text{writes\_797\_9}).\text{p2}) < \mathbf{asType} < \mathbf{integer} > (\$ \text{heap}_{funcstart\_780,1}. \_\mathbf{replace} (\text{p1}
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&$heap._ecv_files[1])
\rightarrow writes_797_9).M2))) && (0 <
asType<integer>($heap<sub>funcstart_780,1</sub>._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow writes_797_9).p3))) &&
(asType<integer>($heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow writes_797_9).p3) < asType<integer>($heap_{funcstart\_780.1}._replace(p1
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow writes_797_9).M3))
\rightarrow [simplify]
[1.45] ((true && (writes_797_25 <
\mathbf{asType} \small{<} \mathbf{integer} \small{>} (\$ \mathbf{heap}_{funcstart\_780,1}. \mathbf{\_replace} (\mathtt{p1} \rightarrow 1). \mathbf{\_replace} (\mathtt{p2} \rightarrow 1). \mathbf{\_repla
2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow writes_797_9).M2))) && (0 <
asType < integer > (\$heap_{funcstart\_780,1}.\_replace(p1 \rightarrow 1).\_replace(p2 \rightarrow 1))
2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow writes_797_9).p3))) &&
(asType < integer > (\$heap_{funcstart\_780.1}.\_replace(p1 \rightarrow 1).\_replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
```

```
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes\_793\_12).\_\mathbf{replace}(p1 \rightarrow writes\_797\_25).\_\mathbf{replace}(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow writes_797_9).p3) < asType<integer>($heap_{tuncstart\_780,1}._replace(p1
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\text{heap._ecv_files}[1])
\rightarrow writes_797_9).M3))
→ [const member of object with modified fields]
[1.57] ((true && (writes_797_25 <
asType < integer > (\$heap_{funcstart\_780,1}.M2))) \&\& (0 < funcstart\_780,1)
asType<integer>(heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow writes_797_9).p3))) &&
(asType<integer>(\$heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow \text{writes\_797\_9}).\text{p3}) < \mathbf{asType} < \mathbf{integer} > (\$ \text{heap}_{funcstart\_780,1}. \_\mathbf{replace} (\text{p1}))
\rightarrow 1).replace(p2 \rightarrow 2).replace(p3 \rightarrow 3).replace((&$heap.ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&$heap.ecv_files[1])
\rightarrow writes_797_9).M3))
\rightarrow [const static or extern object]
[1.58] ((true && (writes_797_25 < asType<integer>($heap_{init}.M2))) && (0
< asType<integer>($heap_{funcstart\_780,1}.\_replace(p1 \rightarrow 1).\_replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow writes_797_9).p3))) &&
(asType<integer>(\$heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
```

```
2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&$heap._ecv_files[1])
\rightarrow writes_797_9).p3) < asType<integer>($heap_{tuncstart\_780,1}._replace(p1
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow writes_797_9).M3))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[1.59] ((true && (writes_797_25 < asType<integer>(asType<short
int>((int)30307))) && (0 <
\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_780,1}.\_\mathbf{replace}(p1 \rightarrow 1).\_\mathbf{replace}(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes\_793\_12).\_\mathbf{replace}(p1 \rightarrow writes\_797\_25).\_\mathbf{replace}(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow writes_797_9).p3))) &&
(asType<integer>(\$heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow writes_797_9).p3) < asType<integer>($heap_{tuncstart}_780_1._replace(p1
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow writes_797_9).M3))
\rightarrow [simplify]
[1.65] ((true && (-30307 < -writes_797_25)) && (0 <
asType < integer > (\$heap_{funcstart\_780,1}.\_replace(p1 \rightarrow 1).\_replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow writes_797_9).p3))) &&
```

```
(asType<integer>(\$heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&$heap._ecv_files[1])
\rightarrow \text{writes\_797\_9}).\text{p3}) < \mathbf{asType} < \mathbf{integer} > (\$ \text{heap}_{funcstart\_780,1}. \_\mathbf{replace} (\text{p1})) + (\$ \text{p1}) + (\$ \text{p2}) + (\$ \text{p
\rightarrow 1).replace(p2 \rightarrow 2).replace(p3 \rightarrow 3).replace((&$heap.ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&$heap._ecv_files[1])
\rightarrow writes_797_9).M3))
\rightarrow [from term 33.3, literala < -writes_797_25 is true whenever (-1 + literala)
< -30307]
        Proof of rule precondition:
        [1.65.0](-30307 + -1) < -30307
        \rightarrow [simplify]
        [1.65.2] true
[1.66] ((true && true) && (0 <
asType<integer>($heap<sub>funcstart</sub> <sub>780.1</sub>._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow writes_797_9).p3))) &&
(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_780,1}.\_\mathbf{replace} (\mathtt{p1} \to 1).\_\mathbf{replace} (\mathtt{p2} \to 1))
2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow \text{writes\_797\_9}).\text{p3}) < \mathbf{asType} < \mathbf{integer} > (\$ \text{heap}_{funcstart\_780,1}. \_\mathbf{replace} (\text{p1}
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow writes_797_9).M3))
\rightarrow [simplify]
[1.70] (true && (0 < writes_797_25)) &&
```

```
(asType<integer>(\$heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow \text{writes\_797\_9}).\text{p3}) < \mathbf{asType} < \mathbf{integer} > (\$ \text{heap}_{funcstart\_780,1}. \_\mathbf{replace} (\text{p1}))
\rightarrow 1).replace(p2 \rightarrow 2).replace(p3 \rightarrow 3).replace((&$heap.ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&$heap._ecv_files[1])
\rightarrow writes_797_9).M3))
\rightarrow [from term 37.2, literala < writes_797_25 is true whenever (-1 + literala) <
    Proof of rule precondition:
    [1.70.0](-1+0)<0
    \rightarrow [simplify]
    [1.70.2] true
[1.71] (true && true) &&
(asType < integer > (\$heap_{funcstart\_780,1}.\_replace(p1 \rightarrow 1).\_replace(p2 \rightarrow 1))
2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow writes_797_9).p3) < asType<integer>($heap_{funcstart\_780,1}._replace(p1
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow writes_797_9).M3))
\rightarrow [simplify]
[1.75] true && (writes_797_25 <
asType < integer > (\$heap_{funcstart\_780,1}.\_replace(p1 \rightarrow 1).\_replace(p2 \rightarrow 1))
2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)._replace(p1 \rightarrow writes_797_25)._replace(p2 \rightarrow
writes_797_25)._replace(p3 \rightarrow writes_797_25)._replace((&\$heap._ecv_files[1])
\rightarrow writes_797_9).M3))
```

```
[1.87] true && (writes_797_25 < asType<integer>($heap_{tuncstart_780,1}.M3))
\rightarrow [const static or extern object]
[1.88] true && (writes_797_25 < asType<integer>($heap_{init}.M3))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[1.89] true && (writes_797_25 < asType<integer>(asType<short
int > ((int)30323)))
\rightarrow [simplify]
[1.95] true && (-30323 < -writes_797_25)
\rightarrow [from term 32.2, literala < -writes_797_25 is true whenever (-1 + literala)
< -30323
   Proof of rule precondition:
   [1.95.0](-30323 + -1) < -30323
   \rightarrow [simplify]
   [1.95.2] true
[1.96] true && true
\rightarrow [simplify]
[1.97] true
Proof of verification condition: Precondition of 'WHprang' satisfied
Condition generated at: C:\Escher\Customers\prang\prang.c (116,25)
Condition defined at: C:\Escher\Customers\prang\prang.c (42,5)
To prove: invariant1(heapIs $heap_loopstart_792.5)
Given:
heap_{init}.LIMIT == (int)80
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta
heap_{init}.M2 == asType < short int > ((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta sheap<sub>init</sub>.b2 == asType<short int>((int)35)
```

 \rightarrow [const member of object with modified fields]

```
heap_{init}.M3 == asType < short int > ((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
heap_{init}.b3 == asType < short int > ((int)63)
\theta
\theta
\theta = asType < short int > ((int)3)
\$heap_{780,1;783,8} == \$heap_{funcstart\_780,1}.\_\mathbf{replace}(p1 \to \mathbf{asType} < \mathbf{short}
int>((int)1)
heap_{780,1:784,8} == heap_{780,1:783,8}.replace(p2 \rightarrow asType<short
int>((int)2)
\text{heap}_{780.1;785.8} == \text{heap}_{780.1;784.8}._replace(p3 \rightarrow asType<short)
int>((int)3))
limit == \$heap_{780,1;785,8}.LIMIT
minof(int const) \leq limit
limit \leq maxof(int const)
count == (int)0
minof(int) \le count
count \leq maxof(int)
heap_{780,1;790,5} == heap_{780,1;785,8}.replace((&heap_{780,1;785,8}.ecv_files[1]).
\rightarrow writes_790_5)
\text{Sheap}_{loopstart\_792,5} == \text{Sheap}_{780,1;790,5}.\_\mathbf{replace}(p1 \rightarrow
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow
writes_793_12)._replace(\_ecv\_files \rightarrow writes\_793\_12)
\#writes_793_12 == \#$heap<sub>780,1;790,5</sub>._ecv_files
\mathbf{minof}(\mathbf{int}) \leq \mathrm{count}_{loopstart\_792,5}
count_{loopstart_{-792,5}} \le maxof(int)
invariant
1<br/>({\bf heapIs}\ \${\rm heap}_{loopstart\_792,5})
count_{loopstart\_792,5} < limit
0 \le (asType < integer const > (limit) -
asType < integer > (count_{loopstart\_792,5}))
(\mathbf{asType} {<} \mathbf{integer} \ \mathbf{const} {>} (\mathbf{limit}) \ - \ \mathbf{asType} {<} \mathbf{integer} {>} (\mathbf{count}_{loopstart\_792,5}))
\leq (asType < integer const > (limit) - asType < integer > (count))
Proof:
[Take given term]
```

```
[5.0] \text{sheap}_{780,1;783,8} == \text{sheap}_{funcstart\_780,1}. \text{replace}(\text{p1} \rightarrow \text{asType} < \text{short})
int > ((int)1)
\rightarrow [simplify]
[5.2] $\text{heap}_{780,1;783,8} == $\text{heap}_{funcstart_780,1}._\text{replace}(p1 \rightarrow 1)$
[Take given term]
[6.0] $\text{heap}_{780,1;784,8} == \text{$heap}_{780,1;783,8}._\text{replace}(p2 \rightarrow \text{asType} < \text{short}
int>((int)2))
\rightarrow [from term 5.2, $heap<sub>780,1:783,8</sub> is equal to $heap<sub>funcstart_780,1</sub>._replace(p1)
\rightarrow 1)
[6.1] \theta == \theta
asType<short int>((int)2))
\rightarrow [simplify]
[6.3] \text{heap}_{780,1;784,8} == \text{heap}_{funcstart\_780,1}.\text{-replace}(p1 \rightarrow 1).\text{-replace}(p2 \rightarrow
[Take given term]
[7.0] $\text{heap}_{780,1;785,8} == $\text{heap}_{780,1;784,8}.$\text{replace}(p3 \to \text{asType} < \text{short}
\rightarrow [from term 6.3, $heap<sub>780,1:784.8</sub> is equal to $heap<sub>funcstart_780,1</sub>._replace(p1)
\rightarrow 1)._replace(p2 \rightarrow 2)]
\label{eq:continuous} \text{[7.1] $$heap_{780,1;785,8} == $$heap_{funcstart\_780,1}.$\_\textbf{replace}(p1 \rightarrow 1).$\_\textbf{replace}(p2 \rightarrow 1).$$
2)._replace(p3 \rightarrow asType<short int>((int)3))
\rightarrow [simplify]
[7.3] heap_{780,1;785,8} == heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)
[Take given term]
[10.0] $heap<sub>780,1;790,5</sub> ==
\$heap_{780,1;785,8}.\_\textbf{replace}((\&\$heap_{780,1;785,8}.\_\textbf{ecv\_files}[1]).\$r \to writes\_790\_5)
\rightarrow [from term 7.3, $heap<sub>780,1;785,8</sub> is equal to $heap<sub>funcstart_780,1</sub>._replace(p1)
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)]
[10.1] $\text{heap}_{780,1;790,5} == $\text{heap}_{funcstart_780,1}._\text{replace}(p1 \to 1)._\text{replace}(p2)
\rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap_{780.1:785.8}.-ecv_files[1]).$r \rightarrow
writes_790_5)
\rightarrow [simplify]
[10.2] heap_{780,1;790,5} == heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2
\rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]).$r \rightarrow writes_790_5)
\rightarrow [attribute value is known from postcondition]
```

```
[10.3] $\text{heap}_{780,1;790,5} == $\text{heap}_{funcstart_780,1}._\text{replace}(p1 \rightarrow 1)._\text{replace}(p2)
\rightarrow 2)._replace(p3 \rightarrow 3)._replace(&$heap._ecv_files[1] \rightarrow writes_790_5)
[Take given term]
[11.0] $\text{heap}_{loopstart_792,5} == $\text{heap}_{780,1;790,5}._\text{replace}(p1 \rightarrow 1.0]$
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow
writes_793_12)._replace(\_ecv\_files \rightarrow writes\_793\_12)
\rightarrow [from term 10.3, $heap<sub>780.1;790.5</sub> is equal to $heap<sub>funcstart_780.1</sub>._replace(p1)
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace(&$heap._ecv_files[1] \rightarrow
writes_790_5)]
[11.1] \text{Sheap}_{loopstart\_792,5} == \text{Sheap}_{funcstart\_780,1}._replace(p1 \rightarrow
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12)
[Take given term]
[21.0] invariant1(heapIs $heap_loopstart_792,5)
\rightarrow [from term 11.1, $heap<sub>loopstart_792,5</sub> is equal to
heap_{funcstart_{-780,1}}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 1)._replace(p3 \rightarrow 1)._re
3)._replace((&\$heap._ecv_files[1]) \rightarrow writes_790_5)._replace(p1 \rightarrow
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow 
writes_793_12)._replace(_ecv_files \rightarrow writes_793_12)]
[21.1] invariant1(heapIs heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2
\rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12))
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
[21.2] (((((0 < asType<integer>($heap_{tuncstart=780.1}.-replace(p1 \rightarrow
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._{\mathbf{replace}}(p1 \rightarrow writes_793_12)._{\mathbf{replace}}(p2 \rightarrow
writes\_793\_12).\_\mathbf{replace}(p3 \to writes\_793\_12).\_\mathbf{replace}(\_ecv\_files \to 0.0000)
writes_793_12).p1)) && (asType<integer>($heap_{funcstart\_780,1}._replace(p1
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p1) < asType<integer>($heap<sub>funcstart_780,1</sub>._replace(p1 \rightarrow
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).M1))) && (0 <
\mathbf{asType} \small{<} \mathbf{integer} \small{>} (\$ heap_{funcstart\_780,1}. \_\mathbf{replace} (p1 \rightarrow 1). \_\mathbf{replace} (p2 \rightarrow 1). \_\mathbf{replace} (p2 \rightarrow 1). \_\mathbf{replace} (p3 \rightarrow 1). \_\mathbf{rep
```

```
2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p2))) && (asType<integer>($heap_{funcstart\_780,1}._replace(p1
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p2) < asType<integer>(\theta).replace(p1 \rightarrow
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).M2))) && (0 <
\mathbf{asType} \small{<} \mathbf{integer} \small{>} (\$ heap_{funcstart\_780,1}. \_\mathbf{replace} (p1 \rightarrow 1). \_\mathbf{replace} (p2 \rightarrow 1). \_\mathbf{replace} (p2 \rightarrow 1). \_\mathbf{replace} (p3 \rightarrow 1). \_\mathbf{rep
2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p3) < asType<integer>(p1 \rightarrow parameter = parameter 
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).M3))
\rightarrow [simplify]
[21.12] (((((0 < writes_793_12) && (writes_793_12 <
asType < integer > (\$heap_{funcstart\_780,1}.\_replace(p1 \rightarrow 1).\_replace(p2 \rightarrow 1))
2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).M1))) && (0 <
asType<integer>($heap<sub>funcstart_780,1</sub>._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes\_790\_5).\_\mathbf{replace}(p1 \rightarrow writes\_793\_12).\_\mathbf{replace}(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p2))) && (asType<integer>($heap_{uncstart\_780.1}._replace(p1
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p2) < asType<integer>($heap<sub>funcstart_780,1</sub>._replace(p1 \rightarrow
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).M2))) && (0 <
```

```
asType<integer>(place(p1 \rightarrow 1))._replace(p1 \rightarrow 1)._replace(p2 \rightarrow 1
2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p3))) && (asType<integer>($heap_funcstart_780,1._replace(p1
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p3) < asType<integer>(p1 \rightarrow parameter = 1200).p3) < asType<integer>(p1 \rightarrow parameter = 1200).p3)
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).M3))
\rightarrow [const member of object with modified fields]
[21.20] (((((0 < writes_793_12) && (writes_793_12 <
asType < integer > (\$heap_{funcstart\_780,1}.M1))) \&\& (0 <
asType<integer>(heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p2))) && (asType<integer>($heap_{tuncstart\_780.1}._replace(p1
\rightarrow 1).replace(p2 \rightarrow 2).replace(p3 \rightarrow 3).replace((&$heap.ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p2) < asType<integer>(\text{$heap_{funcstart}$}_{-780.1}.replace(p1 \rightarrow
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).M2))) && (0 <
asType<integer>(heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p3))) && (asType<integer>($heap<sub>funcstart_780,1</sub>._replace(p1
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p3) < asType<integer>($heap<sub>funcstart_780,1</sub>._replace(p1 \rightarrow
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).M3))
\rightarrow [const static or extern object]
[21.21] (((((0 < writes_793_12) && (writes_793_12 <
```

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asType < integer > (\$heap_{init}.M1))) \&\& (0 <
asType<integer>(heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p2))) && (asType<integer>($heap_{funcstart\_780,1}._replace(p1
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p2) < asType<integer>(p1 \rightarrow p1).period = asType<integer>(p1 \rightarrow p1).properties = asType
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).M2))) && (0 <
asType<integer>(heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p3))) && (asType<integer>($heap_{funcstart\_780,1}._replace(p1
\rightarrow 1)..replace(p2 \rightarrow 2)..replace(p3 \rightarrow 3)..replace((&$heap..ecv_files[1]) \rightarrow
writes_790_5)._{\mathbf{replace}}(p1 \rightarrow writes_793_12)._{\mathbf{replace}}(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p3) < asType<integer>($heap<sub>funcstart_780,1</sub>._replace(p1 \rightarrow
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).M3))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[21.22] (((((0 < writes_793_12) && (writes_793_12 <
asType<integer>(asType<short int>((int)30269)))) && (0 <
\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_780,1}.\_\mathbf{replace}(p1 \rightarrow 1).\_\mathbf{replace}(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p2))) && (asType<integer>($heap_{funcstart\_780,1}._replace(p1
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p2) < asType<integer>(p1 \rightarrow p1).pe
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).M2))) && (0 <
asType<integer>($heap<sub>funcstart_780.1</sub>._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
```

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writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p3))) && (asType<integer>(p1)
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._{\mathbf{replace}}(p1 \rightarrow writes_793_12)._{\mathbf{replace}}(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p3) < asType<integer>(p1 \rightarrow parameter = 1200).p3) < asType<integer>(p1 \rightarrow parameter = 1200).p3)
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).M3)
\rightarrow [simplify]
[21.39] ((((-30269 < -writes_793_12) \land (0 < writes_793_12) \land (0 <
writes_793_12)) && (writes_793_12 <
asType<integer>(heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).M2))) && (0 <
asType<integer>(heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p3))) && (asType<integer>($heap_{funcstart\_780,1}._replace(p1
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p3) < asType<integer>(p1 \rightarrow parameter = 1200).p3) < asType<integer>(p1 \rightarrow parameter = 1200).p3)
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).M3))
\rightarrow [const member of object with modified fields]
[21.47] ((((-30269 < -writes_793_12) \land (0 < writes_793_12) \land (0 <
writes_793_12)) && (writes_793_12 <
asType < integer > (\$heap_{funcstart\_780,1}.M2))) \&\& (0 < funcstart\_780,1)
asType<integer>(heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p3))) && (asType<integer>($heap_{tuncstart\_780.1}._replace(p1
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
```

```
writes_793_12).p3) < asType<integer>(p1 \rightarrow p1).p3) < asType<integer>(p1 \rightarrow p1).p3
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).M3))
\rightarrow [const static or extern object]
[21.48] ((((-30269 < -writes_793_12) \land (0 < writes_793_12) \land (0 <
writes_793_12)) && (writes_793_12 < asType < integer > (heap_{init}.M2))) &&
(0 < asType < integer > (\$heap_{funcstart\_780,1}.\_replace(p1 \rightarrow 1).\_replace(p2))
\rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p3))) && (asType<integer>($heap_{funcstart\_780,1}._replace(p1
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap.ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p3) < asType<integer>($heap<sub>funcstart_780,1</sub>._replace(p1 \rightarrow
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).M3))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[21.49] ((((-30269 < -writes_793_12) \land (0 < writes_793_12) \land (0 <
writes_793_12)) && (writes_793_12 < asType<integer>(asType<short
int>((int)30307)))) && (0 <
asType < integer > (\$heap_{funcstart\_780,1}.\_replace(p1 \rightarrow 1).\_replace(p2 \rightarrow 1))
2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p3))) && (asType<integer>($heap_{tuncstart\_780.1}._replace(p1
\rightarrow 1)..replace(p2 \rightarrow 2)..replace(p3 \rightarrow 3)..replace((&$heap..ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p3) < asType<integer>($heap<sub>funcstart_780,1</sub>._replace(p1 \rightarrow
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).M3)
\rightarrow [simplify]
[21.65] ((-30307 < -writes_793_12) \land (-30269 < -writes_793_12) \land (0 <
writes_793_12) \land (0 < writes_793_12) \land (0 < writes_793_12)) &&
(writes_793_12 < asType<integer>(p1 \rightarrow p_{funcstart_780,1})._replace
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
```

```
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).M3)
→ [const member of object with modified fields]
[21.73] ((-30307 < -writes_793_12) \land (-30269 < -writes_793_12) \land (0 <
writes_793_12) \land (0 < writes_793_12) \land (0 < writes_793_12)) &&
(writes\_793\_12 < \mathbf{asType} < \mathbf{integer} > (\$heap_{funcstart\_780,1}.M3))
\rightarrow [const static or extern object]
[21.74] ((-30307 < -writes_793_12) \land (-30269 < -writes_793_12) \land (0 <
writes_793_12) \land (0 < writes_793_12) \land (0 < writes_793_12)) &&
(writes_793_12 < asType < integer > (\$heap_{init}.M3))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[21.75] ((-30307 < -writes_793_12) \land (-30269 < -writes_793_12) \land (0 <
writes_793_12) \land (0 < writes_793_12) \land (0 < writes_793_12)) &&
(writes_793_12 < asType<integer>(asType<short int>((int)30323)))
\rightarrow [simplify]
[21.83] (-30323 < -writes_793_12) \land (-30307 < -writes_793_12) \land (-30269 <
-writes_793_12) \land (0 < writes_793_12) \land (0
writes_793_12)
\rightarrow [separate conjunction and work on first sub-term]
[21.84] -30323 < -writes_793_12
[Work on sub-term 2 of conjunction in term 21.83]
[22.0] -30307 < -writes_793_12
[Work on sub-term 3 of conjunction in term 21.83]
[23.0] -30269 < -writes_793_12
[Work on sub-term 4 of conjunction in term 21.83]
[24.0] 0 < writes_793_12
[Work on sub-term 5 of conjunction in term 21.83]
[25.0] 0 < writes_793_12
[Work on sub-term 6 of conjunction in term 21.83]
[26.0] 0 < writes_793_12
[Take goal term]
[1.0] invariant1(heapIs $heap_{loopstart_792,5})
\rightarrow [from term 11.1, \rho_{loopstart\_792,5} is equal to
\$heap_{funcstart\_780,1}.\_\mathbf{replace}(p1 \to 1).\_\mathbf{replace}(p2 \to 2).\_\mathbf{replace}(p3 \to 1)
3)._replace((&\$heap._ecv_files[1]) \rightarrow writes_790_5)._replace(p1 \rightarrow
```

```
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow 
writes_793_12)._replace(_ecv_files \rightarrow writes_793_12)]
[1.1] invariant1(heapIs heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12))
\rightarrow [expand definition of function 'invariant1' at prang.c (34,1)]
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes\_793\_12).p1)) \&\& (asType < integer > (\$heap_{funcstart\_780,1}.\_replace (p1))) \&\& (asType < integer) = (\$heap_{funcstart\_780,1}.\_replace (p1)) & (\Sheap_{funcstart\_780,1}.\_replace (p1)) & (\She
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p1) < asType<integer>(heap_{funcstart\_780,1}._replace(p1 \rightarrow
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).M1))) && (0 <
asType < integer > (\$heap_{funcstart\_780,1}.\_replace(p1 \rightarrow 1).\_replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p2))) && (asType<integer>($heap_{funcstart\_780,1}._replace(p1
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p2) < asType<integer>(\text{$heap_{funcstart\_780.1}..replace}(\text{p1} \rightarrow \text{$asType})
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).M2))) && (0 <
asType<integer>(heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\hat{heap._ecv_files}[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p3))) && (asType<integer>($heap<sub>funcstart_780,1</sub>._replace(p1
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes\_793\_12).p3) < \mathbf{asType} < \mathbf{integer} > (\$heap_{funcstart\_780,1}.\_\mathbf{replace}(p1 \rightarrow \texttt{p1})) > \texttt{p2} + \texttt{p2} + \texttt{p3} + \texttt{
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
```

```
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_{793_{12}}.M3))
\rightarrow [simplify]
[1.7] (((((0 < writes_793_12) &&
(asType<integer>(\$heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow
writes_790_5)._{\mathbf{replace}}(p1 \rightarrow writes_793_12)._{\mathbf{replace}}(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p1) < asType<integer>(\theta).replace(p1 \rightarrow
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).M1))) && (0 <
asType<integer>(heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes\_793\_12).p2))) \&\& (asType < integer > (\$heap_{funcstart\_780,1}.\_replace (p1))) \&\& (asType < integer) = (\$heap_{funcstart\_780,1}.\_replace (p1))) & (\$heap_{funcstart\_780,1}.\_replace (p1)) & (\Sheap_{funcstart\_780,1}.\_replace (p1)) & (\S
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p2) < asType<integer>(p1 \rightarrow p1).period (p1 p1)
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).M2))) && (0 <
asType<integer>(heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p3))) && (asType<integer>($heap_{funcstart\_780,1}._replace(p1
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap.ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p3) < asType<integer>($heap<sub>funcstart_780,1</sub>._replace(p1 \rightarrow
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).M3))
\rightarrow [from term 24.0, literala < writes_793_12 is true whenever (-1 + literala) <
0
```

Proof of rule precondition:

```
[1.7.0](-1+0)<0
            \rightarrow [simplify]
            [1.7.2] true
[1.8] ((((true && (asType<integer>(p1 \rightarrow p1.8))))
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes\_793\_12).p1) < \mathbf{asType} < \mathbf{integer} > (\$heap_{funcstart\_780,1}.\_\mathbf{replace}(p1 \rightarrow \texttt{p1})) > \texttt{p2} + \texttt{p2} + \texttt{p2} + \texttt{p3} + \texttt{
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).M1))) && (0 <
\mathbf{asType} \small{<} \mathbf{integer} \small{>} (\$ heap_{funcstart\_780,1}. \_\mathbf{replace} (p1 \rightarrow 1). \_\mathbf{replace} (p2 \rightarrow 1). \_\mathbf{replace} (p2 \rightarrow 1). \_\mathbf{replace} (p2 \rightarrow 1). \_\mathbf{replace} (p3 \rightarrow 1). \_\mathbf{rep
2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p2))) && (asType<integer>($heap_{funcstart\_780,1}._replace(p1
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p2) < asType<integer>($heap<sub>funcstart_780,1</sub>._replace(p1 \rightarrow
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).M2))) && (0 <
asType<integer>($heap<sub>funcstart_780,1</sub>._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p3))) && (asType<integer>($heap_{uncstart\_780.1}._replace(p1
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p3) < asType<integer>($heap<sub>funcstart_780,1</sub>._replace(p1 \rightarrow
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).M3))
\rightarrow [simplify]
[1.13] ((((true && (writes_793_12 <
asType<integer>(heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
```

```
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).M1))) && (0 <
asType<integer>(heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._{\mathbf{replace}}(p1 \rightarrow writes_793_12)._{\mathbf{replace}}(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p2))) && (asType<integer>($heap_{funcstart\_780,1}._replace(p1
\rightarrow 1).replace(p2 \rightarrow 2).replace(p3 \rightarrow 3).replace((&$heap.ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p2) < asType<integer>($heap<sub>funcstart_780,1</sub>._replace(p1 \rightarrow
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).M2))) && (0 <
asType<integer>(place(p1 \rightarrow 1))._replace(p1 \rightarrow 1)._replace(p2 \rightarrow 1
2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p3))) && (asType<integer>($heap_{uncstart_780.1}.replace(p1
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p3) < asType<integer>($heap<sub>funcstart_780,1</sub>._replace(p1 \rightarrow
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).M3))
\rightarrow [const member of object with modified fields]
[1.21] ((((true && (writes_793_12 <
asType < integer > (\$heap_{funcstart\_780,1}.M1))) \&\& (0 <
asType<integer>($heap<sub>funcstart_780,1</sub>._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p2))) && (asType<integer>($heap<sub>funcstart_780,1</sub>._replace(p1
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p2) < asType<integer>(p1 \rightarrow properties = 12.12).p2) < asType<integer>(p1 \rightarrow properties = 12.12).p2)
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).M2))) && (0 <
asType < integer > (\$heap_{funcstart\_780,1}.\_replace(p1 \rightarrow 1).\_replace(p2 \rightarrow
```

```
2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p3))) && (asType<integer>($heap_{funcstart\_780,1}._replace(p1
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p3) < asType<integer>(\theta).replace(p1 \rightarrow
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).M3))
\rightarrow [const static or extern object]
[1.22] ((((true && (writes_793_12 < asType<integer>($heap_{init}.M1))) &&
(0 < asType < integer > (\$heap_{funcstart\_780,1}.\_replace(p1 \rightarrow 1).\_replace(p2))
\rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes\_793\_12).p2))) \&\& (asType < integer > (\$heap_{funcstart\_780,1}.\_replace (p1))) \&\& (asType < integer) = (\$heap_{funcstart\_780,1}.\_replace (p1))) & (\$heap_{funcstart\_780,1}.\_replace (p1)) & (\Sheap_{funcstart\_780,1}.\_replace (p1)) & (\S
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p2) < asType<integer>($heap<sub>funcstart_780,1</sub>._replace(p1 \rightarrow
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).M2))) && (0 <
asType < integer > (\$heap_{funcstart\_780,1}.\_replace(p1 \rightarrow 1).\_replace(p2 \rightarrow 1))
2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p3))) && (asType<integer>($heap_{funcstart\_780,1}._replace(p1
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap.ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p3) < asType<integer>($heap<sub>funcstart_780,1</sub>._replace(p1 \rightarrow
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).M3))
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[1.23] ((((true && (writes_793_12 < asType<integer>(asType<short
int>((int)30269)))) && (0 <
asType<integer>(place(p1 \rightarrow 1))._replace(p1 \rightarrow 1)._replace(p2 \rightarrow 1
```

```
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p2))) && (asType<integer>($heap_{funcstart\_780,1}._replace(p1
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p2) < asType<integer>(heap_{funcstart_780,1}.replace(p1 \rightarrow
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).M2))) && (0 <
\mathbf{asType} \small{<} \mathbf{integer} \small{>} (\$ heap_{funcstart\_780,1}. \_\mathbf{replace} (p1 \rightarrow 1). \_\mathbf{replace} (p2 \rightarrow 1). \_\mathbf{replace} (p2 \rightarrow 1). \_\mathbf{replace} (p3 \rightarrow 1). \_\mathbf{rep
2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p3) < asType<integer>(p1 \rightarrow parameter = parameter 
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).M3))
\rightarrow [simplify]
[1.29] (((true && (-30269 < -writes_793_12)) && (0 <
asType < integer > (\$heap_{funcstart\_780,1}.\_replace(p1 \rightarrow 1).\_replace(p2 \rightarrow 1))
2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p2))) && (asType<integer>($heap_{funcstart\_780,1}._replace(p1
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap.ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p2) < asType<integer>($heap<sub>funcstart_780,1</sub>._replace(p1 \rightarrow
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).M2))) && (0 <
asType<integer>(heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p3))) && (asType<integer>($heap<sub>funcstart_780,1</sub>._replace(p1
```

2)._replace(p3 \rightarrow 3)._replace((&\\$heap._ecv_files[1]) \rightarrow

```
\rightarrow 1)..replace(p2 \rightarrow 2)..replace(p3 \rightarrow 3)..replace((&$heap..ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p3) < asType<integer>($heap<sub>funcstart_780,1</sub>._replace(p1 \rightarrow
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).M3))
\rightarrow [from term 23.0, literala < -writes_793_12 is true whenever (-1 + literala)
< -30269]
    Proof of rule precondition:
    [1.29.0](-30269 + -1) < -30269
    \rightarrow [simplify]
    [1.29.2] true
[1.30] ((((true && true) && (0 <
asType < integer > (\$heap_{funcstart\_780,1}.\_replace(p1 \rightarrow 1).\_replace(p2 \rightarrow 1))
2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._{\mathbf{replace}}(p1 \rightarrow writes_793_12)._{\mathbf{replace}}(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p2))) && (asType<integer>(p1)
\rightarrow 1).replace(p2 \rightarrow 2).replace(p3 \rightarrow 3).replace((&$heap.ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p2) < asType<integer>($heap<sub>funcstart_780,1</sub>._replace(p1 \rightarrow
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).M2))) && (0 <
asType < integer > (\$heap_{funcstart\_780,1}.\_replace(p1 \rightarrow 1).\_replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p3))) && (asType<integer>($heap_{funcstart\_780,1}._replace(p1
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p3) < asType<integer>($heap<sub>funcstart_780,1</sub>._replace(p1 \rightarrow
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).M3))
\rightarrow [simplify]
```

```
[1.35] (((true && (0 < writes_793_12)) &&
(asType < integer > (\$heap_{funcstart\_780,1}.\_replace(p1 \rightarrow 1).\_replace(p2 \rightarrow 1))
2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p2) < asType<integer>(p1 \rightarrow p1).period = asType<integer>(p1 \rightarrow p1).properties = asType
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).M2))) && (0 <
asType<integer>(heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p3))) && (asType<integer>($heap_{funcstart\_780,1}._replace(p1
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p3) < asType<integer>(p1 \rightarrow parameter = 1200).p3) < asType<integer>(p1 \rightarrow parameter = 1200).p3)
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._\mathbf{replace}(p1 \rightarrow writes_793\_12)._\mathbf{replace}(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).M3))
\rightarrow [from term 26.0, literala < writes_793_12 is true whenever (-1 + literala) <
0]
      Proof of rule precondition:
      [1.35.0](-1+0)<0
      \rightarrow [simplify]
      [1.35.2] true
[1.36] (((true && true) &&
(asType<integer>(\$heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p2) < asType<integer>(heap_{funcstart\_780,1}._replace(p1 \rightarrow
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes\_793\_12).\_\mathbf{replace}(p3 \to writes\_793\_12).\_\mathbf{replace}(\_ecv\_files \to 0.0000)
writes_793_12).M2))) && (0 <
asType<integer>($heap<sub>funcstart_780,1</sub>._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
```

```
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p3) < asType<integer>($heap<sub>funcstart_780,1</sub>._replace(p1 \rightarrow
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).M3))
\rightarrow [simplify]
[1.41] ((true && (writes_793_12 <
asType<integer>($heap<sub>funcstart_780,1</sub>._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).M2))) && (0 <
asType<integer>(heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p3))) && (asType<integer>($heap_{funcstart\_780,1}._replace(p1
\rightarrow 1).replace(p2 \rightarrow 2).replace(p3 \rightarrow 3).replace((&$heap.ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p3) < asType<integer>(\text{$heap_{funcstart}$}_{-780.1}.replace(p1 \rightarrow
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).M3))
\rightarrow [const member of object with modified fields]
[1.49] ((true && (writes_793_12 <
asType<integer>($heap_{funcstart\_780,1}.M2))) && (0 <
asType<integer>(heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p3))) && (asType<integer>(p1)
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p3) < asType<integer>($heap<sub>funcstart_780,1</sub>._replace(p1 \rightarrow
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
```

```
writes_793_12).M3))
\rightarrow [const static or extern object]
[1.50] ((true && (writes_793_12 < asType<integer>($heap_{init}.M2))) && (0
<\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_780,1}.\_\mathbf{replace} (\mathtt{p1} \to 1).\_\mathbf{replace} (\mathtt{p2} \to 1))
2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p3))) && (asType<integer>($heap_{funcstart\_780,1}._replace(p1
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes\_793\_12).p3) < \mathbf{asType} < \mathbf{integer} > (\$heap_{funcstart\_780,1}.\_\mathbf{replace}(p1 \rightarrow \texttt{p1})) > \texttt{p2} + \texttt{p2} + \texttt{p2} + \texttt{p3} + \texttt{
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).M3))
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[1.51] ((true && (writes_793_12 < asType<integer>(asType<short
int>((int)30307)))) && (0 <
\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_780,1}.\_\mathbf{replace}(p1 \rightarrow 1).\_\mathbf{replace}(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_{793_{-}12}.p3))) \&\& (asType < integer > ($heap_{funcstart_{780,1}}.\_replace(p1))) & ($heap_{funcstart_{780,1}}.\_replace(p1)) & ($heap_{funcstart
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p3) < asType<integer>(p1 \rightarrow p_{funcstart_780,1}._replace
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).M3))
\rightarrow [simplify]
[1.57] ((true && (-30307 < -writes_793_12)) && (0 <
asType<integer>(place(p1 \rightarrow 1))._replace(p1 \rightarrow 1)._replace(p2 \rightarrow 1
2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p3))) && (asType<integer>(p1)
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p3) < asType<integer>($heap<sub>funcstart_780,1</sub>._replace(p1 \rightarrow
```

```
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).M3))
\rightarrow [from term 22.0, literala < -writes_793_12 is true whenever (-1 + literala)
< -30307
           Proof of rule precondition:
           [1.57.0](-30307 + -1) < -30307
           \rightarrow [simplify]
           [1.57.2] true
[1.58] ((true && true) && (0 <
asType<integer>(place(p1 \rightarrow 1))._replace(p1 \rightarrow 1)._replace(p2 \rightarrow 1
2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p3))) && (asType<integer>($heap_{funcstart\_780,1}._replace(p1
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p3) < asType<integer>(p1 \rightarrow parameter = parameter 
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).M3))
\rightarrow [simplify]
[1.62] (true && (0 < writes_793_12)) &&
(asType < integer > (\$heap_{funcstart\_780,1}.\_replace(p1 \rightarrow 1).\_replace(p2 \rightarrow 1))
2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p3) < asType<integer>(p1 \rightarrow p_{funcstart_780,1}._replace(p1 \rightarrow p_{funcstart_780,1}._replace)
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).M3))
 \rightarrow [from term 25.0, literala < writes_793_12 is true whenever (-1 + literala) <
0
           Proof of rule precondition:
           [1.62.0](-1+0)<0
           \rightarrow [simplify]
```

```
[1.62.2] true
[1.63] (true && true) &&
(\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_780,1}.\_\mathbf{replace} (\mathtt{p1} \to \mathtt{1}).\_\mathbf{replace} (\mathtt{p2} \to \mathtt{p1}))
2)._replace(p3 \rightarrow 3)._replace((&\hat{heap._ecv_files}[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).p3) < asType<integer>($heap<sub>funcstart_780,1</sub>._replace(p1 \rightarrow
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\text{heap.}_ecv_files[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).M3))
\rightarrow [simplify]
[1.67] true && (writes_793_12 <
asType<integer>(place(p1 \rightarrow 1))._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow
writes_790_5)._replace(p1 \rightarrow writes_793_12)._replace(p2 \rightarrow
writes_793_12)._replace(p3 \rightarrow writes_793_12)._replace(_ecv_files \rightarrow
writes_793_12).M3))
\rightarrow [const member of object with modified fields]
[1.75] true && (writes_793_12 < asType<integer>($heap_{tuncstart_780,1}.M3))
\rightarrow [const static or extern object]
[1.76] true && (writes_793_12 < asType<integer>($heap_{init}.M3))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[1.77] true && (writes_793_12 < asType<integer>(asType<short
int > ((int)30323)))
\rightarrow [simplify]
[1.83] true && (-30323 < -writes_793_12)
\rightarrow [from term 21.84, literala < -writes_793_12 is true whenever (-1 + literala)
< -30323
   Proof of rule precondition:
   [1.83.0](-30323 + -1) < -30323
   \rightarrow [simplify]
   [1.83.2] true
[1.84] true && true
\rightarrow [simplify]
[1.85] true
```

```
Proof of verification condition: Arithmetic result of operator '++' is
within limit of type 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (117,9)
Condition defined at:
To prove: minof(int) \le ++count_{loopstart\_792.5}
Given:
heap_{init}.LIMIT == (int)80
\theta
\theta_{init}.r1 == asType < short int > ((int)171)
\theta
\theta
heap_{init}.M2 == asType < short int > ((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
\theta sheap<sub>init</sub>.M3 == asType<short int>((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta
\theta
\theta = asType < short int > ((int)3)
heap_{780.1;783.8} == heap_{funcstart\_780.1}._replace(p1 \rightarrow asType<short
int>((int)1)
\$heap_{780,1;784,8} == \$heap_{780,1;783,8}.\mathbf{\_replace}(p2 \rightarrow \mathbf{asType} {<} \mathbf{short}
int>((int)2))
heap_{780,1;785,8} == heap_{780,1;784,8}._replace(p3 \rightarrow asType<short
int>((int)3)
limit == $heap_{780,1;785,8}.LIMIT
minof(int const) \leq limit
limit < maxof(int const)
count == (int)0
minof(int) < count
```

```
count < maxof(int)
\$heap_{780,1;790,5} == \$heap_{780,1;785,8}.\_\mathbf{replace}((\$\$heap_{780,1:785,8}.\_ecv\_files[1]).\$r
\rightarrow writes_790_5)
\text{Sheap}_{loopstart\_792,5} == \text{Sheap}_{780,1;790,5}.replace(p1 \rightarrow
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow
writes_793_12)._replace(_ecv_files \rightarrow writes_793_12)
\#writes_793_12 == \#$heap<sub>780,1;790,5</sub>._ecv_files
minof(int) \leq count_{loopstart_792.5}
count_{loopstart\_792,5} \le maxof(int)
invariant1(heapIs $heap_loopstart_792,5)
count_{loopstart\_792,5} < limit
0 \le (asType < integer const > (limit) -
asType < integer > (count_{loopstart\_792.5}))
(asType < integer const > (limit) - asType < integer > (count_{loopstart\_792,5}))
\leq (asType < integer const > (limit) - asType < integer > (count))
heap_{797,16} == heap_{loopstart_792,5}._replace(p1 \rightarrow writes_797_25)._replace(p2
\rightarrow writes_797_25)._replace(p3 \rightarrow writes_797_25)
\$ heap_{loopend} == \$ heap_{797,16}. \textbf{\_replace}((\&\$ heap_{797,16}. \textbf{\_ecv\_files}[1]).\$ r \rightarrow \$ heap_{loopend} == \$ heap_{797,16}. \textbf{\_replace}((\&\$ heap_{797,16}. \textbf{\_ecv\_files}[1]).\$ r \rightarrow \$ heap_{100pend} == 
writes_797_9)
asType < real > ((double)0.0) < asType < real > ($result_797_25)
asType < real > (\$result\_797\_25) < asType < real > ((double)1.0)
invariant1(heapIs $heap<sub>797,16</sub>)
Proof:
[Take given term]
[5.0] heap_{780,1;783,8} == heap_{funcstart\_780,1}._replace(p1 \rightarrow asType<short
int>((int)1)
\rightarrow [simplify]
[5.2] $\text{heap}_{780,1;783,8} == $\text{heap}_{funcstart_780,1}._\text{replace}(p1 \rightarrow 1)$
[Take given term]
[6.0] $\text{heap}_{780,1;784,8} == $\text{heap}_{780,1;783,8}.$\text{replace}(p2 \rightarrow asType < short)
int>((int)2))
\rightarrow [from term 5.2, $heap<sub>780,1;783,8</sub> is equal to $heap<sub>funcstart_780,1</sub>._replace(p1)
\rightarrow 1)
\textit{[6.1]} \$ heap_{780,1;784,8} == \$ heap_{funcstart\_780,1}.\_\textbf{replace}(p1 \rightarrow 1).\_\textbf{replace}(p2 \rightarrow 1).\_\textbf{replace}(p2 \rightarrow 1).\_\textbf{replace}(p3 \rightarrow 1).
asType<short int>((int)2))
\rightarrow [simplify]
```

```
[6.3] heap_{780,1;784,8} == heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)
[Take given term]
[7.0] $\text{heap}_{780,1;785,8} == \text{$heap}_{780,1;784,8}._\text{replace}(p3 \to \text{asType} < \text{short}
int>((int)3))
\rightarrow [from term 6.3, $heap<sub>780,1:784,8</sub> is equal to $heap<sub>funcstart_780,1</sub>._replace(p1)
\rightarrow 1)._replace(p2 \rightarrow 2)]
[7.1] \theta_{1.1785.8} = \theta_{1.1785.8} 
2)._replace(p3 \rightarrow asType<short int>((int)3))
\rightarrow [simplify]
[7.3] \theta == \theta
2)._replace(p3 \rightarrow 3)
[Take given term]
[8.0] $heap<sub>780,1:785,8</sub>.LIMIT == limit
\rightarrow [from term 7.3, $heap<sub>780,1;785,8</sub> is equal to $heap<sub>funcstart_780,1</sub>._replace(p1)
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)]
\textit{[8.1]} \$ heap_{funcstart\_780,1}.\_\textbf{replace}(p1 \rightarrow 1).\_\textbf{replace}(p2 \rightarrow 2).\_\textbf{replace}(p3 \rightarrow 1).
3).LIMIT == limit
\rightarrow [const member of object with modified fields]
[8.4] $heap<sub>funcstart_780,1</sub>.LIMIT == limit
\rightarrow [const static or extern object]
[8.5] $heap<sub>init</sub>.LIMIT == limit
\rightarrow [expand definition of constant 'LIMIT' at prang.c (12,18)]
[8.6] (int)80 == limit
\rightarrow [simplify]
[8.7] 80 == limit
[Take given term]
[9.0] (int)0 == count
\rightarrow [simplify]
[9.1] 0 == count
[Take given term]
[28.0] (asType<integer const>(limit) -
\mathbf{asType} {<} \mathbf{integer} {>} (\mathbf{count}_{loopstart\_792,5})) \leq (\mathbf{asType} {<} \mathbf{integer} \ \mathbf{const} {>} (\mathbf{limit})
- asType<integer>(count))
\rightarrow [from term 8.7, limit is equal to 80]
```

```
[28.1] (asType<integer const>(80) -
\mathbf{asType} {<} \mathbf{integer} {>} (\mathbf{count}_{loopstart\_792,5})) \leq (\mathbf{asType} {<} \mathbf{integer} \ \mathbf{const} {>} (\mathbf{limit})
- asType<integer>(count))
\rightarrow [simplify]
[28.4] (80 + -count<sub>loopstart_792,5</sub>) \leq (asType<integer const>(limit) -
asType<integer>(count))
\rightarrow [from term 8.7, limit is equal to 80]
[28.5] (80 + -count_{loopstart\_792,5}) \le (asType < integer const > (80) - (80)
asType<integer>(count))
\rightarrow [simplify]
[28.6] (80 + -count<sub>loopstart_792,5</sub>) \leq (80 - asType<integer>(count))
\rightarrow [from term 9.1, count is equal to 0]
[28.7] (80 + -\text{count}_{loopstart\_792,5}) \le (80 - \text{asType} < \text{integer} > (0))
\rightarrow [simplify]
[28.20] \text{ -1} < \operatorname{count}_{loopstart\_792,5}
[Take goal term]
[1.0] minof(int) \leq ++count<sub>loopstart_792,5</sub>
\rightarrow [simplify]
[1.6] -32770 < count<sub>loopstart_792,5</sub>
\rightarrow [from term 28.20, literala < count<sub>loopstart_792.5</sub> is true whenever (-1 +
literala) < -1
    Proof of rule precondition:
    [1.6.0](-32770 + -1) < -1
    \rightarrow [simplify]
    [1.6.2] true
[1.7] true
Proof of verification condition: Arithmetic result of operator '++' is
within limit of type 'int'
Condition generated at: C:\Escher\Customers\prang\prang.c (117,9)
Condition defined at:
To prove: ++\text{count}_{loopstart\_792,5} \leq \text{maxof(int)}
Given:
heap_{init}.LIMIT == (int)80
```

```
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta = asType < short int > ((int)2)
heap_{init}.M2 == asType < short int > ((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
heap_{780,1;783,8} == heap_{funcstart\_780,1}.\_replace(p1 \rightarrow asType < short)
int>((int)1)
\text{heap}_{780.1;784.8} == \text{heap}_{780.1;783.8}._replace(p2 \rightarrow asType<short)
int>((int)2)
heap_{780,1:785,8} == heap_{780,1:784,8}.replace(p3 \rightarrow asType<short
int>((int)3))
limit == $heap_{780,1;785,8}.LIMIT
minof(int \ const) \le limit
limit \leq maxof(int const)
count == (int)0
minof(int) \le count
count \leq maxof(int)
\text{sheap}_{780.1;790.5} == \text{sheap}_{780.1;785.8}. \text{-replace}((\&\text{sheap}_{780.1;785.8}.\text{-ecv\_files}[1]).\text{sr}
\rightarrow writes_790_5)
heap_{loopstart\_792,5} == heap_{780,1;790,5}._replace(p1 \rightarrow
writes_793_12)._replace(p2 \rightarrow writes_793_12)._replace(p3 \rightarrow
writes_793_12)._replace(_ecv_files \rightarrow writes_793_12)
\#writes_793_12 == \#$heap<sub>780.1:790.5</sub>._ecv_files
minof(int) \leq count_{loopstart\_792,5}
```

```
count_{loopstart\_792,5} \le maxof(int)
invariant1(\mathbf{heapIs}~\$heap_{loopstart\_792,5})
\operatorname{count}_{loopstart\_792,5} < \operatorname{limit}
0 \le (asType < integer const > (limit) -
\mathbf{asType}{<}\mathbf{integer}{>}(\mathtt{count}_{loopstart\_792,5}))
(asType < integer const > (limit) - asType < integer > (count_{loopstart\_792,5}))
\leq (asType < integer const > (limit) - asType < integer > (count))
heap_{797,16} == heap_{loopstart\_792,5}._replace(p1 \rightarrow writes_797_25)._replace(p2
\rightarrow writes_797_25)._replace(p3 \rightarrow writes_797_25)
heap_{loopend} == heap_{797.16}.replace((&heap_{797.16}.ecv_files[1]).$r \rightarrow
writes_797_9)
asType < real > ((double)0.0) < asType < real > ($result_797_25)
asType < real > (\$result\_797\_25) < asType < real > ((double)1.0)
invariant1(heapIs $heap_{797,16})
Proof:
[Take given term]
[5.0] $\text{heap}_{780.1:783.8} == $\text{heap}_{funcstart\_780.1}.$\text{replace}(p1 \rightarrow \text{asType} < \text{short}
int>((int)1)
\rightarrow [simplify]
[5.2] heap_{780,1;783,8} == heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)
[Take given term]
[6.0] $\text{heap}_{780,1;784,8} == $\text{heap}_{780,1;783,8}.$\text{replace}(p2 \rightarrow \text{asType} < \text{short}
int>((int)2)
\rightarrow [from term 5.2, $heap<sub>780,1:783,8</sub> is equal to $heap<sub>funcstart_780,1</sub>._replace(p1
\rightarrow 1)
\textit{[6.1]} \$ heap_{780,1;784,8} == \$ heap_{funcstart\_780,1}.\_\textbf{replace}(p1 \rightarrow 1).\_\textbf{replace}(p2 \rightarrow 1).\_\textbf{replace}(p2 \rightarrow 1).\_\textbf{replace}(p3 \rightarrow 1).
asType<short int>((int)2))
\rightarrow [simplify]
[6.3] $\text{heap}_{780.1:784.8} == $\text{heap}_{funcstart\_780.1}. \text{replace}(p1 \rightarrow 1). \text{replace}(p2 \rightarrow 1).
[Take given term]
[7.0] $\text{heap}_{780,1:785,8} == \text{$heap}_{780,1:784,8}._\text{replace}(p3 \to \text{asType} < \text{short}
int>((int)3))
\rightarrow [from term 6.3, $heap<sub>780.1:784.8</sub> is equal to $heap<sub>funcstart_780.1</sub>._replace(p1)
\rightarrow 1)._replace(p2 \rightarrow 2)]
[7.1] heap_{780,1:785,8} == heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
```

```
2)._replace(p3 \rightarrow asType<short int>((int)3))
\rightarrow [simplify]
[7.3] heap_{780,1;785,8} == heap_{funcstart\_780,1}. replace(p1 \rightarrow 1). replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)
[Take given term]
[8.0] $heap<sub>780,1;785,8</sub>.LIMIT == limit
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)]
[8.1] \text{heap}_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow
3).LIMIT == limit
\rightarrow [const member of object with modified fields]
[8.4] $heap<sub>funcstart_780,1</sub>.LIMIT == limit
\rightarrow [const static or extern object]
[8.5] $heap<sub>init</sub>.LIMIT == limit
\rightarrow [expand definition of constant 'LIMIT' at prang.c (12,18)]
[8.6] (int)80 == limit
\rightarrow [simplify]
[8.7] 80 == limit
[Take given term]
[27.0] \operatorname{count}_{loopstart\_792,5} < \operatorname{limit}
\rightarrow [from term 8.7, limit is equal to 80]
[27.1]\;\mathrm{count}_{loopstart\_792,5} < 80
\rightarrow [simplify]
[27.4] \ \text{-}80 < -\text{count}_{loopstart\_792,5}
[Take goal term]
[1.0] ++count<sub>loopstart_792,5</sub> \leq maxof(int)
\rightarrow [simplify]
\textit{[1.9]} \; \text{-32767} < -\text{count}_{loopstart\_792,5}
\rightarrow [from term 27.4, literala < -count_{loopstart\_792.5} is true whenever (-1 +
literala) < -80
    Proof of rule precondition:
    [1.9.0](-32767 + -1) < -80
```

 \rightarrow [simplify]

```
[1.10] true
Proof of verification condition: Loop initialisation establishes loop
invariant
Condition generated at: C:\Escher\Customers\prang\prang.c (111,5)
Condition defined at: C:\Escher\Customers\prang\prang.c (113,10)
To prove: invariant1(heapIs \$heap_{780,1;790,5})
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta
\theta
\theta_{init}.r2 == asType < short int > ((int)172)
\theta
\theta == asType<short int>((int)35)
\theta sheap<sub>init</sub>.M3 == asType<short int>((int)30323)
\theta_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
\theta
\theta = asType < short int > ((int)3)
\text{Sheap}_{780,1:783,8} == \text{Sheap}_{funcstart\_780,1}.\_\mathbf{replace}(\text{p1} \to \mathbf{asType} < \mathbf{short})
int>((int)1)
heap_{780,1:784.8} == heap_{780,1:783.8}._replace(p2 \rightarrow asType<short
int>((int)2)
\text{sheap}_{780,1;785,8} == \text{sheap}_{780,1;784,8}.\text{replace}(p3 \to asType < short)
int>((int)3)
limit == $heap_{780,1:785,8}.LIMIT
minof(int \ const) \le limit
limit \le maxof(int const)
```

[1.9.2] **true**

```
count == (int)0
minof(int) \le count
count < maxof(int)
\text{sheap}_{780,1:790,5} == \text{sheap}_{780,1:785,8}.replace((&\text{sheap}_{780,1:785,8}.\text{-ecv_files}[1]).\text{sr}
\rightarrow writes_790_5)
Proof:
[Take given term]
[5.0] \theta_{780,1;783,8} == \theta_{funcstart\_780,1}.replace(p1 \to asType < short
int>((int)1))
\rightarrow [simplify]
[5.2] $\text{heap}_{780,1;783,8} == $\text{heap}_{funcstart_780,1}._\text{replace}(p1 \rightarrow 1)$
[Take given term]
[6.0] $heap<sub>780,1:784,8</sub> == $heap<sub>780,1:783,8</sub>._replace(p2 \rightarrow asType<short
int>((int)2))
\rightarrow [from term 5.2, $heap<sub>780,1;783,8</sub> is equal to $heap<sub>funcstart_780,1</sub>._replace(p1)
\rightarrow 1)]
[6.1] heap_{780,1;784,8} == heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
asType < short int > ((int)2))
\rightarrow [simplify]
[6.3] heap_{780,1;784,8} == heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)
[Take given term]
[7.0] $\text{heap}_{780,1;785,8} == \text{$heap}_{780,1;784,8}._\text{replace}(p3 \to \text{asType} < \text{short}
int>((int)3))
\rightarrow [from term 6.3, $heap<sub>780,1;784,8</sub> is equal to $heap<sub>funcstart_780,1</sub>._replace(p1)
\rightarrow 1)._replace(p2 \rightarrow 2)]
[7.1] \theta_{1.785,8} = \theta_{1.785,8} = \theta_{1.785,8} = \theta_{1.785,8} Sheap<sub>780,1:785,8</sub> = \theta_{1.785,8} = \theta_{1.785,8}
2)._replace(p3 \rightarrow asType<short int>((int)3))
\rightarrow [simplify]
[7.3] \text{sheap}_{780,1;785,8} == \text{sheap}_{funcstart\_780,1}. \mathbf{replace}(p1 \rightarrow 1). \mathbf{replace}(p2 \rightarrow 1)
2)._replace(p3 \rightarrow 3)
[Take given term]
[10.0] $heap<sub>780,1;790,5</sub> ==
\$heap_{780,1;785,8}.\_\mathbf{replace}((\&\$heap_{780,1;785,8}.\_ecv\_files[1]).\$r \to writes\_790\_5)
\rightarrow [from term 7.3, $heap<sub>780,1;785,8</sub> is equal to $heap<sub>funcstart_780,1</sub>._replace(p1)
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)]
```

```
[10.1] $\text{heap}_{780,1;790,5} == $\text{heap}_{funcstart_780,1}._{\text{replace}}(p1 \rightarrow 1)._{\text{replace}}(p2)
\rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap_{780,1;785,8}.ecv_files[1]).$r \rightarrow
writes_790_5)
\rightarrow [simplify]
[10.2] $\text{heap}_{780,1:790,5} == $\text{heap}_{funcstart\_780,1}._\text{replace}(p1 \to 1)._\text{replace}(p2)
\rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]).$r \rightarrow writes_790_5)
\rightarrow [attribute value is known from postcondition]
[10.3] $heap<sub>780.1:790.5</sub> == $heap<sub>funcstart_780.1</sub>._replace(p1 \rightarrow 1)._replace(p2
 \rightarrow 2)._replace(p3 \rightarrow 3)._replace(&\text{heap._ecv_files}[1] \rightarrow writes_790_5)
[Take goal term]
[1.0] invariant1(heapIs $heap<sub>780 1:790 5</sub>)
\rightarrow [from term 10.3, $heap_{780,1;790,5}$ is equal to $heap_{funcstart\_780,1}._replace(p1
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace(&$heap._ecv_files[1] \rightarrow
writes_790_5)]
[1.1] invariant1(heapIs heap_{funcstart\_780.1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace(&\text{heap._ecv_files}[1] \rightarrow writes_790_5))
\rightarrow [expand definition of function 'invariant1' at prang.c (34.1)]
[1.2] (((((0 < asType < integer > ($heap_{funcstart\_780,1}.\_replace(p1 \rightarrow
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5).p1)) && (asType<integer>($heap_{funcstart\_780,1}._replace(p1
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes\_790\_5).p1) < \mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_780,1}.\_\mathbf{replace}(p1 \rightarrow \texttt{p1})) > \texttt{p2} + \texttt{p2} + \texttt{p3} + \texttt{
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5).M1))) && (0 <
asType < integer > (\$heap_{funcstart\_780,1}.\_replace(p1 \rightarrow 1).\_replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow writes_790_5).p2)))
&& (asType<integer>(place(p1 \rightarrow 1)).replace(place(p2 \rightarrow 1)).replace(
\rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow \text{writes}_790\text{-}5).p2) <
asType<integer>($heap<sub>funcstart_780,1</sub>._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow writes_790_5).M2)))
&& (0 < asType<integer>($heap_{funcstart\_780,1}.\_replace(p1 \rightarrow
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5).p3))) && (asType<integer>($heap_funcstart_780_1._replace(p1
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes\_790\_5).p3) < \mathbf{asType} < \mathbf{integer} > (\$heap_{funcstart\_780,1}.\_\mathbf{replace}(p1 \rightarrow \texttt{partition})) > \texttt{properties} = \texttt{pr
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5).M3))
\rightarrow [simplify]
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5).M1))) && (0 <
```

```
asType < integer > (\$heap_{funcstart\_780,1}.\_replace(p1 \rightarrow 1).\_replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow writes_790_5).p2)))
&& (asType<integer>(p_1 \rightarrow 1)._replace(p_2 
\rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow writes_790_5).p2) <
asType < integer > (\$heap_{funcstart\_780,1}.\_replace(p1 \rightarrow 1).\_replace(p2 \rightarrow 1))
2)._replace(p3 \rightarrow 3)._replace((&\hat{heap._ecv_files}[1]) \rightarrow writes_790_5).M2)))
&& (0 < asType<integer>($heap_{funcstart\_780,1}.\_replace(p1 \rightarrow
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5).p3))) && (asType<integer>($heap_{tuncstart\_780.1}._replace(p1
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5).p3) < asType<integer>($heap<sub>funcstart_780,1</sub>._replace(p1 \rightarrow
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5).M3))
\rightarrow [const member of object with modified fields]
[1.17] ((((true && (1 < asType < integer > ($heap_{funcstart\_780,1}.M1))) && (0
<\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_780,1}.\_\mathbf{replace} (p1 \rightarrow 1).\_\mathbf{replace} (p2 \rightarrow
2)._replace((3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow writes_790_5).p2)))
&& (asType<integer>(p_1 \rightarrow 1)._replace(p_2 
\rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow \text{writes_790_5}).p2) <
asType<integer>(heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow writes_790_5).M2)))
&& (0 < asType<integer>($heap_{funcstart\_780,1}.\_replace(p1 \rightarrow
1). replace(p2 \rightarrow 2). replace(p3 \rightarrow 3). replace((&$heap.\_ecv\_files[1]) \rightarrow
writes_790_5).p3))) && (asType<integer>($heap_{funcstart\_780,1}._replace(p1
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5).p3) < asType<integer>($heap<sub>funcstart_780,1</sub>._replace(p1 \rightarrow
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5).M3))
\rightarrow [const static or extern object]
[1.18] ((((true && (1 < asType < integer > ($heap_{init}.M1))) && (0 <
asType<integer>($heap<sub>funcstart_780,1</sub>._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow writes_790_5).p2)))
&& (asType<integer>($heap_{funcstart\_780,1}.\_replace(p1 \rightarrow 1).\_replace(p2
\rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow writes_790_5).p2) <
asType<integer>($heap<sub>funcstart_780,1</sub>._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow writes_790_5).M2)))
&& (0 < asType<integer>($heap_{funcstart\_780,1}.\_replace(p1 \rightarrow
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5).p3))) && (asType<integer>($heap_{funcstart\_780,1}._replace(p1
\rightarrow 1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5).p3) < asType<integer>(p1 \rightarrow p1).p3) < asType<integer>(p1 \rightarrow p1).p3)
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5).M3))
```

```
\rightarrow [expand definition of constant 'M1' at prang.c (14,20)]
[1.19] ((((true && (1 < asType < integer > (asType < short))
int>((int)30269)))) && (0 <
asType < integer > (\$heap_{funcstart\_780,1}.\_replace(p1 \rightarrow 1).\_replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow writes_790_5).p2)))
&& (asType<integer>(place(p1 \rightarrow 1))._replace(p2
\rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow writes_790_5).p2) <
asType < integer > (\$heap_{funcstart\_780,1}.\_replace(p1 \rightarrow 1).\_replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow writes_790_5).M2)))
&& (0 < asType<integer>($heap_{funcstart\_780,1}.\_replace(p1 \rightarrow
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5).p3))) && (asType<integer>($heap_{funcstart\_780,1}._replace(p1
\rightarrow 1)..replace(p2 \rightarrow 2)..replace(p3 \rightarrow 3)..replace((&$heap..ecv_files[1]) \rightarrow
writes_790_5).p3) < asType<integer>(heap_{funcstart}_780_1._replace(p1 \rightarrow
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow
writes_790_5).M3))
\rightarrow [simplify]
[1.34] ((true && (2 < asType<integer>(heap_{funcstart\_780.1}._replace(p1 \rightarrow
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_{790_{5}}.M2))) && (0 <
asType < integer > (\$heap_{funcstart\_780,1}.\_replace(p1 \rightarrow 1).\_replace(p2 \rightarrow 1))
2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow writes_790_5).p3)))
&& (asType<integer>(p1 \rightarrow 1)._replace(p1 \rightarrow 1)._replace(p2 \rightarrow 1)._
\rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow writes_790_5).p3) <
\mathbf{asType} < \mathbf{integer} > (\$ heap_{funcstart\_780,1}. \_\mathbf{replace} (p1 \rightarrow 1). \_\mathbf{replace} (p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow writes_790_5).M3))
\rightarrow [const member of object with modified fields]
[1.38] ((true && (2 < asType<integer>($heap_{funcstart\_780,1}.M2))) && (0 <
asType < integer > (\$heap_{funcstart\_780,1}.\_replace(p1 \rightarrow 1).\_replace(p2 \rightarrow 1))
2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow writes_790_5).p3)))
&& (asType<integer>(p_1 \rightarrow 1)._replace(p_2 
\rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow \text{writes_790_5}).p3) <
asType<integer>(heap_{funcstart\_780,1}._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow writes_790_5).M3))
\rightarrow [const static or extern object]
[1.39] ((true && (2 < asType<integer>(heap_{init}.M2))) && (0 <
asType<integer>(part = 1... replace(p1 \rightarrow 1)... replace(p2 \rightarrow 1)... replace(p3 \rightarrow 1)... replace(p3 \rightarrow 1)... replace(p3 \rightarrow 1)... replace(p4 \rightarrow 1)... re
2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow writes_790_5).p3)))
&& (asType<integer>(p1 \rightarrow 1)._replace(p1 \rightarrow 1)._replace(p2 \rightarrow 1)._
\rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow writes_790_5).p3) <
asType<integer>($heap<sub>funcstart_780.1</sub>._replace(p1 \rightarrow 1)._replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow writes_790_5).M3))
```

```
\rightarrow [expand definition of constant 'M2' at prang.c (19,20)]
[1.40] ((true && (2 < asType<integer>(asType<short
int>((int)30307)))) && (0 <
\mathbf{asType}{<}\mathbf{integer}{>}(\$\text{heap}_{funcstart\_780,1}.\_\mathbf{replace}(\text{p1} \rightarrow 1).\_\mathbf{replace}(\text{p2} \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow writes_790_5).p3)))
&& (asType<integer>($heap_{funcstart\_780,1}.\_replace(p1 \rightarrow 1).\_replace(p2
\rightarrow 2)._replace(p3 \rightarrow 3)._replace((&$heap._ecv_files[1]) \rightarrow writes_790_5).p3) <
asType < integer > (\$heap_{funcstart\_780,1}.\_replace(p1 \rightarrow 1).\_replace(p2 \rightarrow
2)._replace(p3 \rightarrow 3)._replace((&\text{heap._ecv_files}[1]) \rightarrow writes_790_5).M3))
\rightarrow [simplify]
[1.53] true && (3 < asType<integer>(sheap_{funcstart}_780,1._replace(p1 \rightarrow
1)._replace(p2 \rightarrow 2)._replace(p3 \rightarrow 3)._replace((&\$heap._ecv_files[1]) \rightarrow
writes_790_5).M3))
\rightarrow [const member of object with modified fields]
[1.57] true && (3 < asType<integer>(sheap_{funcstart\_780.1}.M3))
\rightarrow [const static or extern object]
[1.58] true && (3 < asType < integer > (\$heap_{init}.M3))
\rightarrow [expand definition of constant 'M3' at prang.c (24,20)]
[1.59] true && (3 < asType < integer > (asType < short int > ((int)30323)))
\rightarrow [simplify]
[1.64] true
Proof of verification condition: Type constraint satisfied in explicit
conversion from 'int' to 'short int'
Condition generated at: C:\Escher\Customers\prang\prang.c (31,19)
Condition defined at:
To prove: minof(short int) \le (int)3
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
\theta
heap_{init}.a1 == asType < short int > ((int)177)
\theta = asType < short int > ((int)2)
heap_{init}.M2 == asType < short int > ((int)30307)
\rho_{init}.r2 == asType < short int > ((int)172)
\theta
```

```
heap_{init}.b2 == asType < short int > ((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
heap_{init}.b3 == asType < short int > ((int)63)
\theta
\theta
Proof:
[Take goal term]
[1.0] minof(short int) \leq (int)3
\rightarrow [simplify]
[1.3] true
Proof of verification condition: Type constraint satisfied in explicit
conversion from 'int' to 'short int'
Condition generated at: C:\Escher\Customers\prang\prang.c (31,19)
Condition defined at:
To prove: (int)3 \le maxof(short\ int)
Given:
heap_{init}.LIMIT == (int)80
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
\theta
\theta
heap_{init}.M2 == asType < short int > ((int)30307)
heap_{init}.r2 == asType < short int > ((int)172)
\theta
\theta = asType < short int > ((int)35)
\theta sheap<sub>init</sub>.M3 == asType<short int>((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
```

```
\theta
Proof:
[Take goal term]
[1.0] (int)3 \leq maxof(short int)
\rightarrow [simplify]
[1.3] true
Proof of verification condition: Type constraint satisfied in explicit
conversion from 'int' to 'short int'
Condition generated at: C:\Escher\Customers\prang\prang.c (30,19)
Condition defined at:
To prove: minof(short int) \le (int)2
Given:
heap_{init}.LIMIT == (int)80
\theta
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta = asType < short int > ((int)2)
heap_{init}.M2 == asType < short int > ((int)30307)
heap_{init}.r2 == asType < short int > ((int)172)
\theta
\theta = asType < short int > ((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
\theta
Proof:
[Take goal term]
[1.0] minof(short int) \leq (int)2
\rightarrow [simplify]
[1.3] true
```

```
Proof of verification condition: Type constraint satisfied in explicit
conversion from 'int' to 'short int'
Condition generated at: C:\Escher\Customers\prang\prang.c (30,19)
Condition defined at:
To prove: (int)2 \le maxof(short\ int)
Given:
heap_{init}.LIMIT == (int)80
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
\theta sheap<sub>init</sub>.a1 == asType<short int>((int)177)
\theta
heap_{init}.M2 == asType < short int > ((int)30307)
\rho_{init}.r2 == asType < short int > ((int)172)
\label{eq:asType} $$  \  = asType < short int > ((int)176)$  
\theta == asType<short int>((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
heap_{init}.a3 == asType<short int>((int)178)
\theta = asType < short int > ((int)63)
\theta = asType < short int > ((int)1)
Proof:
[Take goal term]
[1.0] (int)2 \leq maxof(short int)
\rightarrow [simplify]
[1.3] true
Proof of verification condition: Type constraint satisfied in explicit
conversion from 'int' to 'short int'
```

Condition generated at: C:\Escher\Customers\prang\prang.c (29,19)

Condition defined at:

To prove: $minof(short int) \le (int)1$

Given:

 $heap_{init}.LIMIT == (int)80$

```
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta = asType < short int > ((int)2)
heap_{init}.M2 == asType < short int > ((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType < short int > ((int)178)
\theta = asType < short int > ((int)63)
Proof:
[Take goal term]
[1.0] minof(short int) \leq (int)1
\rightarrow [simplify]
[1.3] true
Proof of verification condition: Type constraint satisfied in explicit
conversion from 'int' to 'short int'
Condition generated at: C:\Escher\Customers\prang\prang.c (29,19)
Condition defined at:
To prove: (int)1 \le maxof(short\ int)
Given:
heap_{init}.LIMIT == (int)80
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
\theta
\theta
\theta = asType < short int > ((int)2)
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\rho_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta
```

```
heap_{init}.M3 == asType < short int > ((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
heap_{init}.a3 == asType<short int>((int)178)
heap_{init}.b3 == asType < short int > ((int)63)
Proof:
[Take goal term]
[1.0] (int)1 \leq maxof(short int)
\rightarrow [simplify]
[1.3] true
Proof of verification condition: Type constraint satisfied in explicit
conversion from 'int' to 'short int'
Condition generated at: C:\Escher\Customers\prang\prang.c (27,29)
Condition defined at:
To prove: minof(short int) \le (int)63
Given:
heap_{init}.LIMIT == (int)80
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
\theta
heap_{init}.a1 == asType<short int>((int)177)
\theta
heap_{init}.M2 == asType < short int > ((int)30307)
\theta_{init}.r2 == asType<short int>((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
\theta sheap<sub>init</sub>.M3 == asType<short int>((int)30323)
\theta
heap_{init}.a3 == asType < short int > ((int)178)
Proof:
[Take goal term]
[1.0] minof(short int) \leq (int)63
\rightarrow [simplify]
[1.3] true
```

```
Proof of verification condition: Type constraint satisfied in explicit
conversion from 'int' to 'short int'
Condition generated at: C:\Escher\Customers\prang\prang.c (27,29)
Condition defined at:
To prove: (int)63 \le maxof(short\ int)
Given:
heap_{init}.LIMIT == (int)80
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
\theta sheap<sub>init</sub>.a1 == asType<short int>((int)177)
\theta
\theta
\rho_{init}.r2 == asType < short int > ((int)172)
\theta
\theta = asType < short int > ((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
\theta_{init}.r3 == asType<short int>((int)170)
heap_{init}.a3 == asType<short int>((int)178)
Proof:
[Take goal term]
[1.0] (int)63 \leq maxof(short int)
\rightarrow [simplify]
[1.3] true
```

Proof of verification condition: Type constraint satisfied in explicit conversion from 'int' to 'short int'

 $\textbf{Condition generated at: } C:\ \ Customers \setminus prang \setminus prang.c \ (26,29)$

Condition defined at:

To prove: $minof(short int) \le (int)178$

Given:

```
\label{eq:heap} $$ $ = (int)80 $$ $ = asType < short int > ((int)30269) $$ $$ $ = asType < short int > ((int)171) $$
```

```
heap_{init}.a1 == asType < short int > ((int)177)
\theta = asType < short int > ((int)2)
heap_{init}.M2 == asType < short int > ((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
heap_{init}.b2 == asType<short int>((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
Proof:
[Take goal term]
[1.0] minof(short int) \leq (int)178
\rightarrow [simplify]
[1.3] true
Proof of verification condition: Type constraint satisfied in explicit
conversion from 'int' to 'short int'
Condition generated at: C:\Escher\Customers\prang\prang.c (26,29)
Condition defined at:
To prove: (int)178 \le maxof(short\ int)
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\theta
heap_{init}.a2 == asType < short int > ((int)176)
\theta
\theta = asType < short int > ((int)30323)
heap_{init}.r3 == asType < short int > ((int)170)
Proof:
[Take goal term]
```

```
[1.0] (int)178 \leq maxof(short int)
\rightarrow [simplify]
[1.3] true
Proof of verification condition: Type constraint satisfied in explicit
conversion from 'int' to 'short int'
Condition generated at: C:\Escher\Customers\prang\prang.c (25,29)
Condition defined at:
To prove: minof(short int) \le (int)170
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
heap_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta
\theta_{init}.M2 == asType < short int > ((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
\theta sheap<sub>init</sub>.a2 == asType<short int>((int)176)
\theta = asType < short int > ((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
Proof:
[Take goal term]
[1.0] minof(short int) \leq (int)170
\rightarrow [simplify]
[1.3] true
Proof of verification condition: Type constraint satisfied in explicit
conversion from 'int' to 'short int'
Condition generated at: C:\Escher\Customers\prang\prang.c (25,29)
Condition defined at:
To prove: (int)170 < maxof(short int)
Given:
```

 $heap_{init}.LIMIT == (int)80$

```
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta = asType < short int > ((int)2)
heap_{init}.M2 == asType < short int > ((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
\theta = asType < short int > ((int)35)
heap_{init}.M3 == asType < short int > ((int)30323)
Proof:
[Take goal term]
[1.0] (int)170 \leq maxof(short int)
\rightarrow [simplify]
[1.3] true
Proof of verification condition: Type constraint satisfied in explicit
conversion from 'int' to 'short int'
Condition generated at: C:\Escher\Customers\prang\prang.c (24,29)
Condition defined at:
To prove: minof(short int) \le (int)30323
Given:
heap_{init}.LIMIT == (int)80
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
\theta
\theta
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
\theta_{init}.r2 == asType < short int > ((int)172)
\theta
\theta = asType < short int > ((int)35)
Proof:
[Take goal term]
[1.0] minof(short int) \leq (int)30323
```

```
\rightarrow [simplify]
[1.3] true
Proof of verification condition: Type constraint satisfied in explicit
conversion from 'int' to 'short int'
Condition generated at: C:\Escher\Customers\prang\prang.c (24,29)
Condition defined at:
To prove: (int)30323 \le maxof(short int)
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta
heap_{init}.M2 == asType < short int > ((int)30307)
\label{eq:short_int} $$ $ = asType < short int > ((int)172) $$
\theta
\theta == asType<short int>((int)35)
Proof:
[Take goal term]
[1.0] (int)30323 \leq maxof(short int)
\rightarrow [simplify]
[1.3] true
Proof of verification condition: Type constraint satisfied in explicit
conversion from 'int' to 'short int'
Condition generated at: C:\Escher\Customers\prang\prang.c (22,29)
Condition defined at:
To prove: minof(short int) < (int)35
Given:
heap_{init}.LIMIT == (int)80
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
```

```
\theta sheap<sub>init</sub>.b1 == asType<short int>((int)2)
\theta sheap<sub>init</sub>.M2 == asType<short int>((int)30307)
heap_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
Proof:
[Take goal term]
[1.0] minof(short int) \leq (int)35
\rightarrow [simplify]
[1.3] true
Proof of verification condition: Type constraint satisfied in explicit
conversion from 'int' to 'short int'
Condition generated at: C:\Escher\Customers\prang\prang.c (22,29)
Condition defined at:
To prove: (int)35 \le maxof(short\ int)
Given:
heap_{init}.LIMIT == (int)80
\label{eq:heapinit} \$ \mathrm{heap}_{init}.\mathrm{M1} == \mathbf{asType} < \mathbf{short\ int} > ((\mathbf{int})30269)
heap_{init}.r1 == asType < short int > ((int)171)
\theta
\theta
heap_{init}.M2 == asType < short int > ((int)30307)
\rho_{init}.r2 == asType < short int > ((int)172)
heap_{init}.a2 == asType < short int > ((int)176)
Proof:
[Take goal term]
[1.0] (int)35 \leq maxof(short int)
\rightarrow [simplify]
[1.3] true
```

 $heap_{init}.a1 == asType < short int > ((int)177)$

Proof of verification condition: Type constraint satisfied in explicit conversion from 'int' to 'short int'

```
Condition defined at:
To prove: minof(short int) \le (int)176
Given:
heap_{init}.LIMIT == (int)80
\theta
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta
heap_{init}.M2 == asType < short int > ((int)30307)
\theta
Proof:
[Take goal term]
[1.0] minof(short int) \leq (int)176
\rightarrow [simplify]
[1.3] true
Proof of verification condition: Type constraint satisfied in explicit
conversion from 'int' to 'short int'
Condition generated at: C:\Escher\Customers\prang\prang.c (21,29)
Condition defined at:
To prove: (int)176 \le maxof(short\ int)
Given:
heap_{init}.LIMIT == (int)80
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
\theta
\theta
\theta
\theta
\theta_{init}.r2 == asType < short int > ((int)172)
Proof:
[Take goal term]
[1.0] (int)176 \leq maxof(short int)
```

Condition generated at: C:\Escher\Customers\prang\prang.c (21,29)

```
\rightarrow [simplify]
[1.3] true
Proof of verification condition: Type constraint satisfied in explicit
conversion from 'int' to 'short int'
Condition generated at: C:\Escher\Customers\prang\prang.c (20,29)
Condition defined at:
To prove: minof(short int) \le (int)172
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta
heap_{init}.M2 == asType < short int > ((int)30307)
Proof:
[Take goal term]
[1.0] minof(short int) \leq (int)172
\rightarrow [simplify]
[1.3] true
Proof of verification condition: Type constraint satisfied in explicit
conversion from 'int' to 'short int'
Condition generated at: C:\Escher\Customers\prang\prang.c (20,29)
Condition defined at:
To prove: (int)172 \le maxof(short\ int)
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
\theta
heap_{init}.M2 == asType < short int > ((int)30307)
```

```
Proof:
[Take goal term]
[1.0] (int)172 \leq \max(\text{short int})
\rightarrow [simplify]
[1.3] true
Proof of verification condition: Type constraint satisfied in explicit
conversion from 'int' to 'short int'
Condition generated at: C:\Escher\Customers\prang\prang.c (19,29)
Condition defined at:
To prove: minof(short int) \le (int)30307
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
\theta sheap<sub>init</sub>.a1 == asType<short int>((int)177)
\theta
Proof:
[Take goal term]
[1.0] minof(short int) \leq (int)30307
\rightarrow [simplify]
[1.3] true
Proof of verification condition: Type constraint satisfied in explicit
conversion from 'int' to 'short int'
Condition generated at: C:\Escher\Customers\prang\prang.c (19,29)
Condition defined at:
To prove: (int)30307 \le maxof(short int)
Given:
```

 $heap_{init}.LIMIT == (int)80$

 $\rho_{init}.M1 == asType < short int > ((int)30269)$ $\rho_{init}.r1 == asType < short int > ((int)171)$ $\rho_{init}.a1 == asType < short int > ((int)177)$

```
Proof:
[Take goal term]
[1.0] (int)30307 \leq maxof(short int)
\rightarrow [simplify]
[1.3] true
Proof of verification condition: Type constraint satisfied in explicit
conversion from 'int' to 'short int'
Condition generated at: C:\Escher\Customers\prang\prang.c (17,29)
Condition defined at:
To prove: minof(short int) \leq (int)2
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
Proof:
[Take goal term]
[1.0] minof(short int) \leq (int)2
\rightarrow [simplify]
[1.3] true
Proof of verification condition: Type constraint satisfied in explicit
conversion from 'int' to 'short int'
Condition generated at: C:\Escher\Customers\prang\prang.c (17,29)
Condition defined at:
To prove: (int)2 \leq maxof(short\ int)
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
\theta_{init}.r1 == asType < short int > ((int)171)
heap_{init}.a1 == asType < short int > ((int)177)
```

```
Proof:
```

```
[Take goal term]

[1.0] (int)2 \leq maxof(short int)

\rightarrow [simplify]

[1.3] true
```

Proof of verification condition: Type constraint satisfied in explicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (16,29)

Condition defined at:

To prove: $minof(short int) \le (int)177$

Given:

```
$heap<sub>init</sub>.LIMIT == (int)80
$heap<sub>init</sub>.M1 == asType<short int>((int)30269)
$heap<sub>init</sub>.r1 == asType<short int>((int)171)
```

Proof:

```
[Take goal term]
[1.0] \mathbf{minof}(\mathbf{short\ int}) \leq (\mathbf{int})177
\rightarrow [\mathbf{simplify}]
[1.3] \mathbf{true}
```

Proof of verification condition: Type constraint satisfied in explicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (16,29)

Condition defined at:

To prove: (int)177 \le maxof(short int)

Given:

```
$heap_init.LIMIT == (int)80
$heap_init.M1 == asType<short int>((int)30269)
$heap_init.r1 == asType<short int>((int)171)
Proof:
[Take goal term]
```

[1.0] (int)177 \leq maxof(short int)

```
\rightarrow [simplify]
[1.3] true
Proof of verification condition: Type constraint satisfied in explicit
conversion from 'int' to 'short int'
Condition generated at: C:\Escher\Customers\prang\prang.c (15,29)
Condition defined at:
To prove: minof(short int) \le (int)171
Given:
heap_{init}.LIMIT == (int)80
heap_{init}.M1 == asType < short int > ((int)30269)
Proof:
[Take goal term]
[1.0] minof(short int) \leq (int)171
\rightarrow [simplify]
[1.3] true
Proof of verification condition: Type constraint satisfied in explicit
conversion from 'int' to 'short int'
Condition generated at: C:\Escher\Customers\prang\prang.c (15,29)
Condition defined at:
To prove: (int)171 \le maxof(short int)
Given:
heap_{init}.LIMIT == (int)80
\theta sheap<sub>init</sub>.M1 == asType<short int>((int)30269)
Proof:
[Take goal term]
[1.0] (int)171 \leq maxof(short int)
\rightarrow [simplify]
[1.3] true
```

Proof of verification condition: Type constraint satisfied in explicit conversion from 'int' to 'short int'

Condition generated at: C:\Escher\Customers\prang\prang.c (14,29)

```
Condition defined at:
To prove: minof(short int) \le (int)30269
Given:
heap_{init}.LIMIT == (int)80
Proof:
[Take goal term]
[1.0] minof(short int) \leq (int)30269
\rightarrow [simplify]
[1.3] true
Proof of verification condition: Type constraint satisfied in explicit
conversion from 'int' to 'short int'
Condition generated at: C:\Escher\Customers\prang\prang.c (14,29)
Condition defined at:
To prove: (int)30269 \le maxof(short\ int)
Given:
heap_{init}.LIMIT == (int)80
Proof:
[Take goal term]
[1.0] (int)30269 \leq maxof(short int)
\rightarrow [simplify]
[1.3] true
```

 $End \ of \ proofs \ for \ file \ C: \backslash Escher \backslash Customers \backslash prang \backslash prang.c$