SHRADDHA

Date
Page

Problem - 1

Polymorphic calls at lines

6. if (pa→get() > pb→get())

14. if (pa→get() > pc→get())

~~28~~. if (pa→get() + pc→get() >
pb→get())

List of possible binding for given polymorphic at line 6

1. pa → get()   class A Object

2. pb → get()   class B Object

bindings for line 14:-

1. pa → get()   class A's Object

2. pa → get()   class B's Object

3. pc → get() class C's object

4. pc → get() class D's object

For line 18 :-

1. pa → get() class A's object

2. pa → get() class B's object

3. pa → get() class C's object

4. pa → get() class D's object

5. pc → get() class A's object

6. pc → get() class B's object

7. pc → get() class C's object

8. pc → get() class D's object

9. pb → get() class A's object

10. pb → get() class B's object.

Test Cases

1. a=4 b=7 c=6 d=1

Binding covered.

6.1, 6.2, 14.2, 14.3, 18.2, 18.7

18.9

Binding covered :- 7/16

2. a=6 b=7 c=8 d=-2

Additional binding covered

14.4, 18.8

total binding covered :- 9/16.

3. a=8 b=8 c=8 d=8

Additional binding covered

14.1, 18.1, 18.10

total binding covered

12 | 16

(4) a = 8 b = 5 c = 5 , d = 12

Additional binding covered

18.3 , 18.5

total binding covered

14 | 16.

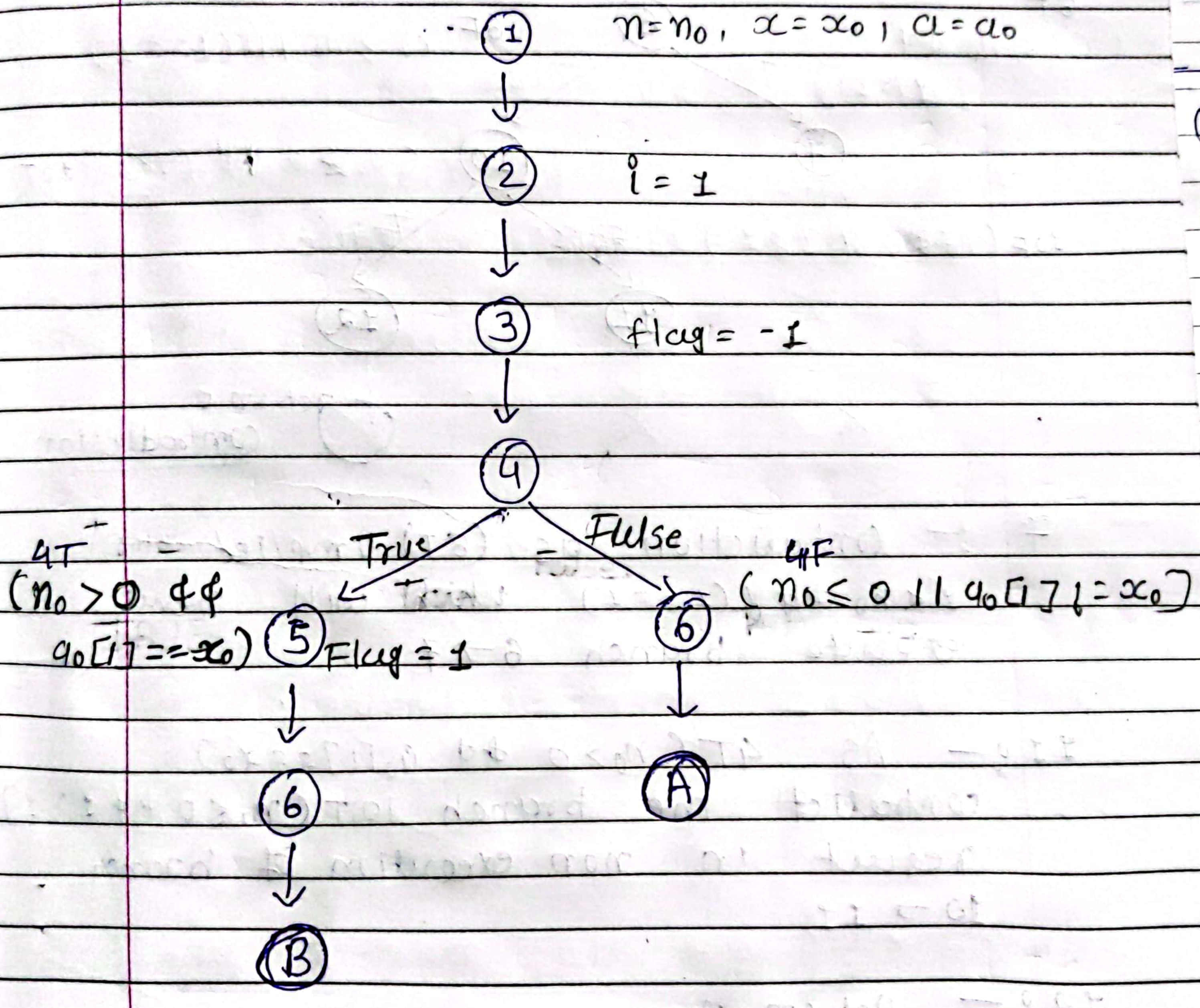
(5) a = 7 b = 3 c = 4 d = -4

Additional binding covered

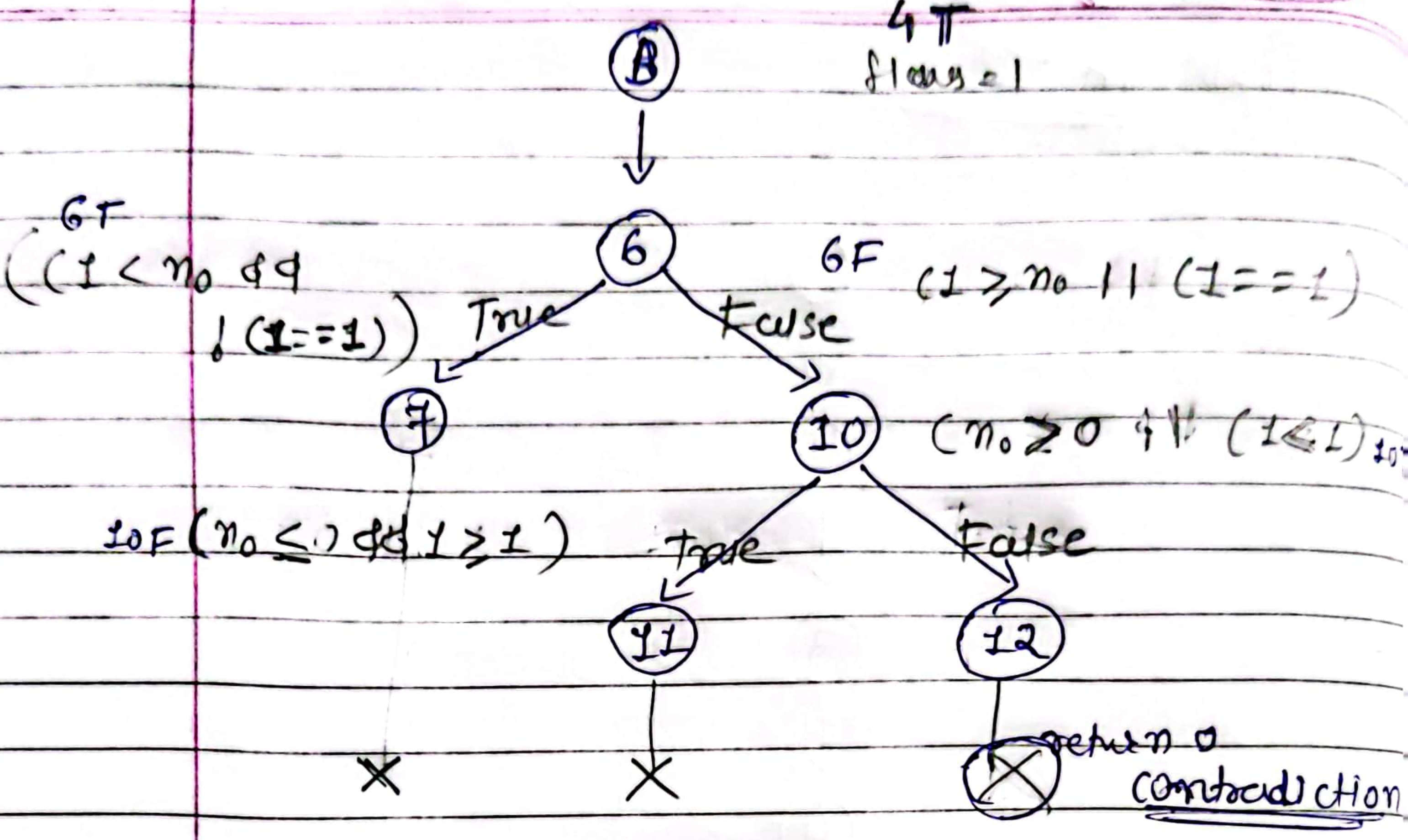
18.4 , 18.6

total binding covered = 16/16

Problem - 2



1
n = n0 , x = x0 , a = a0
2
i = 1
3
flag = -1
4
True
False
4T
(n0 > 0 && a0[i] == x0)
5
Flag = 1
4F
(n0 ≤ 0 || a0[i] != x0)
6
6
A
B



7 :- contradiction as (6T) implied $1 < n_0$ && $(1==1)$ which will never execute branch $6 \to 7$

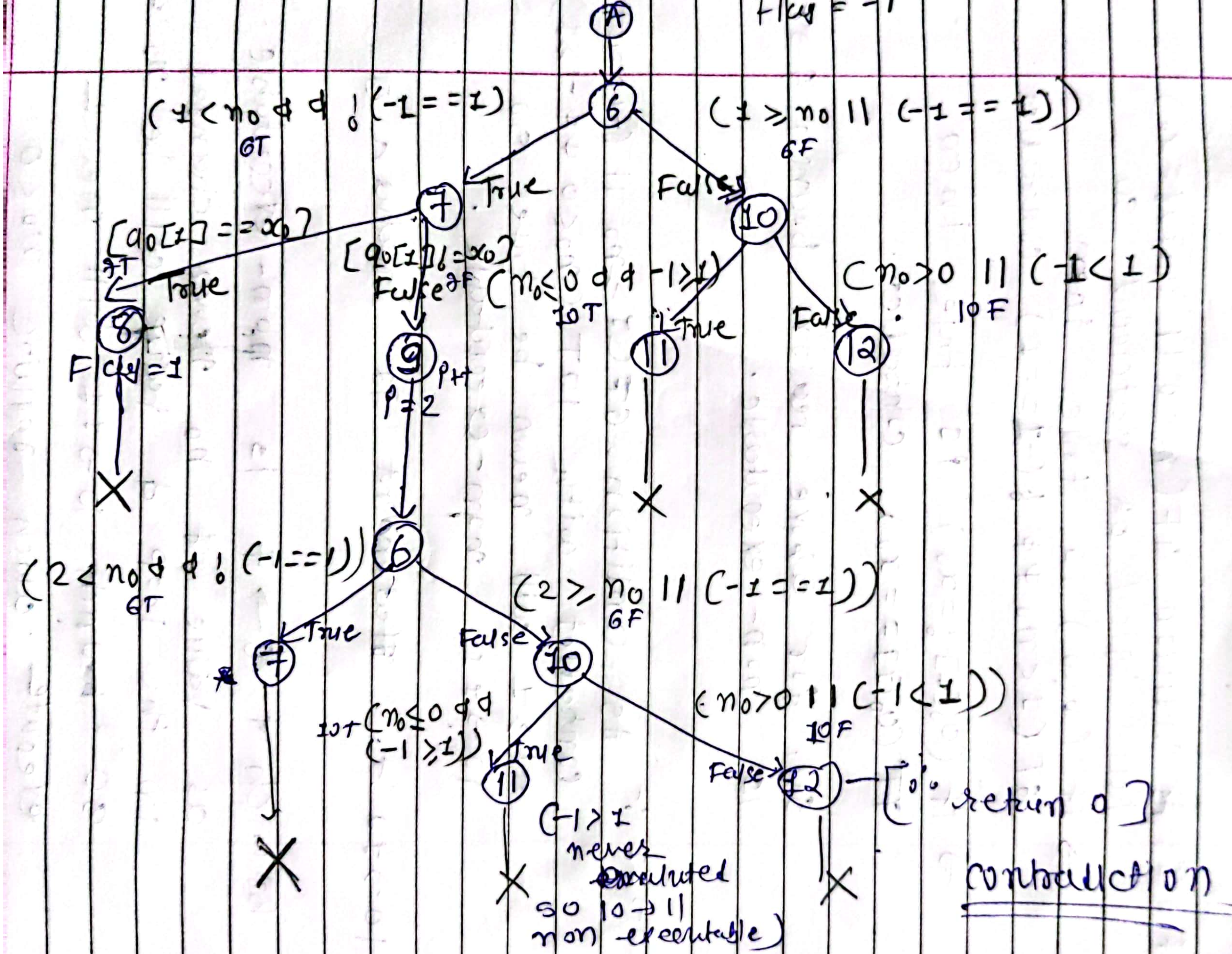
11 :- As 4T ($n_0 > 0$ && $a_0[1] == x_0$) contradict the branch 10T ($n_0 \le 0$ && $1 \ge 1$) result in non execution of branch $10 \to 11$

12 :- Return 0

4F - 6A

4F $(n_0 \leq 0) \| a_0[1] != x_0$

Flag = -1



Contradiction (A)

$7 \rightarrow 8$:- As condition 4F ($no \le 0$ || $a[i]$!= x_0) has logical OR statement so

⇒ if ($no < 0$) is true then 6T ($i < no$ && (-1 == 1)) contradict.

→ if ($a[i]$!= x_0) is true then 7T ($a[i] == x_0$) contradict.

so, for above reason branch $7 \rightarrow 8$ is non- executable.

$10 \rightarrow 11$:- As condition 6F ($i \ge no$ || (-1 == 1)) contradict with 10T ($no \le 0$ && $-1 \ge 1$) $-1 \ge 1$ will never be true so $10 \rightarrow 11$ non-executable.

$10 \rightarrow 12$:- Statement 12 return 0.

Branch of $6 \rightarrow 7$ is non- executable. as value of no never changed in the loop & value will be $no > 2$ ~~so branch $10 \rightarrow 11$ will never~~ execute. which require $no \le 0$.

Problem-3

Precondition

$1 \le n \le 100$

post condition

for all $(1 \le j \le n)$: $min \le |a[j]|$

Solution:-

Loop Invariant

for all $(i+1 \le t \le n)$: $min \le |a[t]|$

1. $k=1$
Value for variable

$i = n-1$, $min = a[n]$, $min = -a[n]$

$\Rightarrow min = |a[n]|$

$\Rightarrow \forall \; i+1 \le t \le n$; $min \le |a[t]|$

$n-1+1 \le t \le n$: $min \le |a[t]|$

$n \le t \le n$: $|a[n]| \le |a[t]|$

$n \le t \le n$: $|a[n]| \le |a[n]|$

is true.

2. Assume that

for all,

$$i_{k+1} \leq t \leq n : (min_k \leq |a[t]|)$$

is true for some k.

3. We need to show that

for all,

$$(i_{k+1} + 1 \leq t \leq n) : (min_{k+1} \leq |a[t]|)$$

is also true for $k = k+1$

there are three path inside the while loop.

We need to consider each subpath

path #1

6 7 8 11 6

$i_{k+1} = i_k - 1$

7 $\Downarrow$

$a[i_k] \geq 0$ && $min_k > a[i_k]$

$\Downarrow$

True

$min_{k+1} = a[i_k]$

We have

$$min_{k+1} = a[i_k] \; , \quad i_{k+1} = i_k - 1$$

⇒ Because of Branch (7, 8),

the following condition is true

$$(min_k > a[i_k] \;\&\&\; a[i_k] \geq 0)$$

$$\Rightarrow (a[i_k] \geq 0 \;\&\&\; min_k > a[i_k])$$

$$(min_{k+1} \geq 0 \;\&\&\; min_k > \underset{a[i_k]}{min_{k+1}})$$

is true -

$\Rightarrow$ for all

$(i_{k+1}+1 \leq t \leq n)$: $min_{k+1} \leq |a[t]|)$

$\Rightarrow$ for all
$(i_k - 1 + 1 \leq t \leq n)$: $min_{k+1} \leq |a[t]|)$

$\Rightarrow$ for all

$[(i_k + 1 \leq t \leq n)$: $min_{k+1} \leq |a[t]|]$ and

$(min_{k+1} \leq |a[i_k]|)$

$(\because a[i_k] \geq 0$ $\quad min_{k+1} = |a[i_k]|)$

$\Rightarrow$ For all,

$(i_k+1 < t \leq n$: $min_{k+1} \leq |a[t]|)$ and

$(\underline{a[i_k] \leq |a[i_k]|})$
True

$\Rightarrow$ For all,

$(i_k+1 \leq t \leq n)$: $(min_{k+1} \leq |a[t]|)$

Since for all $i+1 < t \leq n$: $min_k \leq |a[t]|$ is true and $min_k > min_{k+1}$ is true it follows that

For all $(i_k+1 \leq t \leq n)$: $min_{k+1} \leq |a[t]|$

is also true.

path #2

6 $\quad \xrightarrow{7 \quad\quad} 9 \quad$ 10 $\quad$ 11 $\quad$ 6.

$\Downarrow \qquad\qquad \Downarrow \qquad\qquad \underbrace{\quad}_{i_{k+1} = i_k - 1}$

$min_{k+1} = -a[i_k]$

$a[i_k] < 0$ & $min_k > -a[i_k]$

$\Rightarrow$ we have

$min_{k+1} = -a[i_k]$, $i_{k+1} = i_k - 1$

$\Rightarrow$ ~~for all~~

~~$(i_{k+1} \le t \le$~~

$\Rightarrow$ for all

$(i_{k+1} + 1 \le t \le n) : (min_{k+1} \le |a[t]|)$

$\Rightarrow$ for all

$(i_k - 1 + 1 \le t \le n) : (min_{k+1} \le |a[t]|)$

$\Rightarrow$ for all

$[$ for all $(i_k + 1 \le t \le n) : (min_{k+1} \le |a[t]|)]$

and

$(min_{k+1} \le |a[i_k]|)$

$\Rightarrow$ [for all $(i_k + 1 \le t \le n)$: $min_{k+1} \le |a[t]|$]

and $\underbrace{(-a[i_k] \le |a[i_k]|)}_{\text{true}}$

$\Rightarrow$ (for all $(i_{k+1} \le t \le n)$: $min_{k+1} \le |a[t]|$)

path #3

6 7 9 11 6

$\Downarrow$

$\left(\therefore \text{ so } min \le |a[i_k]| \right)$ true

$i_{k+1} = i_k - 1$

$\Rightarrow$ we have $i_{k+1} = i_k - 1$, $min_{k+1} = min_k$

$\Rightarrow$ (for all $(i_{k+1} \le t \le n)$: $min_{k+1} \le |a[t]|$)

$\Rightarrow$ for all $(i_k - 1 + 1 \le t \le n)$: $(min_{k+1} \le |a[t]|)$

$\Rightarrow$ for all $(i_k + 1 - 1 \le t \le n)$: $min_k \le |a[t]|$)

$\Rightarrow$ [for all $(i_k + 1 \le t \le n)$: $min_k \le |a[t]|$) and $min_k \le |a[i_k]|$

true.

$\Rightarrow$ (for all $(i_k + 1 \le t \le n)$: $min_k \le |a[t]|$ and true

true and true.

$\Rightarrow$ True End of Proof.

On Termination

$i = 0$ and for all $(i+1 \le t \le n)$: $min \le |a[t]|$

$\Rightarrow$ $i = 0$ and [for all $(i+1 \le t \le n)$: $min \le |a[t]|$)

$\Rightarrow$ (for all $1 \le t \le n$: $min \le |a[t]|$)
that is Post - condition.