

How to typeset verification problems

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This document explains how to typeset verification problems when solving the exercises for the course “Formal Methods in Computer Science”.

1 Annotation calculus

The L^AT_EX code in the left column produces the output shown in the right column.

<code>\documentclass{scrartcl}</code>		
<code>\usepackage{fvsw}</code>		
<code>\begin{document}</code>		
<code>\begin{ALG}</code>		
<code>\ASSERT F\\</code>		$\{ F \}$
<code>\ASSERTN1\INV</code>	<code>\quad(wh)\\</code>	$\{ 1: Inv \} \quad (wh)$
<code>\WHILE\ \$e\$ \DO\\</code>		while e do
<code>\>\ASSERTN2{\INV\land e}</code>	<code>\quad(wh)\\</code>	$\{ 2: Inv \wedge e \} \quad (wh)$
<code>\>\IF\ \$e'\$ \THEN\\</code>		if e' then
<code>\>\>\ASSERTN6{\INV\land e\land e'}</code>	<code>\quad(if)\$\da\$\\</code>	$\{ 6: Inv \wedge e \wedge e' \} \quad (if)\downarrow$
<code>\>\>\ASSERTN{10}{\INV\sub{x<-x+1}}</code>	<code>\quad(sk)\$\ua\$\\</code>	$\{ 10: Inv[x/x+1] \} \quad (sk)\uparrow$
<code>\>\>\SKIP\\</code>		skip
<code>\>\>\ASSERTN8{\INV\sub{x<-x+1}}</code>	<code>\quad(fi)\$\ua\$\\</code>	$\{ 8: Inv[x/x+1] \} \quad (fi)\uparrow$
<code>\>\ELSE\\</code>		else
<code>\>\>\ASSERTN7{\INV\land e\land\not e'}</code>	<code>\quad(if)\$\da\$\\</code>	$\{ 7: Inv \wedge e \wedge \neg e' \} \quad (if)\downarrow$
<code>\>\>\ASSERTN{11}\TRUE</code>	<code>\quad(ab)\$\ua\$\\</code>	$\{ 11: true \} \quad (ab)\uparrow$
<code>\>\>\ABORT\\</code>		abort
<code>\>\>\ASSERTN9{\INV\sub{x<-x+1}}</code>	<code>\quad(fi)\$\ua\$\\</code>	$\{ 9: Inv[x/x+1] \} \quad (fi)\uparrow$
<code>\>\FI;\\</code>		fi ;
<code>\>\ASSERTN5{\INV\sub{x<-x+1}}</code>	<code>\quad(as)\$\ua\$\\</code>	$\{ 5: Inv[x/x+1] \} \quad (as)\uparrow$
<code>\>\ASS x{x+1}\\</code>		$x := x + 1$
<code>\>\ASSERTN3\INV</code>	<code>\quad(wh)\\</code>	$\{ 3: Inv \} \quad (wh)$
<code>\OD\\</code>		od
<code>\ASSERTN4{\INV\land\not e}</code>	<code>\quad(wh)\\</code>	$\{ 4: Inv \wedge \neg e \} \quad (wh)$
<code>\ASSERT G</code>		$\{ G \}$
<code>\end{ALG}</code>		
<code>\end{document}</code>		

2 Hoare calculus

The same verification task as above, but this time presented as derivation in the Hoare calculus. The output can be found on the next page.

```

\documentclass{scrartcl}
\usepackage{fullpage,rotating}
\advance\textheight20pt
\usepackage{fvsw}
\begin{document}
\begin{sideways}
\small\infertrue
$
\LaTeX{\CA F{\WHILE\ e\ \DO\ \IF\ e'\ \THEN\ \SKIP\ \ELSE\ \ABORT\ \FI;\ \ASS x{x+1}\ \OD}G}%
{\FRM{1}{F\lfi\INV}\hspace{-5em}}%
{\WH{\CA\INV
{\WHILE\ e\ \DO\ \IF\ e'\ \THEN\ \SKIP\ \ELSE\ \ABORT\ \FI;\ \ASS x{x+1}\ \OD}%
{\INV\land\not e}%
}%
{\SC{\CA{\INV\land e}{\IF\ e'\ \THEN\ \SKIP\ \ELSE\ \ABORT\ \FI;\ \ASS x{x+1}}\INV}%
{\Ia{\CA{\INV\land e}%
{\IF\ e'\ \THEN\ \SKIP\ \ELSE\ \ABORT\ \FI}%
{\INV\sub{x<-x+1}}}%
}%
{\Lb{\CA{\INV\land e\land e'}\SKIP{\INV\sub{x<-x+1}}}%
{\FRM{2}{\INV\land e\land e'\lfi\INV\sub{x<-x+1}}}%
{\SK{\CA{\INV\sub{x<-x+1}}\SKIP{\INV\sub{x<-x+1}}}%
}%
{\AB{\CA{\INV\land e\land\not e'}\ABORT{\INV\sub{x<-x+1}}}%
}%
{\Aa{\CA{\INV\sub{x<-x+1}}{\ASS x{x+1}}\INV}}%
}%
}%
{\hspace{-8.8em}\FRM{3}{\INV\land\not e\lfi G}}
$
\end{sideways}
\end{document}

```

$$\begin{array}{c}
\frac{Inv \wedge e \wedge e' \Rightarrow Inv[x/x+1] \quad \{ Inv[x/x+1] \} \text{skip} \{ Inv[x/x+1] \}}{\{ Inv \wedge e \wedge e' \} \text{skip} \{ Inv[x/x+1] \}} \quad \text{(sk)} \\
\frac{\{ Inv \wedge e \wedge e' \} \text{skip} \{ Inv[x/x+1] \}}{\{ Inv \wedge e \wedge \neg e' \} \text{abort} \{ Inv[x/x+1] \}} \quad \text{(lc)} \\
\frac{\{ Inv \wedge e \wedge \neg e' \} \text{abort} \{ Inv[x/x+1] \}}{\{ Inv \wedge e \} \text{if } e' \text{ then skip else abort fi; } x := x + 1 \{ Inv \}} \quad \text{(if)} \\
\frac{\{ Inv \wedge e \} \text{if } e' \text{ then skip else abort fi; } x := x + 1 \{ Inv \}}{\{ Inv \wedge e \} \text{if } e' \text{ then skip else abort fi; } x := x + 1 \{ Inv \}} \quad \text{(ab)} \\
\frac{\{ Inv \wedge e \} \text{if } e' \text{ then skip else abort fi; } x := x + 1 \{ Inv \}}{\{ Inv \wedge e \} \text{if } e' \text{ then skip else abort fi; } x := x + 1 \{ Inv \}} \quad \text{(as)} \\
\frac{\{ Inv \wedge e \} \text{if } e' \text{ then skip else abort fi; } x := x + 1 \{ Inv \}}{\{ F \} \text{while } e \text{ do if } e' \text{ then skip else abort fi; } x := x + 1 \text{ od } \{ G \}} \quad \text{(wh)} \\
\frac{\{ F \} \text{while } e \text{ do if } e' \text{ then skip else abort fi; } x := x + 1 \text{ od } \{ G \}}{\{ F \} \text{while } e \text{ do if } e' \text{ then skip else abort fi; } x := x + 1 \text{ od } \{ G \}} \quad \text{(3)} \\
\frac{\{ F \} \text{while } e \text{ do if } e' \text{ then skip else abort fi; } x := x + 1 \text{ od } \{ G \}}{\{ F \} \text{while } e \text{ do if } e' \text{ then skip else abort fi; } x := x + 1 \text{ od } \{ G \}} \quad \text{(sc)} \\
\frac{\{ F \} \text{while } e \text{ do if } e' \text{ then skip else abort fi; } x := x + 1 \text{ od } \{ G \}}{\{ F \} \text{while } e \text{ do if } e' \text{ then skip else abort fi; } x := x + 1 \text{ od } \{ G \}} \quad \text{(lc)}
\end{array}$$