1 4F-1 Bookkeeping

- 0 pts Correct

2F-2

VC(let $x = e$ in c, B) = VC($[e/x]$ c, B). The original rule does not properly handle shadowing, and behaves as assignment.

2F-3

$$\begin{aligned} c &= (\mathsf{let}\ x = 1\ \mathsf{in\ skip}) \\ B &= (x = 1) \\ \sigma &= [x := 0] \end{aligned}$$

This verification condition is valid:

$$\begin{aligned} VC(\mathsf{let}\ x = 1\ \mathsf{in\ skip}, x = 1) &= [e/x]VC(\mathsf{skip}, x = 1) \\ &= VC(\mathsf{skip}, 1 = 1) \\ &= 1 = 1 \\ &= \mathsf{true} \end{aligned}$$

But Using the evaluation rule for let:

$$\frac{< e, \sigma > \Downarrow v \qquad < c, \sigma[x := v] > \Downarrow \sigma'}{< \mathsf{let}\ x = e\ \mathsf{in}\ c, \sigma > \Downarrow \sigma'[x := \sigma(x)]}$$

This evaluates to the state $\sigma' = [x := 0]$:

$$\frac{< 1, [x := 0] > \Downarrow 1 \qquad < \mathsf{skip}, \sigma[x := 1] > \Downarrow [x := 1]}{< \mathsf{let}\ x = 1\ \mathsf{in\ skip}, [x := 0] > \Downarrow [x := 0]}$$

which does not satisfy B $(x = 1)$ because $x = 0$ under σ'.

2F-4

$$\frac{\vdash \{A\}c\{B\} \qquad \vdash \{B \wedge b\}c\{B\}}{\vdash \{A\}\mathsf{do}\ c\ \mathsf{while}\ b\{B \wedge \neg b\}}$$

2 4F-2 VCGen for Let

- 0 pts Correct

2F-2

VC($\mathsf{let}\ x = e\ \mathsf{in}\ c$, B) = VC($[e/x]\ c$, B). The original rule does not properly handle shadowing, and behaves as assignment.

2F-3

$$\begin{aligned} c &= (\mathsf{let}\ x = 1\ \mathsf{in}\ \mathsf{skip}) \\ B &= (x = 1) \\ \sigma &= [x := 0] \end{aligned}$$

This verification condition is valid:

$$\begin{aligned} VC(\mathsf{let}\ x = 1\ \mathsf{in}\ \mathsf{skip}, x = 1) &= [e/x]VC(\mathsf{skip}, x = 1) \\ &= VC(\mathsf{skip}, 1 = 1) \\ &= 1 = 1 \\ &= \mathsf{true} \end{aligned}$$

But Using the evaluation rule for let:

$$\frac{< e, \sigma > \Downarrow v \qquad < c, \sigma[x := v] > \Downarrow \sigma'}{< \mathsf{let}\ x = e\ \mathsf{in}\ c, \sigma > \Downarrow \sigma'[x := \sigma(x)]}$$

This evaluates to the state $\sigma' = [x := 0]$:

$$\frac{< 1, [x := 0] > \Downarrow 1 \qquad < \mathsf{skip}, \sigma[x := 1] > \Downarrow [x := 1]}{< \mathsf{let}\ x = 1\ \mathsf{in}\ \mathsf{skip}, [x := 0] > \Downarrow [x := 0]}$$

which does not satisfy B ($x = 1$) because $x = 0$ under σ'.

2F-4

$$\frac{\vdash \{A\}c\{B\} \qquad \vdash \{B \wedge b\}c\{B\}}{\vdash \{A\}\mathsf{do}\ c\ \mathsf{while}\ b\{B \wedge \neg b\}}$$

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3 4F-3 VCGen Mistakes

- 0 pts Correct

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2F-2

VC(let $x = e$ in c, B) = VC($[e/x]$ c, B). The original rule does not properly handle shadowing, and behaves as assignment.

2F-3

$$
\begin{aligned}
c &= (\mathsf{let}\ x = 1\ \mathsf{in\ skip}) \\
B &= (x = 1) \\
\sigma &= [x := 0]
\end{aligned}
$$

This verification condition is valid:

$$
\begin{aligned}
VC(\mathsf{let}\ x = 1\ \mathsf{in\ skip}, x = 1) &= [e/x]VC(\mathsf{skip}, x = 1) \\
&= VC(\mathsf{skip}, 1 = 1) \\
&= 1 = 1 \\
&= \mathsf{true}
\end{aligned}
$$

But Using the evaluation rule for let:

$$
\frac{< e, \sigma >\Downarrow v \qquad < c, \sigma[x := v] >\Downarrow \sigma'}{< \mathsf{let}\ x = e\ \mathsf{in}\ c, \sigma >\Downarrow \sigma'[x := \sigma(x)]}
$$

This evaluates to the state $\sigma' = [x := 0]$:

$$
\frac{< 1, [x := 0] >\Downarrow 1 \qquad < \mathsf{skip}, \sigma[x := 1] >\Downarrow [x := 1]}{< \mathsf{let}\ x = 1\ \mathsf{in\ skip}, [x := 0] >\Downarrow [x := 0]}
$$

which does not satisfy B ($x = 1$) because $x = 0$ under σ'.

2F-4

$$
\frac{\vdash \{A\}c\{B\} \qquad \vdash \{B \wedge b\}c\{B\}}{\vdash \{A\}\mathsf{do}\ c\ \mathsf{while}\ b\{B \wedge \neg b\}}
$$

4 4F-4 Axiomatic Do-While

- 0 pts Correct

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