1 4F-1 Bookkeeping

- **0 pts** Correct

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2   Exercise 4F-2. VCGen for Let [6 points].

The problem of the current rule is that it does not restore the old value. Therefore, we introduce a fresh variable s. s will keep track of the original value and assign it back to x at the end.

The rule **let** $x = e$ **in** c therefore can be re-written as:

$$s := x; x := e; c; x := s$$

Now we transform the problem to a new one:

$$\text{VC(let x=e in c, B)} \rightarrow \text{VC(s:=x; x:=e; c; x:=s, B)}$$

We perform the simplifications

$$
\begin{aligned}
&\text{VC(s:=x; x:=e; c; x:=s, B)}\\
&= \text{VC(s:=x; VC(x:=e; c; x:=s, B))}\\
&= \text{[x/s]VC(x:=e; c; x:=s, B)}\\
&= \text{[x/s]VC(x:=e; VC(c; x:=s, B))}\\
&= \text{[x/s][e/x]VC(c; x:=s, B)}\\
&= \text{[x/s][e/x]VC(c; VC(x:=s, B))}\\
&= \text{[x/s][e/x]VC(c; [s/x]B)}
\end{aligned}
$$

In conclusion we have a new rule with fresh variable s:

$$\text{VC(let x=e in c, B)} \;=\; \text{[x/s][e/x]VC(c; [s/x]B)}$$

3   Exercise 4F-3. VCGen Mistakes [6 points].

1. c: let x=1 in skip

2. B: x=1

3. $\sigma(x) = 0$

4. $\sigma \models VC(c, B)$; Here, VC(c,B) is satisfied since the rule does not restore the old value. We simply have 1=1.

5. $< c, \sigma > \Downarrow \sigma'$; Here $\sigma'(x) = 0$, which is the original value.

6. $\sigma' \not\models B$ because $\sigma'(x) = 0$ and $\sigma' \not\models x = 1$

2

2 4F-2 VCGen for Let

- 0 pts Correct

2 Exercise 4F-2. VCGen for Let [6 points].

The problem of the current rule is that it does not restore the old value. Therefore, we introduce a fresh variable s. s will keep track of the original value and assign it back to x at the end.

The rule **let** $x = e$ **in** c therefore can be re-written as:

$$s := x; x := e; c; x := s$$

Now we transform the problem to a new one:

$$VC(\text{let x=e in c, B}) \rightarrow VC(\text{s:=x; x:=e; c; x:=s, B})$$

We perform the simplifications

$$
\begin{aligned}
&VC(\text{s:=x; x:=e; c; x:=s, B}) \\
&= VC(\text{s:=x; VC(x:=e; c; x:=s, B)}) \\
&= [\text{x/s}]VC(\text{x:=e; c; x:=s, B}) \\
&= [\text{x/s}]VC(\text{x:=e; VC(c; x:=s, B)}) \\
&= [\text{x/s}][\text{e/x}]VC(\text{c; x:=s, B}) \\
&= [\text{x/s}][\text{e/x}]VC(\text{c; VC(x:=s, B)}) \\
&= [\text{x/s}][\text{e/x}]VC(\text{c; [s/x]B})
\end{aligned}
$$

In conclusion we have a new rule with fresh variable s:

$$VC(\text{let x=e in c, B}) = [\text{x/s}][\text{e/x}]VC(\text{c; [s/x]B})$$

3 Exercise 4F-3. VCGen Mistakes [6 points].

1. c: let x=1 in skip

2. B: x=1

3. $\sigma(x) = 0$

4. $\sigma \models VC(c, B)$; Here, VC(c,B) is satisfied since the rule does not restore the old value. We simply have 1=1.

5. $< c, \sigma > \Downarrow \sigma'$; Here $\sigma'(x) = 0$, which is the original value.

6. $\sigma' \not\models B$ because $\sigma'(x) = 0$ and $\sigma' \not\models x = 1$

2

3 4F-3 VCGen Mistakes

- 0 pts Correct

4 Exercise 4F-4. Axiomatic Do-While [6 points]

Rewrite do-while as follows:

$$\text{do c while b} \rightarrow \text{c; while b do c}$$

We can write Hoare Rule

$$\frac{\vdash \{A\}c\{B\} \quad \vdash \{B\}\text{while b do c}\{C\}}{\vdash \{A\}\text{do c while b}\{C\}}$$

This can be further simplified to

$$\frac{\vdash \{A\}c\{B\} \quad \vdash \{B \wedge b\}\text{c}\{B\}}{\vdash \{A\}\text{do c while b}\{B \wedge \neg b\}}$$

3

- 0 pts Correct

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