1 5F-1 Bookkeeping

- **0 pts** Correct

5 F-2

$$VC(\ do_{inv}\ c\ \text{while}\ b\ ,\ P) \quad =$$

$$= \quad VC(\ c;\ \text{while}\ b\ \text{do}\ c\ ,\ P)$$

$$= \quad VC(\ c\ ,\ VC(\ \text{while}\ b\ \text{do}\ c, P))$$

$$=$$

$$VC(c, inv) \ \wedge \ (\forall x_1 \ldots x_n.\ inv \Rightarrow (b \Rightarrow VC(c, inv) \ \wedge \ \neg b \Rightarrow P))$$

The only change will be in the entry condition. Instead of checking the invariant as we do in while ... do .. , we should check $VC(c, inv)$ because the the loop body c will already have been executed once before reaching the invariant for the first time. The condition for checking the invariant on an arbitrary iteration should remain the same.

2 5F-2 VCGen Do-While

- **0 pts** Correct

5F-3

1. Stark

2. $x = 0$

3. $x = 5$

4. $\sigma[x] = 0$

5. $\sigma'[x] = 5$

6. while $x < 5$ do $x := x+1$

7. $\langle \text{while } x<5 \text{ do } x := x+1, \sigma[x=0] \rangle \Downarrow \sigma'[x=5]$

8. $\sigma \vDash A = \sigma \vDash x=0 = \text{true}$

9. $\sigma' \vDash B = \sigma' \vDash x=5 = \text{true}$

10.

$\vdash \{A\}\ c\ \{B\}$

$= \vdash \{x=0\}$ while $x<5$ do $x:=x+1$ $\{x=5\}$

To show the provability of the above statement, we need to find an intermediate condition $Z$ such that:

① $\{x=0\} \Rightarrow \{Z\}$

② $\vdash \{Z \wedge x<5\}\ c\ \{Z\}$

③ $\{Z\} \Rightarrow \{x=5\}$

Combining ① and ③

$\{x=0\} \Rightarrow \{x=5\}$

which is clearly false. Thus, the system $\{①, ②, ③\}$ is unsatisfiable. Thus, such a $Z$ does not exist.



$\{A\}\ c\ \{B\}$ is not provable by rule Stark

1. targaryen

2. $x = 0$

3. $x = 5$

4. $\sigma[x] = 0$

5. $\sigma'[x] = 5$

6. while $x < 5$ do $x := x+1$

7. $\langle$ while $x<5$ do $x := x+1$, $\sigma[x=0] \rangle \Downarrow \sigma'[x=5]$

8. $\sigma \vDash A = \sigma \vDash x=0 =$ true

9. $\sigma' \vDash B = \sigma' \vDash x=5 =$ true

10.

$\vdash \{A\}\ c\ \{B\}$

$= \vdash \{x=0\}$ while $x<5$ do $x:=x+1$ $\{x=5\}$

To show the provability of the above statement, we need to find an intermediate condition $Z$ such that:

① $\{x=0\} \Rightarrow \{z\}$

② $\vdash \{z\}\ c\ \{z\}$

③ $\vdash \{z \wedge x \geq 5\} \Rightarrow \{x=5\}$

By ③ $z = \{x=5\}$ or $z = \{x<6\}$

Case 1: $z = \{x=5\}$

This contradicts with ① because

$\{x=0\} \Rightarrow \{x=5\}$

is clearly false

Case 2: $z = \{x > 6\}$

This contradicts with ② because

$$\{x > 6\} \quad x := x + 1 \quad \{x > 6\}$$

is clearly not provable

Thus, the system $\{①, ②, ③\}$ is unsatisfiable.

Thus, such a $z$ does not exist.

$\{A\}\ c\ \{B\}$ is not provable by rule targaryen

## 3 5F-3 VCGen Mistakes

- **0 pts** Correct