1 5F-1 Bookkeeping

- 0 pts Correct

Exercise 5F-2:

$$vc(\mathrm{do}_{Inv}\ c\ \mathrm{while}\ b,\ P)$$

$$= vc(c\ ;\ \mathrm{while}_{Inv}\ b\ \mathrm{do}\ c,\ P)$$

$$= vc(c,\ vc(\mathrm{while}_{Inv}\ b\ \mathrm{do}\ c,\ P))$$

$$= vc(c,\ Inv \wedge (\forall x_1 \ldots x_n.\ Inv \to (b \to vc(c, Inv) \wedge \neg b \to P))).$$

2 5F-2 VCGen Do-While

- 0 pts Correct

Exercise 5F-3:

① . I select the stark rule. Compared with the original while rule, stark rule is incomplete because it is missing the "$\neg b$" check when the loop finishes.

1. stark
2. Let A be $\{x=0\}$
3. Let B be $\{x=1\}$
4. $\sigma(x)=0$
5. $\sigma'(x)=1$
6. c is while $x \neq 1$ do $x:=1$
7. $\langle c,\sigma\rangle \Downarrow \sigma'$ because $\sigma(x)=0$, c will assign 1 to x, and thus $\sigma'(x)=1$
8. $\sigma \models A$ because $\sigma(x)=0$ and A is $\{x=0\}$
9. $\sigma' \models B$ because $\sigma'(x)=1$ and B is $\{x=1\}$
10. it is not possible to prove $\vdash \{A\}\ c\ \{B\}$ using the stark rule.

we have

$$\frac{\vdash \{X \wedge b\}\ c\ \{X\}}{\vdash \{X\}\ \text{while } b \text{ do } c\ \{X\}}$$

where b is the assumption $x \neq 1$ and c is the loop body $x:=1$

We cannot assume $\neg b$, which is $x=1$, when the loops finishes in the stark rule. Then, given A, or $\{x=0\}$ which satisfies $x \neq 1$, we cannot make a derivation that when the loop terminates, we have B, or $\{x=1\}$.

② . I select the targaryen rule. The problem of this variant is that it doesn't let you assume b when executing the loop body c in while b do c.

1. targaryen
2. A is $\{x \le 0\}$
3. B is $\{x = 6\}$
4. $\sigma(x) = 0$
5. $\sigma'(x) = 6$
6. c is while $x \le 5$ do $x := x+1$
7. $\langle c, \sigma \rangle \Downarrow \sigma'$ by apply the while loop on $x = 0$.
8. $\sigma \models A$ because $\sigma(x) = 0$ and A is $\{x \le 0\}$.
9. $\sigma' \models B$ because $\sigma'(x) = 6$ and B is $\{x = 6\}$.
10. it is not possible to prove $\vdash \{A\}\ c\ \{B\}$ using the targaryen rule.

We first use invariant $x \le 6$.

$$\dfrac{\dfrac{\vdash x \le 6 \wedge x \le 5 \to x+1 \le 6 \qquad \overline{\vdash \{x+1 \le 6\}\ x := x+1\ \{x \le 6\}}}{\text{fail} \Rightarrow \vdash \{x \le 6 \boxed{\wedge\ x \le 5}\}\ x := x+1\ \{x \le 6\}}}{\vdash \{x \le 6\}\ c\ \{x \le 6 \wedge x > 5\}}$$

Then we finish off with consequence: $\vdash x \le 0 \to x \le 6$

$$\dfrac{\vdash x \le 6 \wedge x > 5 \to x = 6 \qquad \vdash \{x \le 6\}\ c\ \{x \le 6 \wedge x > 5\}}{\vdash \{x \le 0\}\ c\ \{x = 6\}}$$

Compared with the correct while loop, the part written in red and enclosed by a red box is missing. Thus, the left part fails. There is no way to make a derivation for the $\vdash \{x \le 6\}\ x := x+1\ \{x \le 6\}$. this line fails when $x = 6$.
So targaryen is incomplete.

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3 5F-3 VCGen Mistakes

- 0 pts Correct

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