

Advanced Programming Languages

Homework Assignment 4F

EECS 590

Logistics. You must work alone. Your name and Michigan email address must appear on the first page of your PDF submission but *may not appear anywhere else*. This is to protect your identity during peer review. The first page of your submission is *not* shared during peer view but all subsequent pages are.

Exercise 4F-1. Bookkeeping [2 points].

1. Indicate in a sentence or two how much time you spent on this homework.
2. Indicate in a sentence or two how difficult you found it subjectively.

All subsequent answers should appear after the first page of your submission and may be shared publicly during peer review.

Exercise 4F-2. VCGen for Let [6 points]. In class we gave the following rules for the (backward) verification condition generation of assignment and let:

$$\begin{aligned} \text{VC}(c_1; c_2, B) &= \text{VC}(c_1, \text{VC}(c_2, B)) \\ \text{VC}(x := e, B) &= [e/x] B \\ \text{VC}(\text{let } x = e \text{ in } c, B) &= [e/x] \text{VC}(c, B) \end{aligned}$$

That rule for **let** has a bug. Give a correct rule for **let**.

Exercise 4F-3. VCGen Mistakes [6 points]. Given $\{A\}c\{B\}$ we desire that $A \implies \text{VC}(c, B) \implies \text{WP}(c, B)$. We say that our VC rules are *sound* if $\models \{\text{VC}(c, B)\} c \{B\}$. Demonstrate the unsoundness of the buggy **let** rule by giving the following six things:

1. a command c and
2. a post-condition B and
3. a state σ such that
4. $\sigma \models \text{VC}(c, B)$ and

5. $\langle c, \sigma \rangle \Downarrow \sigma'$ but

6. $\sigma' \not\models B$.

Exercise 4F-4. Axiomatic Do-While [6 points]. Write a sound and complete Hoare rule for **do** c **while** b . This statement has the standard semantics (e.g., c is executed at least once, before b is tested).

Submission. Turn in the formal component of the assignment as a single PDF document via the **gradescope** website. Your name and Michigan email address must appear on the first page of your PDF submission but may not appear anywhere else.