HW4 Problem Set

ECS 261

Due: Friday, May 30, 2025

1. For a program P and formula φ, let $\mathsf{WP}(P, \varphi)$ denote the weakest precondition and $\mathsf{SP}(P, \varphi)$ denote the strongest postcondition.

   Give examples in Dafny which show the following:

   (a) A program P, a precondition φ and postcondition ψ, where ψ is the strongest postcondition for φ but φ is not the weakest precondition for ψ.

   (b) A program P, precondition φ and postcondition ψ, where φ is the weakest precondition for ψ but ψ is not the strongest postcondition for φ.

   For both parts, show that the original strongest-postcondition (or weakest-precondition) relationship holds, *and* that the new different precondition (or postcondition, respectively) holds, by adding it also in the code, as shown below. Your program may be the same for the two parts. Additionally, use Dafny to show that the new precondition or postcondition is different by giving specific examples that satisfy one precondition or postcondition, but not the other.

```
method Prog_a()
requires (old_precondition_a) || (new_precondition)
ensures (old_postcondition_a)
{
}

method Prog_b()
requires (old_precondition_b)
ensures (old_postcondition_b) && (new_postcondition)
{
}

lemma Stronger_a()
// State and prove that new_precondition is different than
// old_precondition_a
{
}

lemma Stronger_b()
// State and prove that new_postcondition is different than
// old_postcondition_b
```

```
{
}
```

2. State which of the following is possible. If it is possible, give an example; if it is impossible, give a short proof. For all parts, preconditions and postconditions are considered the same if they are logically equivalent as formulas (i.e., each one implies the other).

   (a) For the same postcondition, two different programs have the same weakest precondition.

   (b) For the same precondition, two different programs have the same strongest postcondition.

   (c) For the same program, two different preconditions have the same strongest postcondition.

   (d) For the same program, two different postconditions have the same weakest precondition.

   (e) For a program P and postconditions φ_1 and φ_2 such that φ_1 is strictly stronger than φ_2, $\mathsf{WP}(P, \varphi_1)$ is equivalent to $\mathsf{WP}(P, \varphi_2)$.

   (f) For a program P and preconditions φ_1 and φ_2 such that φ_1 is strictly stronger than φ_2, $\mathsf{SP}(P, \varphi_1)$ is equivalent to $\mathsf{SP}(P, \varphi_2)$.

3.

4.

5.

Submission instructions:

- Upload your solutions (as a PDF) and your code (in Dafny) in Gradescope.

- If you use this LaTeX template to create your solutions, please remove the problem statements and include only your solutions.

- Your code should be a file `hw4.py`, together with any necessary helper files. It should include your solutions for parts 1, 3, and 5.

- Please include all of the function names and signatures as listed in the document above, and do not modify any function signatures. (You are welcome to add additional functions and tests.)