Assignment 1   CSSE3100/7100 Reasoning about Programs

Due: 3pm on 27 March, 2020

Instructions: Answer all questions below and submit a single pdf file with your solutions to Blackboard by the due date and time.

Question 1 [4 marks]

A pair of integers, (x, y), where $x \leq y$, represents a line segment containing all points from x up to, but not including, y (i.e., all integers z such that $x \leq z < y$).

For each of the methods described below, write a method signature and formal specification without using quantifiers (forall and exists). You may define functions to which your specifications refer. You do not need to provide specifications for your functions.

(a) A method to determine whether one line segment (x,y) contains another (x',y'), i.e., all points of (x',y') lie within (x,y).

(b) A method to determine whether one line segment is disjoint from another, where two line segments are disjoint if they have no points in common.

(c) A method to find the smallest line segment which contains two given line segments.

Question 2 [4 marks]

Your friend claims that the method below always terminates and returns x * y, provided x and y are non-negative. Prove that your friend is either right or wrong. To do so, complete the specification below and use weakest precondition reasoning to show whether or not the implementation satisfies the specification.

If the implementation is not correct, explain the cases when it will fail to compute x * y.

```
method mult(x: int; y: int) returns (r: int)
        requires …
        ensures …
        decreases …
{
        if x < y {
                r := mult(y, x);
        } else if y !=0 {
                r := mult(x, y-1);
                r := r + x;
        } else {
                r := 0;
        }
}
```

Question 3 [2 marks]

A particular brand of breakfast cereal costs b dollars per box. In each box there is one token. For t tokens (where $t > 1$), you get a free box of cereal (also with a token in it). Write a method signature and specification that determines how many boxes of cereal you can get with m dollars taking into account free boxes you get with tokens. m, b and t should be input parameters to the method.

Marking

For all questions, you will receive marks for providing correct pre- and postconditions or parts thereof. There are no marks for the method signatures, but they **are required** to understand which variables are input and output parameters and what their types are.

For question 2, you will additionally receive marks for providing a correct termination metric, and weakest precondition proof.

A detailed breakdown of the marks is given below.

Q1(a)	precondition	0.5 marks
	postcondition	0.5 marks
Q1(b)	precondition	0.5 marks
	postcondition	0.5 marks
Q1(c)	precondition	0.5 marks
	postcondition	1.5 marks
Q2	precondition	0.5 marks
	postcondition	0.5 marks
	termination metric	0.5 marks
	weakest precondition proof [1]	2.5 marks
Q3	precondition	0.5 marks
	postcondition	1.5 marks

[1] Including explanation of program failure if necessary.

School Policy on Student Misconduct

This assignment is to be completed individually. You are required to read and understand the School Statement on Misconduct, available on the Schools website at: http://www.itee.uq.edu.au/itee-student-misconduct-including-plagiarism