CMPS 1600 Introduction to Computer Science II – Spring 14

3/1/14

# 6. Homework

Due **Friday 3/14/14** at the beginning of class.
(This is an entirely written homework.)

1. **Maximum (7 points)**

```
public static int myMax(int[] A){
  int maxValue = A[0];
  for(int i=1; i<A.length; i++){
    // Invariant
    if(A[i]>maxValue)
      maxValue=A[i];
  }
  return maxValue;
}
```

The goal of this exercise is to use a loop invariant to show that the code above correctly computes the maximum of the numbers in the input array. This is similar to the myMin method covered on the slides in class.

(a) (2 point) Give an output specification that describes that the code above computes the maximum of the numbers in the input array. Your output specification should be a logic formula. For easier notation you can use $n$ instead of A.length.

(b) (1 point) Derive a loop invariant from your output specification. Your loop invariant should use $i$ instead of $n$.

(c) Now, use the loop invariant to prove that the output specification is true (i.e., that the code correctly computes the maximum):

i. (1 point) Show the base case for the loop invariant, for $i = 1$.

ii. (2 points) Perform the inductive step: Assume the loop invariant is true for $i$, then perform one iteration of the loop, and now show that it is true for $i + 1$.

iii. (1 point) Now show how to draw the conclusion that after the loop the code returns the maximum of all numbers in the array.

2. **Reverse (3 points)**
Consider the problem of reversing an array of $n$ elements. What is the output specification for this problem?

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3. **Power (5 points)**

```
public static int power_of_two(int n){
  int power=1;
  for(int i=0; i<n; i++){
    // Invariant
    power = power*2;
  }
  return power;
}
```

Assume $n \geq 0$. The goal of this exercise is to use the loop invariant $power = 2^i$ to show that the code below correctly computes $2^n$.

(a) (1 point) Show the base case for the loop invariant, for $i = 0$.

(b) (2 points) Perform the inductive step: Assume $power = 2^i$ is true, then perform one iteration of the loop, and now show that $power = 2^{i+1}$ is true.

(c) (2 point) Now show how to draw the conclusion that the code returns $2^n$. What is the output specification?

4. **Array copy (5 points)**

(a) (2 points) Give code that copies the values of one array of integers into another array of integers.

(b) (2 points) Give the output specification.

(c) (1 point) What is the corresponding loop invariant? (You do not need to prove it.)