

CMSC 451 Homework 1

1. Consider the following iterative function:

```
int pentagonal(int n)
{
    int result = 0;
    for (int i = 1; i <= n; i++)
        result += 3 * i - 2;
    return result;
}
```

Rewrite the function `pentagonal` using recursion and add preconditions and postconditions as comments. Then prove by induction that the recursive function you wrote is correct.

2. Suppose the number of steps required in the worst case for two algorithms are as follows:

- Algorithm 1: $f(n) = 10n^2 + 6$
- Algorithm 2: $g(n) = 21n + 7$

Determine at what point algorithm 2 becomes more efficient than algorithm 1.

3. Given the following function that evaluates a polynomial whose coefficients are stored in an array:

```
double evaluate(double[] coefficients, double x)
{
    double result = coefficients[0];
    double power = 1;
    for (int i = 1; i < coefficients.length; i++)
    {
        power = power * x;
        result = result + coefficients[i] * power;
    }
    return result;
}
```

Let n be the length of the array. Determine the number of additions and multiplications that are performed in the worst case as a function of n .

4. Given the following recursive binary search algorithm for finding an element in a sorted array of integers:

```
int recursiveBinarySearch(int[] array, int target, int left, int right)
{
    if (left > right)
        return -1;
    int middle = (left + right) / 2;
    if (array[middle] == target)
```

```

    return middle;
    if (array[middle] > target)
        return recursiveBinarySearch(array, target, left, middle - 1);
    return recursiveBinarySearch(array, target, middle + 1, right);
}

```

Assume n is the length of the array. Find the initial condition and recurrence equation that expresses the execution time for the worst case of this algorithm and then solve that recurrence.

Grading Rubric

Problem	Meets	Does Not Meet
Problem 1	10 points	0 points
	Recursive version correctly written (3)	Recursive version not correctly written (0)
	Precondition is correct (1)	Precondition is not correct (0)
	Postcondition is correct (1)	Postcondition is not correct (0)
	Base case is correct (1)	Base case is not correct (0)
	Inductive case is correct (4)	Inductive case is not correct (0)
Problem 2	10 points	0 points
	Determined correct value for n (5)	Did not determine correct value for n (0)
	Show calculation for determining n (5)	Did not show calculation for determining n (0)
Problem 3	10 points	0 points
	Provided correct formulas for additions (5)	Did not provide correct formulas for additions (0)
	Provided correct formulas for multiplications (5)	Did not provide correct formulas for multiplications (0)
Problem 4	10 points	0 points
	Provided correct initial condition (2)	Did not provide correct initial condition (0)
	Provided correct recurrence equation (4)	Did not provide correct recurrence equation (0)
	Provided correct solution to recurrence equation (4)	Did not provide correct solution to recurrence equation (0)