**Johnny Nguyen – ECGR 3180**

Answer = **Bolded**

Q1. For each of the following 6 program fragments, give a Big-Oh analysis of the running time (3 points) –

( 1 )

sum = 0 ; // O(1)

f o r ( i = 0 ; i < n ; i++ ) // O(n)

++sum ; // O(1)

Ans: **O(n)**

(2) sum = 0 ;

f o r ( i = 0 ; i < n ; i++ )

f o r ( j = 0 ; j < n ; j++)

++sum ;

Ans: **O(n^2)**

(3) sum = 0 ;

f o r ( i = 0 ; i < n ; i++ )

f o r ( j = 0 ; j < n\*m ; j++) // n \* m 🡪 O(n^2)

++sum ;

Ans: **O(n^3)**

(4) sum = 0 ;

f o r ( i = 0 ; i < n ; i++ )

f o r ( j = 0 ; j < i ; j++)

++sum ;

Ans: **O(n^2)**

(5) sum = 0 ;

f o r ( i = 0 ; i < n ; i++ )

f o r ( j = 0 ; j < i\*i ; j++) // O(n^2)

for (k = 0; k < j; k++)

++sum;

Ans: **O(n^4)**

(6) sum = 0 ;

f o r ( i = 0 ; i < n ; i++ )

f o r ( j = 0 ; j < i\*i ; j++)

if (j % i == 0) // If necessary to have multiple execution. 🡪 O(n)

for (k = 0; k < j; k++)

++sum;

Ans: **O(n^4), if the if statement executes.**

Q2. Programs A and B are analyzed and found to have worst-case running times no greater than 150Nlog2N and N2 , respectively. Answer the following questions (3 points) -

a. Which program has the better guarantee on the running time for large values of N (N > 10,000)?

Ans: Ex. N = 2^14 = 16,384

150Nlog2N = 150 \* 2^14 \* 14 = 34,406,400

N^2 = 268,435,456

150Nlog2N < N^2 🡪 **150Nlog2N is optimal.**

b. Which program has the better guarantee on the running time for small values of N (N < 100)?

Ans: Ex. N = 2^7 = 128

150Nlog2N = 150\* 2^7 \* 7 = 134400

N^2 = 16384

N^2 < 150Nlog2N 🡪 **N^2 is more optimal.**

c. Which program will run faster on average for N = 1000?

Ans: 150Nlog2N = 1,494,868

N^2 = 1,000,000

N^2 < 150Nlog2Nv 🡪 **N^2 is more optimal.**

Q3. Q3. Solve the following recurrence relations using the Master theorem (2 points) -

a. T(n) = 3T(n/2) + n/2

b = 2, a = 3, d = 1 🡪 3 > 2^1 (Case 3)

Ans: O(n) = **O(n^(log23))**

b. T(n) = 4T(n/2) + n2.5

b = 2, a = 4, d = 2.5 🡪 4 < 2^2.5 (Case 2)

Ans: O(n) = **O(n^2.5)**

Q4. Analyze the run time complexity of the following algorithms (2 points)

a. Given an array (or string), the task is to reverse the array/string.

Algorithm -

1) Initialize start and end indexes as start = 0, end = n-1

2) In a loop, swap arr[start] with arr[end] and change start and end as follows : start = start +1, end = end – 1 3)

Repeat 2) while start < end

Ans: **O(n) because it will loop through indexes once.**

Q5. Given an array A[], the task is to segregate even and odd numbers. All even numbers should appear first, followed by odd numbers.

Algorithm -

1) Initialize two index variables left and right: left = 0, right = size -1

2) Keep incrementing left index until we see an odd number.

3) Keep decrementing right index until we see an even number.

4) Swap arr[left] and arr[right]

5) Repeat 2 - 4 while left < right

Ans: **O(n^2) loop through indexes twice.**