

## CS 302

### Homework, Asst. #02

Purpose: Learn concepts regarding algorithm analysis.

Due: Tuesday (9/09) → Must be submitted on-line before class.

Points: 85

### Assignment:

Answer the following questions.

- 1) Order the following functions by growth rate: (5 pts)

$$N, \sqrt{N}, N^{1.5}, N^2, N \log N$$

$$N \log \log N, N \log(N^2), \frac{2}{N}, 2^N, 2^{\frac{N}{2}}$$

$$37, N^2 \log N, N^3$$

Note, indicate when functions grow at the same rate.

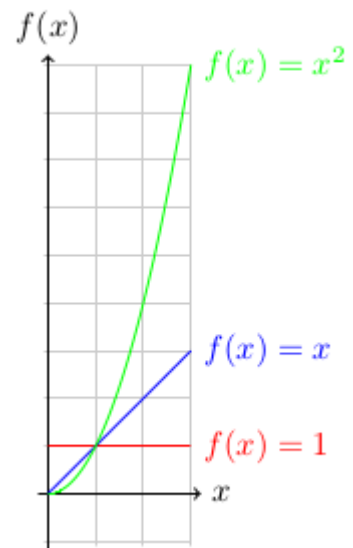
- 2) Provide a formal definition for each of the following: (10 pts)

$$\text{Big O} \rightarrow O(f(N))$$

$$\text{Big Omega} \rightarrow \Omega(g(N))$$

$$\text{Big Theta} \rightarrow \Theta(h(N))$$

$$\text{Little O} \rightarrow o(p(N))$$



- 3) Informally, explain the difference between *Big O* notation and *Big Theta* notations. (5 pts)
- 4) Suppose  $T_1(N) = O(f(N))$  and  $T_2(N) = O(f(N))$  which of the following are true. (10 pts)  
Note, if false, provide a counter example to explain your answer.
- a)  $T_1(N) + T_2(N) = O(f(N))$
  - b)  $T_1(N) - T_2(N) = o(f(N))$
  - c)  $\frac{T_1(N)}{T_2(N)} = O(1)$
  - d)  $T_1(N) = O(T_2(N))$

5) How much time is required to compute  $f(x) = \prod_{i=0}^{N-1} x^i$  ?

Respond with big O notation.

(5 pts)

- a) Using a simple routine to perform exponentiation.
- b) Using the more efficient exponentiation routine in Section 2.4.4 of the text.

6) Given a standard, correct binary search algorithm on a sorted array.

(15 pts, 5 pts each)

- a) What is the Big-O analysis of the running time for finding an element.
- b) Explain the answer for **a)**. including a comparison to a sequential search.
- c) Assuming the data structure used is a sorted linked list, what is the Big-O running time for inserting a new element in the sorted linked list.

7) For each of the following program fragments, provide a Big O analysis of the running time.

*Note*, assume that all arrays are appropriately declared and sized.

```
sum = 0;
for (int i=0; i<n; i++)
    sum += arr[i];
```

(5 pts)

```
sum = 0;
for (int i=0; i<n; i++)
    for (int j=0; j<n; j++)
        sum += arr[i][j];
```

(5 pts)

```
sum = 0;
for (int i=0; i<n; i++)
    for (int j=0; j<n*n; j++)
        sum += arr[i][j];
```

(5 pts)

```
sum = 0;
for (int i=0; i<n; i++)
    for (int j=0; j<i*i; j++)
        for (int k=0; k<j; k++)
            sum += arr[i][j][k];
```

(10 pts)

```
sum = 0;
for (int i=0; i<n; i++)
    for (int j=0; j<n*n; j++)
        if (j%i == 0)
            for (int k=0; k<j; k++)
                sum += arr[i][j][k];
```

(10 pts)

**Submission:**

When complete, submit:

- A copy of the answers. Must use “.odt”, “.doc”, “.txt”, “.rtf”, “.docx”, or “.pdf” format.

***Assignments received after the due date/time will not be accepted.***

You may re-submit as many times as desired. Each new submission will require you to remove (delete) the previous submission.