

## CSE 310 Recitation 2

### Objectives:

1. Review on Bubble sort and Binary search algorithm
2. Exercise on asymptotic upper bound (Big-O), lower bound (Big-Ω) and Big-Θ

### Instruction

1. For all recitation: the solution should be clearly typed or written and must be saved in .pdf or .jpg format. Note: unreadable answer receives no credits!
2. All recitation must be submitted through the link posted on Blackboard, we do NOT accept any hand-in submissions or submissions sent through emails!

### Question

1. [3 pts] For the following Bubblesort algorithm, how many times would the inner for loop iterate (give the closed form)? What is the worst-case running time of Bubblesort?

BUBBLESORT(A)

```

1  for i = 1 to A.length-1 - n times
2      for j = A.length downto i+1
3          if A[j] < A[j-1]
4              exchange A[j] with A[j-1]

```

} n times

$$n \sum_{i=1}^n (n-i) \Rightarrow O(n^2)$$

2. [2 pts] Give the Big-O (upper bound), Big-Ω and Big-Θ notation of the following functions.

a.  $f(n) = n + 5n^{0.5}$

$O(n)$   
 $\Omega(n)$   
 $\Theta(n)$

b.  $f(n) = 3n^2 + 5n + 1$

$O(n^2)$   
 $\Omega(n^2)$   
 $\Theta(n^2)$

3. [5 pts] For the following Binary search algorithm, write its recurrence equation and solve it by giving an asymptotic upper bound.

```

BINARYSEARCH(A, l, r, key)    //Array, left, right and the search key
1    if l <= r
2        m = (l + r) / 2
3        if A[m] == key
4            return m
5        else if A[m] < key
6            return BINARYSEARCH(A, m+1, r, key)    splits n/2
7        else
8            return BINARYSEARCH(A, l, m-1, key)    splits n/2

```

$$T(n) = T(n/2) + c_1$$

$T(n)$

"  $c_1$

$c_1$

0

$\sum_{i=1}^{\lg n}$

$c_0 \Rightarrow$

$O(\lg n)$

$+ T(n/2)$

"  $c_1$

$c_1$

1

$+ T(n/4)$

"  $c_1$

$c_1$

2

$+ T(n/8)$

$T(1)$

$c_1$

$\lg n$