CSE 3010 – Data Structures & Algorithms

Lecture #4

What will be covered today

- Understanding time complexity
- Differentiating best, average and worst case
- What is Big O notation

Running time of algorithms

- Time taken to execute the algorithm
- Known as **time complexity**

Easy to understand, code and debug the code	**Run as fast as possible resulting in efficient use of resources**

1. Program is run just a few times 2. Input size is small 3. Problem is simple	1. Program is run again and again 2. Input size is large 3. Problem is complex

Understanding run time of a program

Assume time taken is 1 second for every instruction

Code	Time Taken

```i = 1;```
```j = 1;```
```a = i + j;```
	4

```if (a == b)```
```   printf("Yes\n");```
```else```
```   printf("No\n");```
	2

```for (i = 0; i < 10; i++)``` ``` printf("%d\n", i+1);```	42

```for (i = 0; i < 10; i++)```
```   for (j = i; j < i; j++)```
```   printf("%d\n, j+1);```
	?

Best case – Average case – Worst case of an algorithm

Scenario	Definition	Example
Best case	• At least time • Minimum number of steps on input n • Algorithmic behavior in 'optimal' conditions	Element being searched is the first element in the list
Average case	• On average time • Average number of steps on input n	
Worst case	• At most time • Maximum number of steps on input n • Gives 'upper' bound on the time required by the algorithm	Element being searched is the last element in the list

Measuring time complexity of a program

- Depends on
    1. **<u>Input to the program</u>**
    2. Quality of code generated by the compiler
    3. Speed of instructions computer uses to execute the program

- Defined as a function of the input

```
Time complexity = Function of (input)
```

Measuring running time of a program

- Running time depends
    - <u>Not</u> on the exact input
    - <u>Only</u> on the size of the input
- Running time is specified as T(n)
- Growth rate of function is denoted using 'big o' as O
- Big O is the theoretical measure of the execution of an algorithm

    Example: $T(n) = O(n^2)$