Tutorial 2

DSA

Efficiency of Algorithms

Q1.) The time factor when determining the efficiency of algorithm is measured by:

1. Counting microseconds
2. Counting the no.of key operations
3. Counting the no. of statements
4. Counting the kilobytes of algorithm

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Q2.) Two main measures for the efficiency of algorithm are:

1. Processor and memory
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3. Time and Space

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Q3.) What is the time, space complexity of following code:

```
int a = 0, b = 0;
for (i = 0; i < N; i++) {
    a = a + rand();
}
for (j = 0; j < M; j++) {
    b = b + rand();
}
```

Q3.) What is the time, space complexity of following code:

```
int a = 0, b = 0;
for (i = 0; i < N; i++) {
    a = a + rand();
}
for (j = 0; j < M; j++) {
    b = b + rand();
}
```

O(N + M) time, O(1) space

Q4.) What is the time complexity of following code:

```
int a = 0;
for (i = 0; i < N; i++) {
    for (j = N; j > i; j--) {
        a = a + i + j;
    }
}
```

Q4.) What is the time complexity of following code:

```
int a = 0;
for (i = 0; i < N; i++) {
    for (j = N; j > i; j--) {
        a = a + i + j;
    }
}
```

code runs total no of times
= N + (N – 1) + (N – 2) + … 1 + 0
= N * (N + 1) / 2
= 1/2 * N^2 + 1/2 * N
O(N^2) times.

Q5.) What is the time complexity of following code:

```
int a = 0, i = N;
while (i > 0) {
    a += i;
    i /= 2;
}
```

Q5.) What is the time complexity of following code:

```
int a = 0, i = N;
while (i > 0) {
    a += i;
    i /= 2;
}
```

O(log N)

Q6. What is the time complexity of fun()?

```
int fun(int n) {
    for (int i = 1; i <= n; i++) {
        for (int j = 1; j < n; j += i)  {
            // Some O(1) task
        }
     }
}
```

https://www.geeksforgeeks.org/interesting-time-complexity-question/

Harmonic Series:

$$\sum_{k=1}^{n} \frac{1}{k} = 1 + \frac{1}{2} + \ldots + \frac{1}{n} \approx \ln n$$

Source: Lecture slides

Ans. 6) Time complexity of fun()

For i = 1, the inner loop is executed n times.

For i = 2, the inner loop is executed approximately n/2 times.

For i = 3, the inner loop is executed approximately n/3 times.

For i = 4, the inner loop is executed approximately n/4 times.

…….

…….

For i = n, the inner loop is executed approximately n/n times.

Ans. 6) Time complexity of fun()

The total time complexity of the above algorithm is (n + n/2 + n/3 + … + n/n)

= n * (1/1 + 1/2 + 1/3 + … + 1/n)

[Recall the complexity of harmonic series]

Hence, the time complexity of fun is O(nLogn)

Q7.) Find the time complexity of demo()

```
void demo()

{

   int i, j;

   for (i=1; i<=n; i++)

      for (j=1; j<=log(i); j++)

         printf("Hello World");

}
```

Ans 7.) Time complexity of demo()

$\Theta(\log 1) + \Theta(\log 2) + \Theta(\log 3) + \ldots + \Theta(\log n)$

$= \Theta(\log n!)$

$= \Theta(n \log n)$

Questions???