

# 1 Introduction to Algorithms

An algorithm is a sequence of unambiguous instructions for solving a problem i.e. for obtaining a required output for any legitimate(valid) input in finite time.

## 1.1 Performance/Analysis of Algorithms

It refers to the memory and time representation of the program.

Methods of Analysis:

- Analytical
- Experimental

Any algorithm is analysed on the following criteria:

- Space Complexity
- Time Complexity

### 1.1.1 Space Complexity

It is the amount of memory required for a program to completion. It has 3 categories:

- Instruction Space (Compiled Program)
- Data Space (Space needed by var/const)
- Environment Stack Space (Recursive calls)

Denoted by: $C + S_p$
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## Sample Questions

### 1. Sum of array without recursion

```
int sum(int a[],int n)      1
{                             2
    int sum = 0;            3
    for(int i = 0;i < n;i++) 4
        sum = sum + a[i];    5
    return sum;              6
}                             7
```

Space Complexity:  $6x$  bytes<sup>a</sup>

Reason: Line 1 occupies  $x$  bytes for pointer  $a$  and  $x$  bytes for integer  $n$ . Line 3 occupies  $x$  bytes for  $sum$  and  $x$  bytes for allocating 0. Line 4 will occupy  $x$  bytes for allocating integer  $i$ . In Line 6 space will reserved for returning data.

<sup>a</sup>where  $x$  is bytes occupied by int

### 2. Sum of array with recursion

```
int sum(int a[],int n)      1
{                             2
    if(n > 0)                 3
        return sum(a,n-1) + a[n-1]; 4
    return 0;                 5
}                             6
```

Space Complexity:  $3x \times (n + 1)$  bytes<sup>a</sup>

Reason: Line 1 occupies  $x$  bytes for pointer  $a$  and  $x$  bytes for integer  $n$ . Line 4 will execute  $n$  times and each time space is reserved for pointer  $a$  and  $n - 1$  thus giving  $3x \times n$ . During the last case of  $n = 0$ , Line 5 will be executed returning 0 thus occupying  $x$  bytes.

<sup>a</sup>where  $x$  is bytes occupied by int and  $n$  is the size of array