

What is an algorithm?

Definition: An algorithm is a finite set of instructions that, if followed, accomplishes a particular task or solves a problem.

→ A program is the expression of an algorithm in a programming language.

→ All algorithms must satisfy the following criteria.

Characteristics or properties of an algorithm:

① Input: zero or more quantities are externally supplied as input.

→ There may be some algorithms which do not take any input, but give an output.

Eg: Program (algorithm) that displays "Hello world" message.

② Output: At least one quantity must be produced as output.

③ Definiteness : Each instruction is clear and unambiguous.

→ Each operation must be definite, meaning that it must be perfectly clear what should be done.

→ The following type of instructions should not be present in an algorithm.

"add 6 or 7 to x" or

"compute 5%"

It is not clear which of the two possibilities should be done or what the result is.

④ Finiteness :- If we trace out the instructions of an algorithm, then for all cases, the algorithm must terminate after a finite no. of steps. It should not go into an infinite loop.

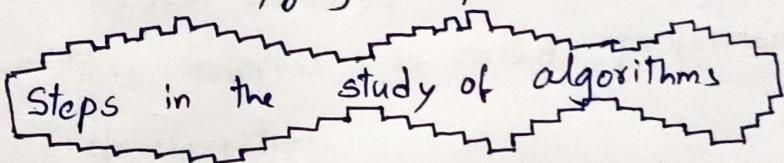
⑤ Effectiveness :- Every instruction must be very basic (not complex), so that it can be carried out, in principle, by a person using only pencil & paper.

- Algorithms That are definite and effective are also called as computational procedures (functions).
- We consider only computational procedures that always terminate

### Applications of algorithms:

Now a days algorithms (programs) are being used in every field.

- 1) computer science
- 2) operations research.
- 3) For analyzing complex electrical circuits

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Steps in the study of algorithms

### How to design algorithms:

For a given problem how to design an algorithm.

For different problem, there are different

problem solving methods or algorithm design techniques. For example

- ① Divide and conquer technique
- ② Backtracking method
- ③ Dynamic programming technique.

4) Greedy method

5) Branch - and - Bound method.

## 2) How to Validate algorithms:-

Once an algorithm is designed, it is necessary to show that it computes the correct answer for all possible inputs.

## 3) How to analyze algorithms:-

- If there are 2 or more algorithms to solve a problem, we select the best algorithm that requires minimum CPU time and system memory.
- This process is called performance analysis of algorithms.

## 4) How to Test a program:-

After selecting the best algorithm, we will write the program in a programming language.

Program testing consists of 2 phases.

Debugging is the process of executing a program on sample input data sets to determine whether any faulty results occur and if so correct them.

Performance measurement: It is the process of executing a correct program on input data-sets and measuring the CPU time and system memory, <sup>p</sup>it takes to compute the results.

- The performance of an algorithm is estimated in terms of its time complexity and space complexity.

## Algorithm Specification:-

We can describe an algorithm in many ways.

- 1) We can use ENGLISH language like statements
- 2) Graphics representations called flowcharts are another possibility, but they work well only if the algorithm is small & simple.

→ We present most of our algorithms by using a pseudo code that resembles C and Pascal language code.

Pseudo - code conventions for expressing algorithms:-

```
while <condition> do
{
    <statement 1>
    :
    <statement n>
}
```

```
for i:=1 to n do
begin
    Block of one or more statements
end;
```

if (condition) then

<statement>

if (condition) then

<statement 1>

else

<statement 2>

## Performance Analysis of an Algorithm:-

There are many criteria upon which we can judge an algorithm.

- 1) Does it do what we want it to do?
- 2) Does it work correctly according to the original specifications of the task?
- 3) Is there documentation that describes how to use it and how it works?
- 4) Are procedures created in such a way that they perform logical subfunctions?
- 5) Is the code readable?  
Can any other person read and understand your code easily?

→ Apart from these there are 2 main criteria for judging the performance of an algorithm.

They are :

- (i) space complexity
- (ii) Time complexity

Space complexity of an algorithm (program)

is the amount of computer memory

it (the algorithm) needs to run to completion.

Time complexity of an algorithm is the

amount of computer ~~(CPU)~~ time the algorithm

needs to run to completion.