Data Structures & Algorithm
Course Code: 71203002002

Basics of Algorithm

Foundation of Problem
Solving in Computer Science
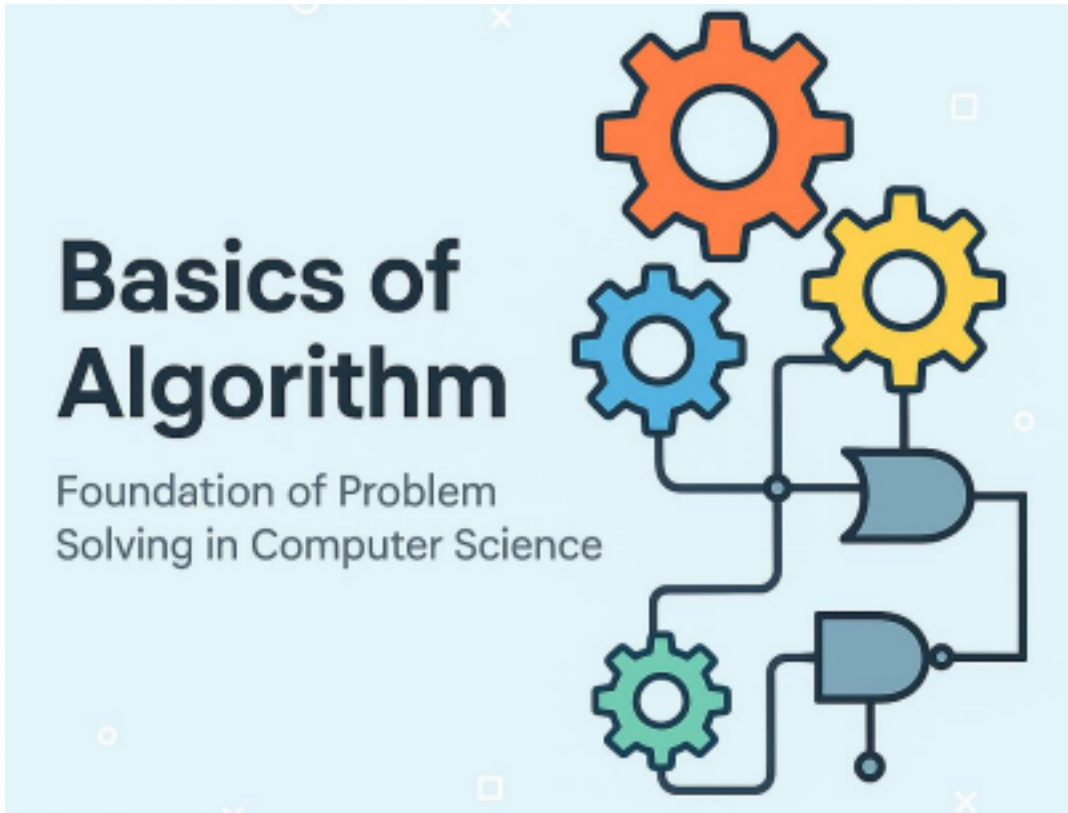
"An algorithm is a finite, ordered sequence of unambiguous instructions that solves a problem or performs a computation."

Breakdown of definition:
Finite: It must terminate after a limited number of steps.
Ordered: Steps follow a logical sequence.
Unambiguous: Instructions are clear and precise.
Effective: It must be practically implementable.

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Example: "Make a cup of tea" is an algorithm:

Step1: Boil water

Step2: Add tea leaves

Step3: Pour water

Step4: Add milk/sugar

Step5: Serve

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Importance of Algorithms

Content:

1. Essential for solving problems efficiently

2. Central to computer science, AI, data processing, networking

3. Key to writing optimized code

4. Help improve **speed**, **memory usage**, and **scalability**

Example Use-Cases:

1. Google Search uses ranking and indexing algorithms

2. Navigation apps use path-finding algorithms

3. E-commerce uses recommendation algorithms

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Examples:

Cooking recipe (sequence of instructions)
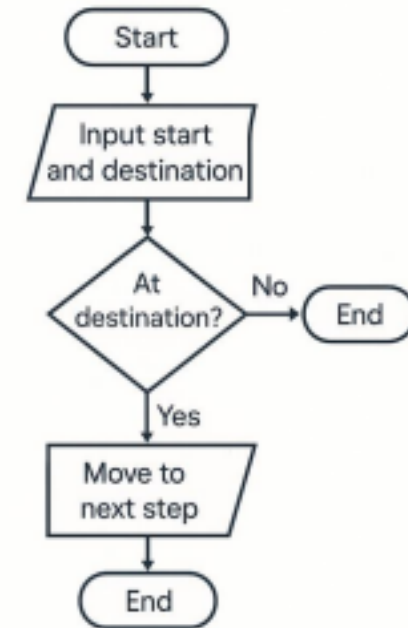
Traffic light system (time-based conditional logic)

Boarding an airplane (priority queue system)

Google Maps (shortest path algorithm: Dijkstra's or A*)

Cooking Recipe

Start → Boil water → Add tea leaves → Pour water → Add milk/sugar → Serve

Navigation Algorithm

Start → Input start and destination → At destination? — No → End / Yes → Move to next step → End

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Use a table or checklist format:

Property	Description
Input	Accepts zero or more inputs
Output	Produces at least one output
Finiteness	Terminates after a finite number of steps
Definiteness	Each step is unambiguous and precise
Effectiveness	Steps can be performed using basic operations

These properties ensure the process is computable, understandable, and solvable. If a procedure lacks one of these, it's not a valid algorithm.

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Pseudocode Example:

Algorithm FindMax(A[1..n]): 1. max ←
A[1]

2. for i = 2 to n do

3. if A[i] > max then 4. max ← A[i]

5. return max

Advantages of Pseudocode:

•No language-specific syntax •Focuses on logic, not implementation •Easy to translate into any programming language

Pseudocode is like writing the algorithm in structured English. It lets us focus on the logic before thinking about how to implement it in code.

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UNIVERSITY **Unitedworld Institute of Technology** **Algorithm Representation - Flowchart**

Start → Input → Initialize max → Loop (i = 2 to n) → Compare A[i] to max → Update max → End

Symbols Used:

Rectangle = Process

Parallelogram = Input / Output

Diamond = Decision

Arrow = Flow

Flowcharts give a visual structure to logic. They're helpful for planning and debugging, especially when working in teams.

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Aspect	Algorithm	Program
Nature	Logical steps	Actual implementation
Syntax rules	No strict rules	Follows language syntax
Execution	Abstract idea	Executes on a machine
Language	Language-independent	Language-specific (e.g., Python, C++)
Output	Describes what to achieve	Actually produces output

An algorithm is the blueprint. A program is the building. The same algorithm can be implemented in multiple programming languages.

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By Technique:

Divide and Conquer – e.g., Merge Sort **Greedy** – e.g., Huffman Encoding

Dynamic Programming – e.g., Longest Common Subsequence

Backtracking – e.g., N-Queens problem **Brute Force** – e.g., Checking all permutations

By Purpose:

Sorting (Quick Sort) Searching (Binary Search) Graph (Dijkstra)

Cryptography (RSA) Compression (Huffman)

Classifying algorithms helps us choose the right strategy. Each design paradigm has its strengths depending on the problem type.

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Unitedworld Institute of Technology **Example: Linear Search Algorithm**

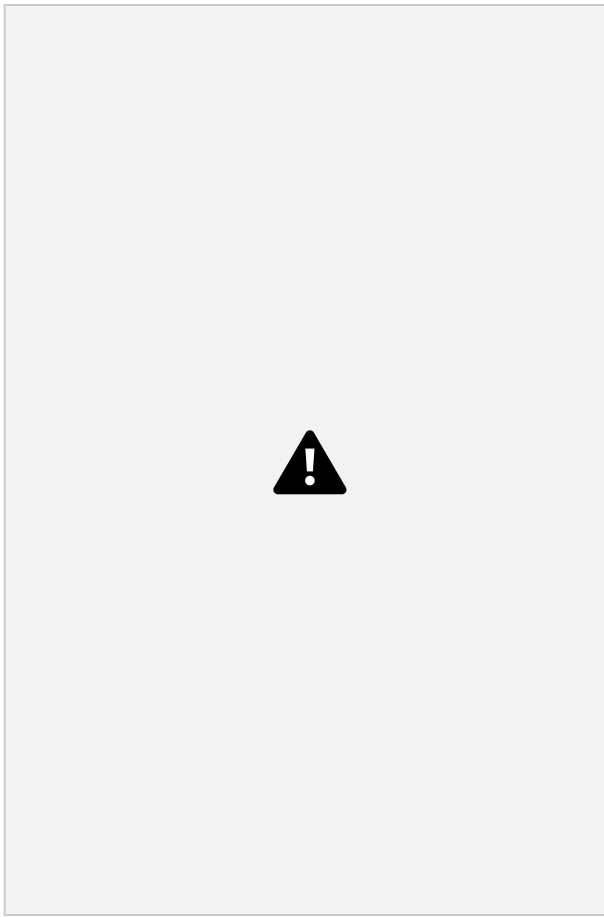**Pseudocode:**

Input: List A of n elements, target value x
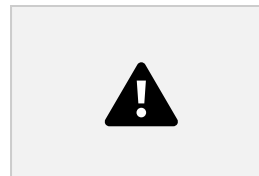1. for i from 0 to n-1
2. if A[i] == x
3. return i
4. return -1

Time Complexity: O(n)

Flowchart:

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Bullet Points:

1. Algorithms solve problems in a structured, logical way.

2. Must have input, output, definiteness, finiteness, effectiveness.

3. Represented using pseudocode or flowcharts.

4. Algorithms are not the same as programs.

5. Many categories and real-world applications.

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