Introduction to Algorithms

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Lets understand Algorithms

Informally, an algorithm is any well-defined computational procedure that takes some value, or set of values, as input and produces some value, or set of values, as output. An algorithm is thus a sequence of computational steps that transform the input into the output.

We can also view an algorithm as a tool for solving a well-specified computational problem. The statement of the problem specifies in general terms the desired input/output relationship. The algorithm describes a specific computational procedure for achieving that input/output relationship.

Example 1: Write an algorithm to bake a cake

Step 1: Preheat the oven

Step 2: Gather the ingredients

Step 3: Measure out the ingredients

Step 4: Mix together the ingredients to make the batter

Step 5: Grease a pan

Step 6: Pour the batter into the pan

Step 7: Put the pan in the oven

Step 8: Set a timer

Step 9: When the timer goes off, take the pan out of the oven

Example 2: Write an algorithm to print 1 - 10 numbers

Step 1: Start

Step 2: Initialize variable K to 1, K=1

Step 3: Output K

Step 4: Increment K by 1

Step 4: Check if the value of K is less than or equal to 10.

Step5: IF K<=10 THEN GOTO Step 3 else GOTO Step 6

Step 6: Stop

Real-life problems solved using algorithms:

1. Problem 1 - Electronic commerce enables goods and services to be negotiated and exchanged electronically, and it depends on the privacy of personal information such as credit card numbers, passwords, and bank statements. The core technologies used in electronic commerce include public-key cryptography and digital signatures (covered in Chapter 31), which are based on numerical algorithms and number theory.

2. Problem 2 - We are given a road map on which the distance between each pair of adjacent intersections is marked, and we wish to determine the shortest route from one intersection to another. The number of possible routes can be huge, even if we disallow routes that cross over themselves. How do we choose which of all possible routes is the

shortest? Here, we model the road map (which is itself a model of the actual roads) as a graph, and we wish to find the shortest path from one vertex to another in the graph.

Types of Algorithms

Algorithms are classified based on the concepts that they use to accomplish a task. While there are many types of algorithms, the most fundamental types of computer science algorithms are:

1. **Divide and conquer algorithms** – divide the problem into smaller subproblems of the same type; solve those smaller problems, and combine those solutions to solve the original problem.
2. **Brute force algorithms** – try all possible solutions until a satisfactory solution is found.
3. **Randomized algorithms** – use a random number at least once during the computation to find a solution to the problem.
4. **Greedy algorithms** – find an optimal solution at the local level with the intent of finding an optimal solution for the whole problem.
5. **Recursive algorithms** – solve the lowest and simplest version of a problem to then solve increasingly larger versions of the problem until the solution to the original problem is found.
6. **Backtracking algorithms** – divide the problem into subproblems, each which can be attempted to be solved; however, if the desired solution is not reached, move backwards in the problem until a path is found that moves it forward.
7. **Dynamic programming algorithms** – break a complex problem into a collection of simpler subproblems, then solve each of those subproblems only once, storing their solution for future use instead of re-computing their solutions.