

Problem Solving Process

Computers are primarily meant for solving complex, large scale problems. These computational problems could arise in any discipline — physics, chemistry, mathematics, biology, materials science, environmental science, engineering, social sciences, etc.

1. Examples of typical problems

- Designing and implementing a web search engine

- The primary operation here is to search for keywords in millions of documents
- The challenge is to complete the task in milliseconds, wading through a huge number of crawled documents

• Sorting a database of records based on a key

- for example, sorting the collection of more than 1 million records of AIEEE candidates based on their All India Rank

• Simulation of ~~s~~ models of systems and processes to predict their behaviour

- for example, simulating the traffic flow at bottleneck junctions in order to design better scheduling policies to smoothen the traffic

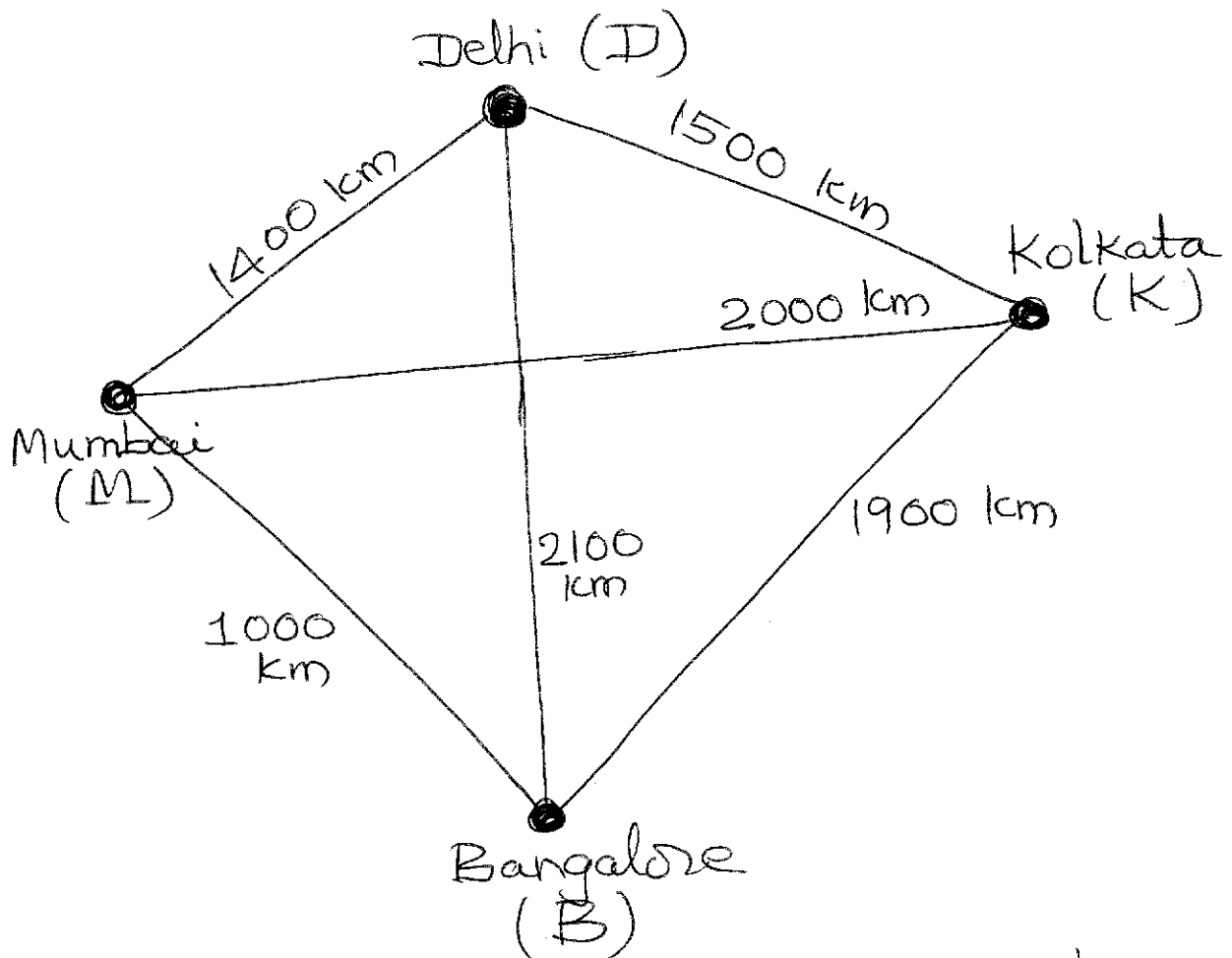
- Simulating air traffic at busy airports to reduce time ~~the~~ delays and improve resource utilization

- Simulate the dynamics of neural networks to obtain a deeper understanding of functioning of brain

- etc.

- Solve computationally challenging problems such as the Travelling Salesman Problem.

Given an undirected graph of n cities and inter-city distances, find a Hamiltonian cycle (a path that starts from a given city, visits every city exactly once, and returns to the original city) with minimum total distance travelled.



Three Hamiltonian cycles are possible:

B — D — K — M — B	(6600 km)
B — D — M — K — B	(7400 km)
B — M — D — K — B	(5800 km)

The problem looks deceptively simple, but is in fact one of the hardest problems to solve. The main reason for this is the number of Hamiltonian cycles in a complete undirected graph with "n" cities is equal to

$$\frac{(n-1)!}{2}$$

which grows exponentially with "n."

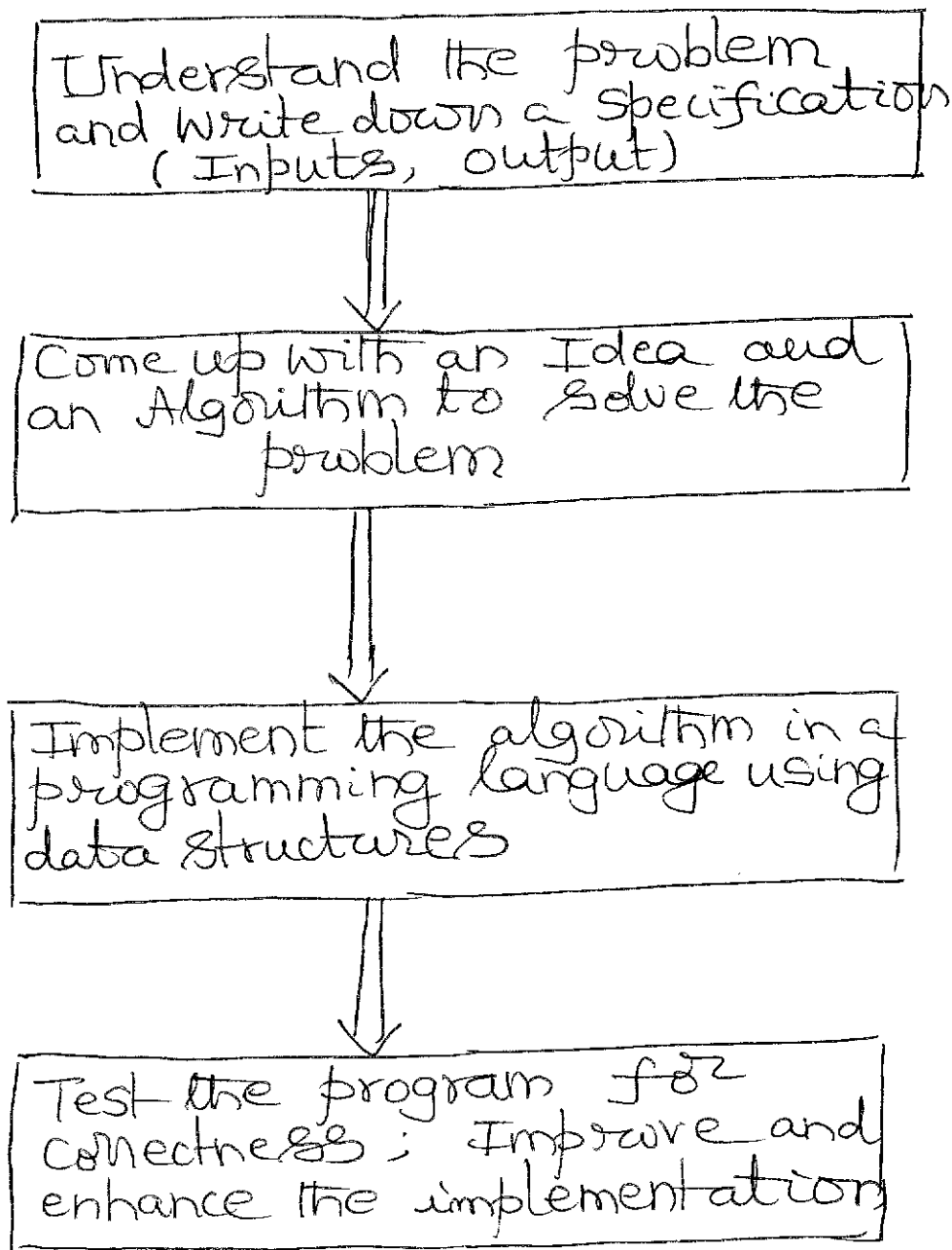
Numerous interesting algorithms have been proposed and improved for the travelling salesman problem and hundreds of research papers have been written on this problem.

Searching, sorting, simulation, and TSP are only four typical examples of problems that can be solved by computers.

Computers have been used for solving a wide variety of such challenging problems

2. Problem Solving Process

The following picture summarizes the various steps in the problem solving process.



This course deals with all the above aspects with emphasis on Algorithms and Programming. "Algorithms" will be covered in the theory classes and "Programming" will be the main activity in the labs.