➢ **What is a graph?**

A graph, in the context of graph theory, is a structured datatype that has nodes (entities that hold information) and edges (connections between nodes that can also hold information). A graph is a way of structuring data, but can be a datapoint itself. Graphs are a type of Non-Euclidean data, which means they exist in 3D, unlike other datatypes like images, text, and audio.

➢ **Graph Theory in AI**

It is briefly the study of network graphs, which are mathematical representations used to model pairwise relations between objects.
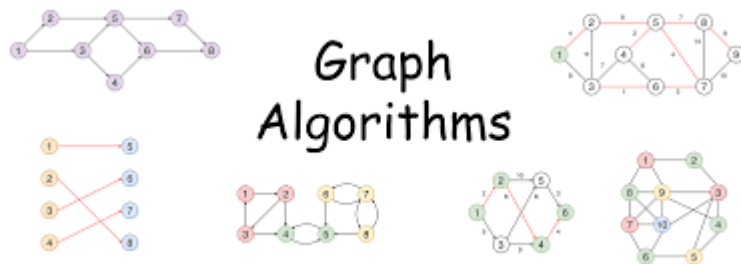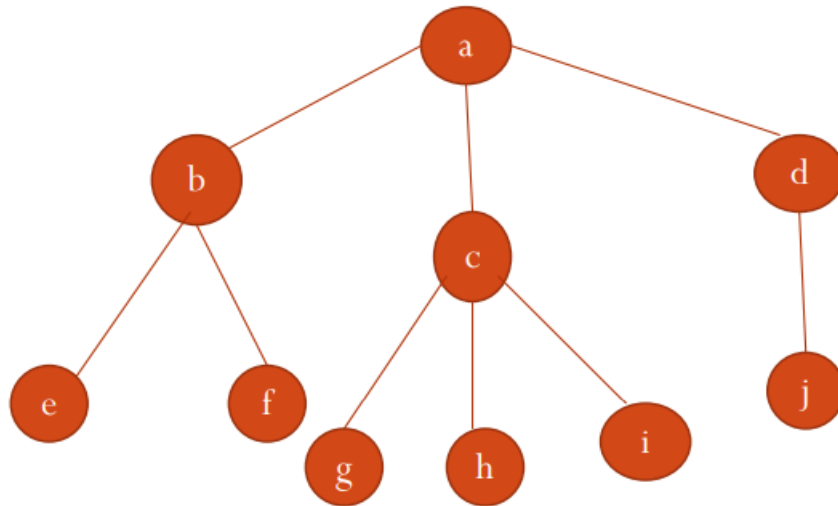

Graph Theory:- A graph consists of a set of a nodes and a set of arcs or links connecting pairs of nodes. The domain of state space search, the nodes are interpreted to be stated in problem solving process, and the arcs are taken to be transitions between states.

Graph Theory
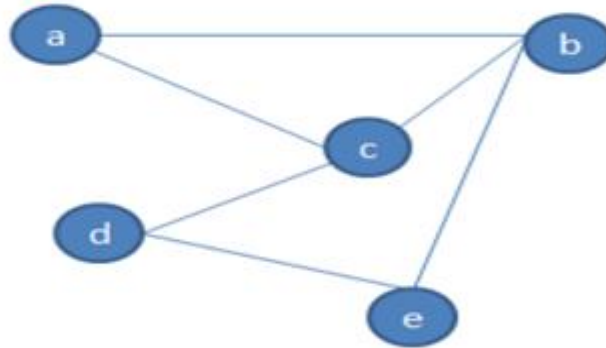
Nodes={a,b,c,d,e}
Arcs={(a,b), (a,c),(b,c),(b,e),(d,e),(d,c),(e,d)}

Nodes={a,b,c,d,e,f,g,h,i,j}
Arcs={(a,b),(a,c),(a,d),(b,e),(b,f),(c,g),(c,h),(c,i),(d,j)}

State Space Representation

A state space is represented by four tuple [N,A,S,GD], where:-

- **N** is a set of nodes or states of the graph. These correspond to the states in a problem –solving process.
- **A** is the set of arcs between the nodes. These correspond to the steps in a problem –solving process.
- **S** a nonempty subset of N , contains the start state of the problem.

- **G** a nonempty subset of N contains the goal state of the problem.

- **A solution path:- Is a path through this graph from a node S to a node in GD.**

  ➢ Graph Features

    - Graphs can have labels on their edges and/or nodes.

    - Labels can also be considered weights.

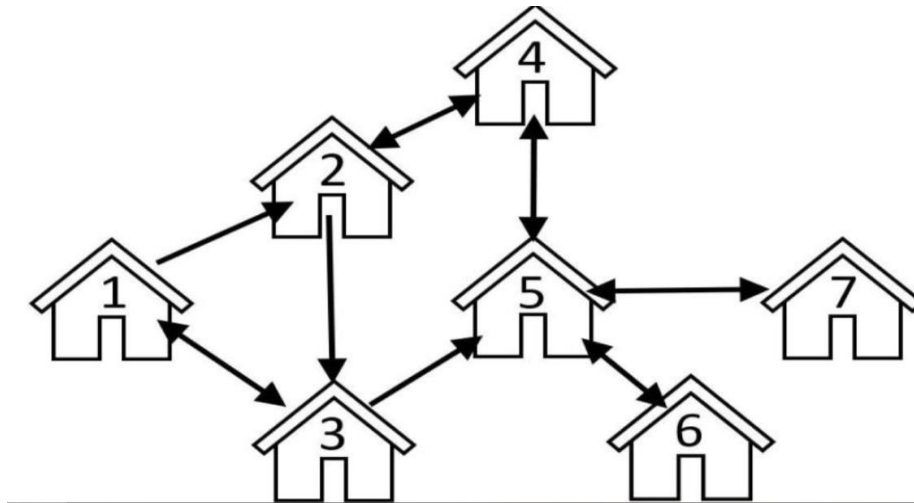   - Graphs can be directed or undirected.

Directed Graph   Undirected Graph
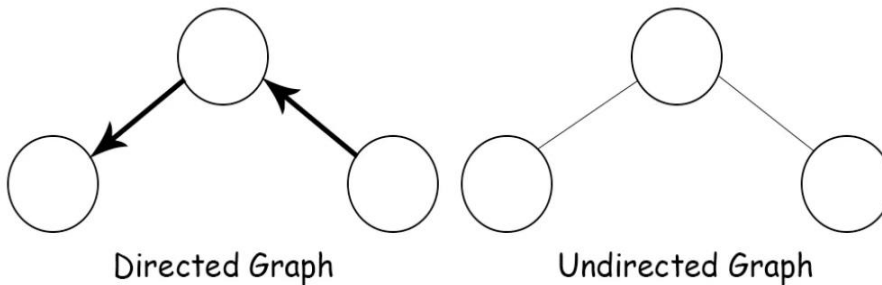
    - A node in the graph can even have an edge that points/connects to itself. This is known as a self-loop.
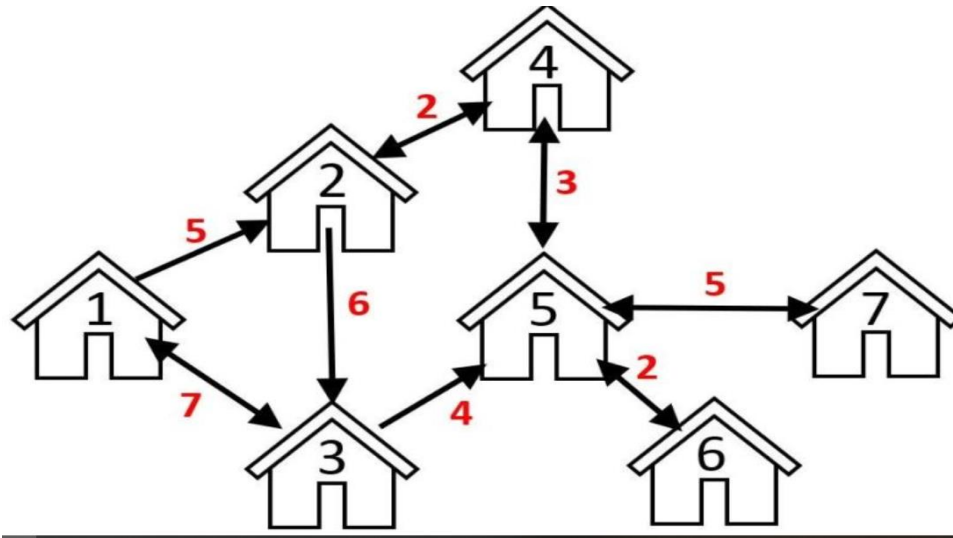
THREE TYPES OF GRAPHS TO KNOW IN GRAPH THEORY

Undirected graphs: All paths between each node are bidirectional.
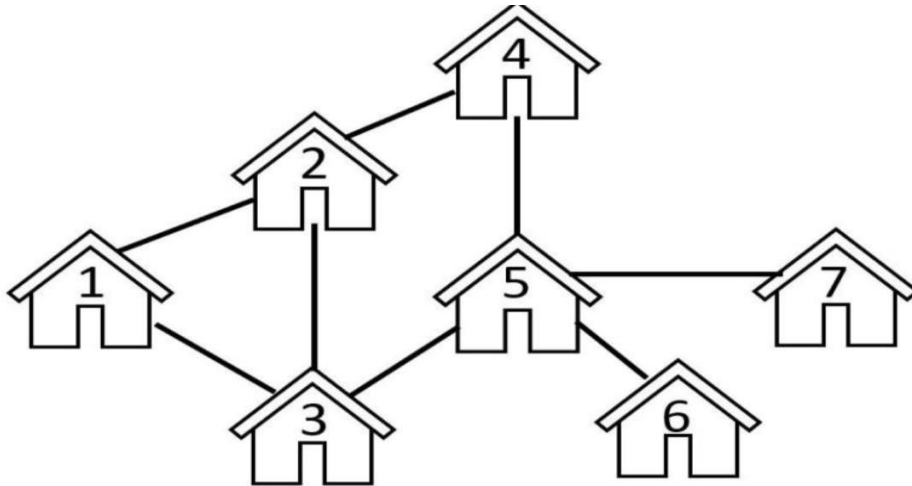
Directed graphs : Paths between the nodes have specified directions.

Weighted graphs: The paths between each node have specified directions and weights to indicate distance.

Travelling salesman problem TSP

is an algorithmic problem tasked with finding the shortest route between a set of points and locations that must be visited.

Given a set of cities and distances between every pair of cities, the problem is to find the shortest possible route that visits every city exactly once and returns to the starting point.

For example: consider the graph shown in the figure on the right side.
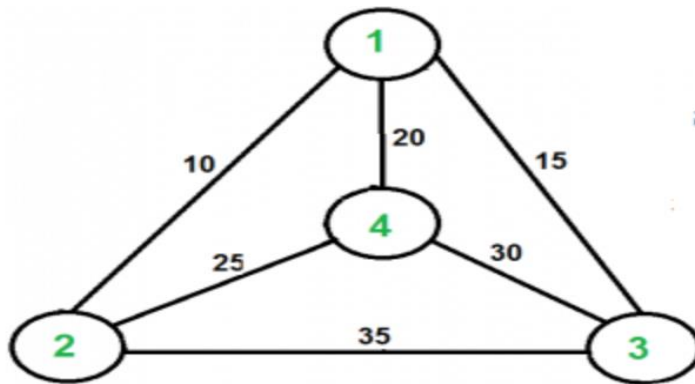
1- Consider city 1 as the starting and ending point.

2- Generate all (n-1)! permutations of cities

3- Calculate the cost of every permutation and keep track of the minimum cost permutation.

4- Return the permutation with minimum cost.

A TSP tour in the graph is 1-2-4-3-1. The cost of the tour is 10+25+30+15 which is 80.

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Output of Given Graph:
minimum weight Hamiltonian Cycle :
10 + 25 + 30 + 15 := 80
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