



Backtracking

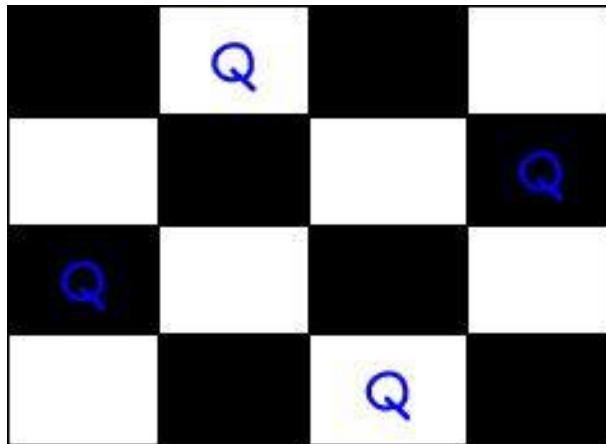
Backtracking is a technique of designing algorithms to solve various problems. In backtracking, the algorithm tries to find a sequence path to the solution which has some small checkpoints from where the problem can backtrack if no feasible solution is found for the problem.

Backtracking algorithm is applied to some specific types of problems,

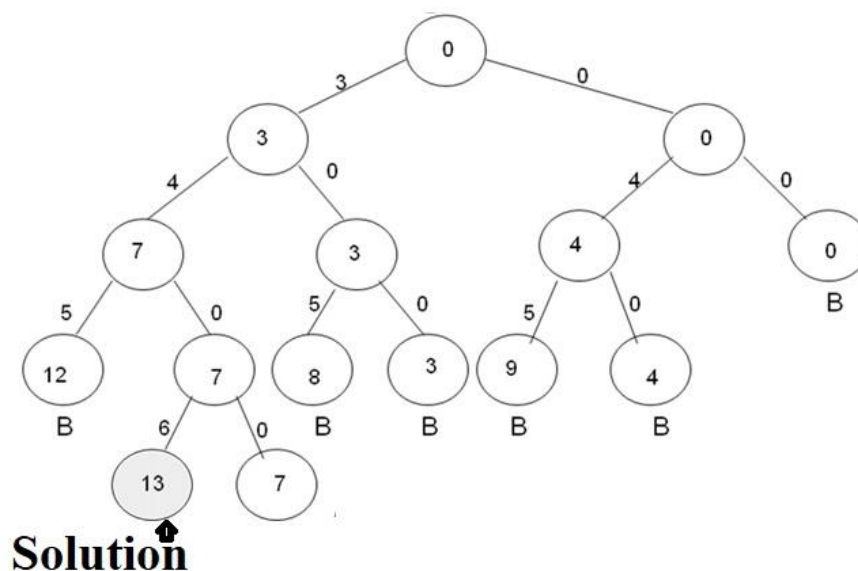
- Decision problem used to find a feasible solution of the problem.
- Optimization problem used to find the best solution that can be applied.
- Enumeration problem used to find the set of all feasible solutions of the problem

N-Queen Problem

In N-Queen problem, we are given an $N \times N$ chessboard and we have to place n queens on the board in such a way that no two queens attack each other. A queen will attack another queen if it is placed in horizontal, vertical or diagonal points in its way. Following is the solution to 4-Queen problem-



For solving n -queen problem, we will try placing queen into different positions of one row and check if it clashes with other queens. In current positioning of queens, if there are any two queens attacking each other, we will backtrack to previous location of the queen and change its positions. And check clash of queen again. This process is repeated to find the solution to the problem. Following is state space tree for 4-Queen problem-



Knapsack Problem

You are given the following-

- A knapsack (kind of shoulder bag) with limited weight capacity.
- Few items where each item having some weight and value.

The Knapsack problem states that-

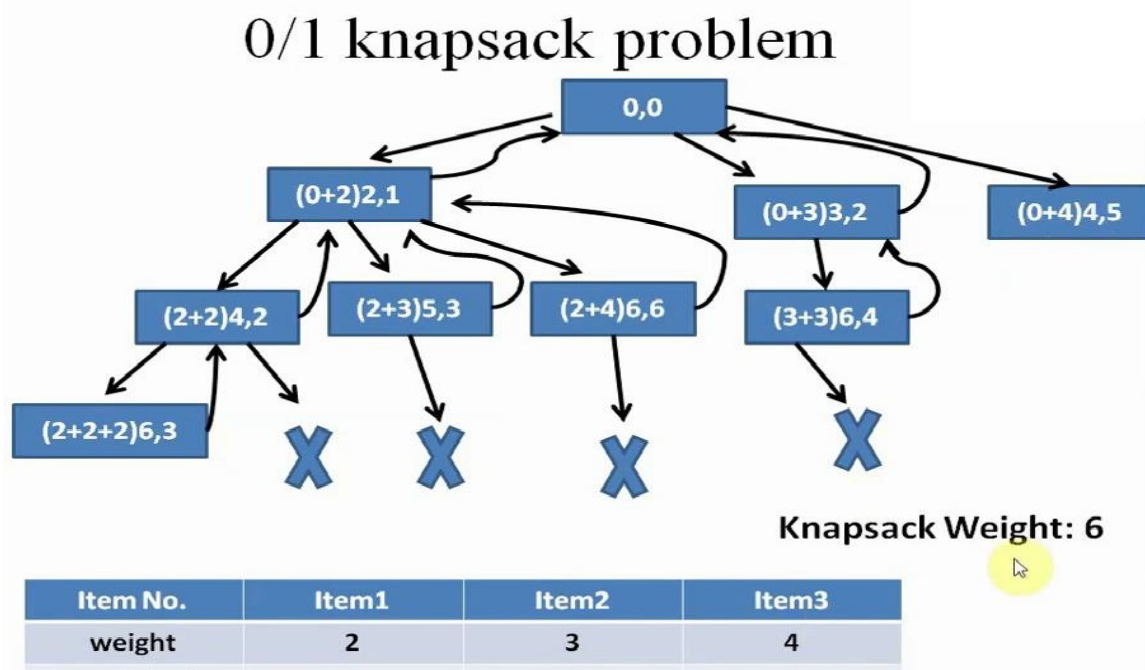
Which items should be placed into the knapsack such that-

- The value or profit obtained by putting the items into the knapsack is maximum.
- And the weight limit of the knapsack does not exceed.

0/1 Knapsack Problem-

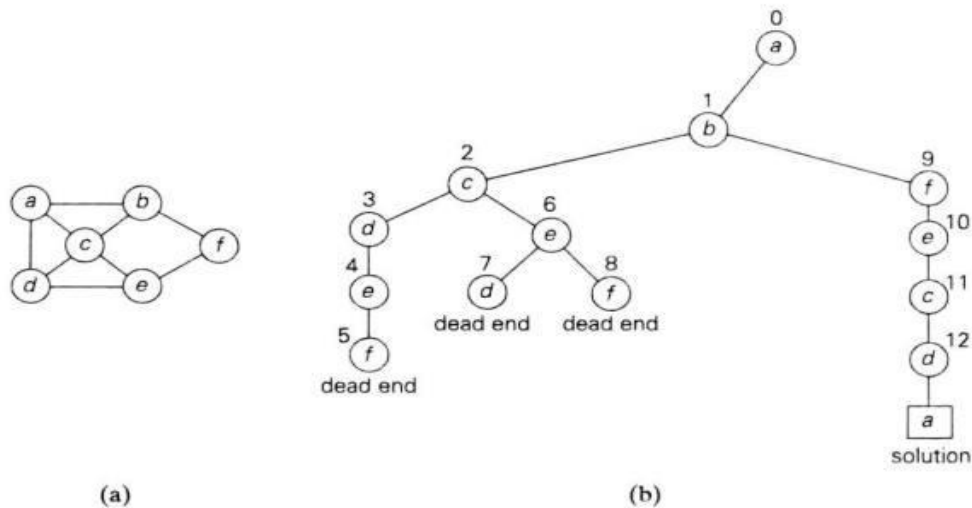
In 0/1 Knapsack Problem,

- As the name suggests, items are indivisible here.
- We cannot take the fraction of any item.
- We have to either take an item completely or leave it completely.
- It is solved using dynamic programming approach and backtracking approach.



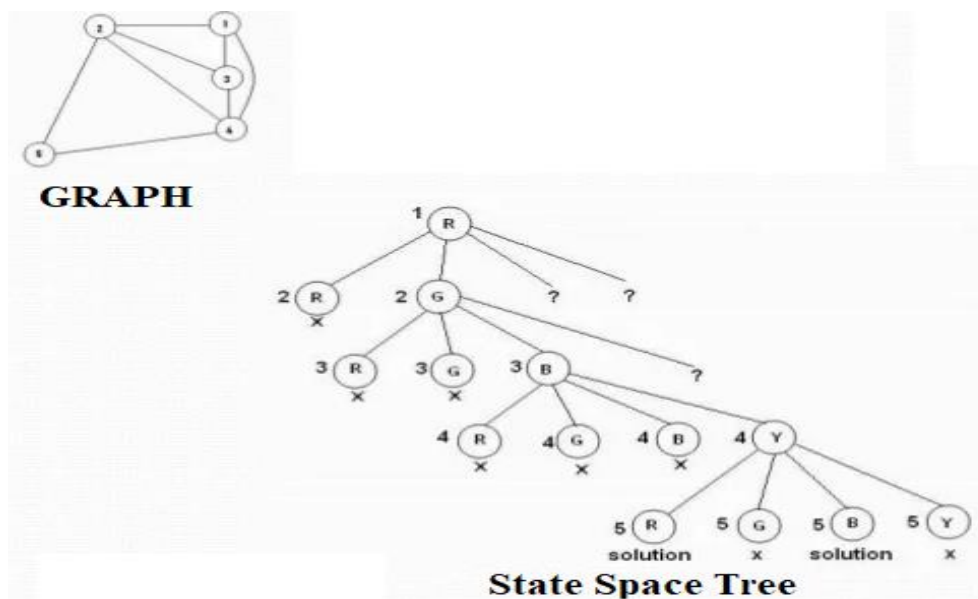
Hamiltonian Cycle Problem

Hamiltonian Path in an undirected graph is a path that visits each vertex exactly once. A Hamiltonian cycle (or Hamiltonian circuit) is a Hamiltonian Path such that there is an edge (in the graph) from the last vertex to the first vertex of the Hamiltonian Path. ***Hamiltonian Cycle problem is to determine whether a given graph contains Hamiltonian Cycle or not. If it contains, then print the path.*** Following are the input and output of the required function.



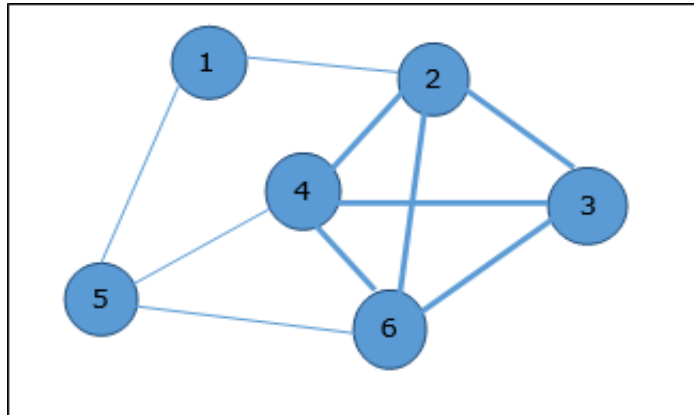
Graph Coloring Problem

We have been given a graph and we are asked to color all vertices with the 'M' number of given colors, in such a way that no two adjacent vertices should have the same color.



Clique Problem

A Clique is a subgraph of graph such that all vertices in subgraph are completely connected with each other. Take a look at the following graph. Here, the sub-graph containing vertices 2, 3, 4 and 6 forms a complete graph. Hence, this sub-graph is a **clique**. As this is the maximum complete sub-graph of the provided graph, it's a **4-Clique**.



Clique problem is of two types:

1. **Decision Problem:** To check whether a clique of given size exists in the given graph or not.
2. **Optimization Problem:** To find the cliques of maximum size in a given graph.

Solution to both of these clique problems belongs to NP-Complete category.