DEFINING THE PROBLEM AS STATE SPACE

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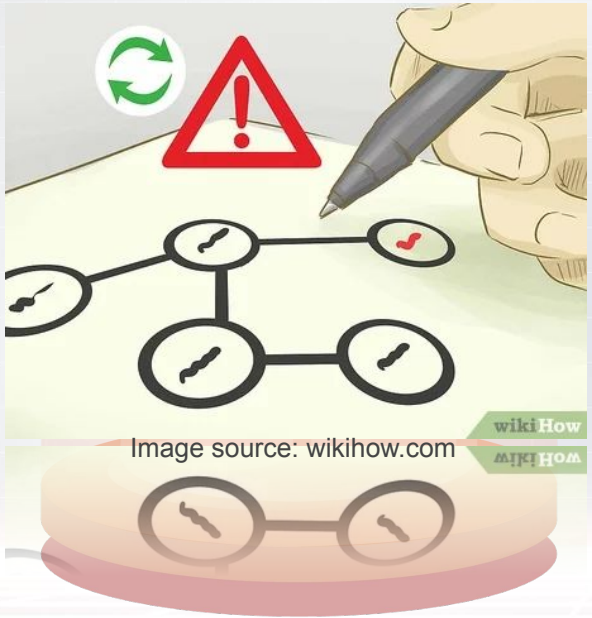

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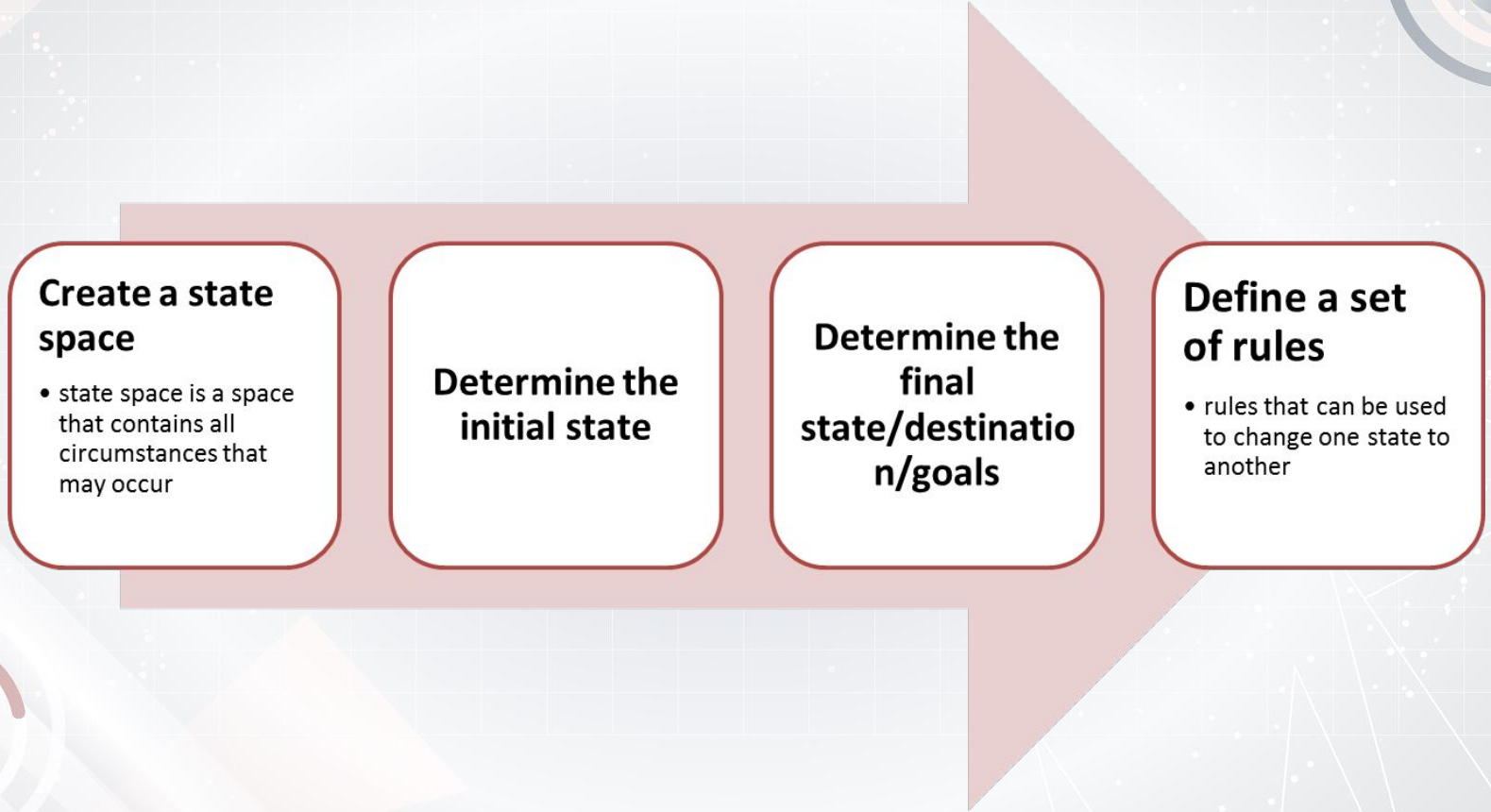
PROBLEM ???

FORMAL DESCRIPTION OF A PROBLEM

- **Space of all possible configurations where each configuration is call a state**

- An initial state
- One or more goal state
- Set of rules/operators which move the problem from one state to the next

HOW TO DEFINE THE PROBLEM?



Problem 1: Water Bucket Case

Water Bucket Case

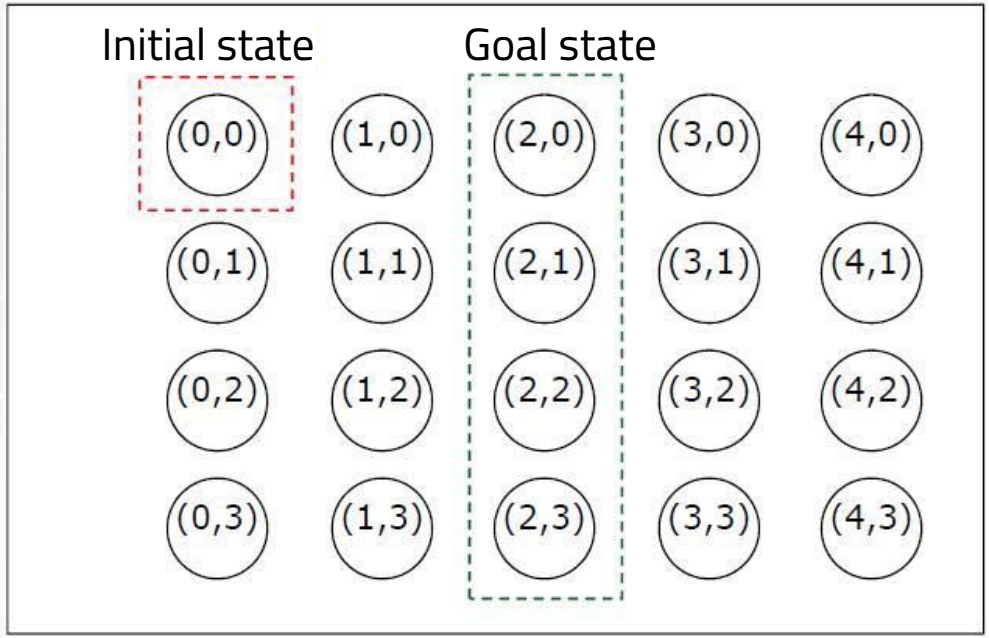
- There are 2 buckets where each bucket has a capacity of 4 liters (Bucket A) and 3 liters (Bucket B).
- There is a water pump used to fill the water in the bucket.
- How would you fill exactly 2 liters of water into bucket A?

Water Bucket Case – Define the problem

1. **State space identification**
   a. x = The amount of water filled into bucket A (4 liters), $x \in \{0,1,2,3,4\}$
   b. Y = The amount of water filled into bucket B (3 liters), $y \in \{0,1,2,3\}$
2. **Initial state and destination/goal state**
   a. **Initial state**: Both buckets are empty, so it can be described that x,y = (0,0)
   b. **Goal state**: bucket A is filled with exactly 2 liters of water, so we can plot x,y = (2, n) where **n** is any value

Water Bucket Case –Define the problem

3. The state space of a bucket can be described as follows:



Water Bucket Case –Define the problem

4. Rules for the water bucket case:

No	IF	THEN
1	(x,y) x<4	(4,y), Fill bucket A until it is full
2	(x,y) y<3	(x,3), Fill bucket B until it is full
3	(x,y) x>0	(x-d,y), Pour some of the water out of bucket A
4	(x,y) y>0	(x,y-d), Pour some of the water out of bucket B
5	(x,y) x>0	(0,y), Empty bucket A by dumping the water on the ground

Water Bucket Case –Define the problem

4. Rules for the water bucket case:

No	IF	THEN
6	(x,y) y>0	(x,0), Empty bucket B by dumping the water on the ground
7	(x, y) x+y≥ 4 and y >0	(4, y-(4-x)), Pour water from bucket B into bucket A until bucket A is full
8	(x,y) x+y≥ 3 and x > 0	(x-(3-y),3), Pour water from bucket A into bucket B until bucket B is full
9	(x,y) x+y≤ 4 and y > 0	(x+y, 0), Pour all the water from bucket B into bucket A

Water Bucket Case –Define the problem

4. Rules for the water bucket case:

No	IF	THEN
10	(x,y) x+y≤ 3 dan x > 0	(0,x+y), Pour all the water from bucket A into bucket B
11	(0,2)	(2,0), Pour 2 liters of water from bucket B into bucket A
12	(2,y)	(0,y), Empty 2 liters of water from bucket A by dumping the water on the ground

Water Bucket Case – Define the problem

Find a solution based on the rules that have been made

Option 1

Bucket A (l)	Bucket B (l)	Rule
0	0	1
4	0	8
1	3	6
1	0	10
0	1	1
4	1	8
2	3	**solved**

Option 2

Bucket A (l)	Bucket B (l)	Rule
0	0	2
0	3	9
3	0	2
3	3	7
4	2	5
0	2	9
2	0	**solved**

Water Bucket Case – Define the problem

Find a solution based on the rules that have been made

Option 3

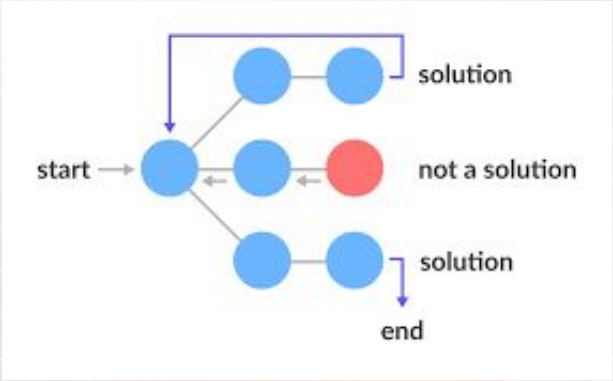
Bucket A (l)	Bucket B (l)	Rule
0	0	1
4	0	2
4	3	5
0	3	7
3	0	2
3	3	7
4	2	5
0	2	9
2	0	**solved**

Water Bucket Case – Define the problem

5. State space representation with tree:

The search for a solution can be described using a tree. Each node shows one state. The path from parent to child shows 1 operation. Each node has child nodes which represent states that can be reached by the parent.

State space representation



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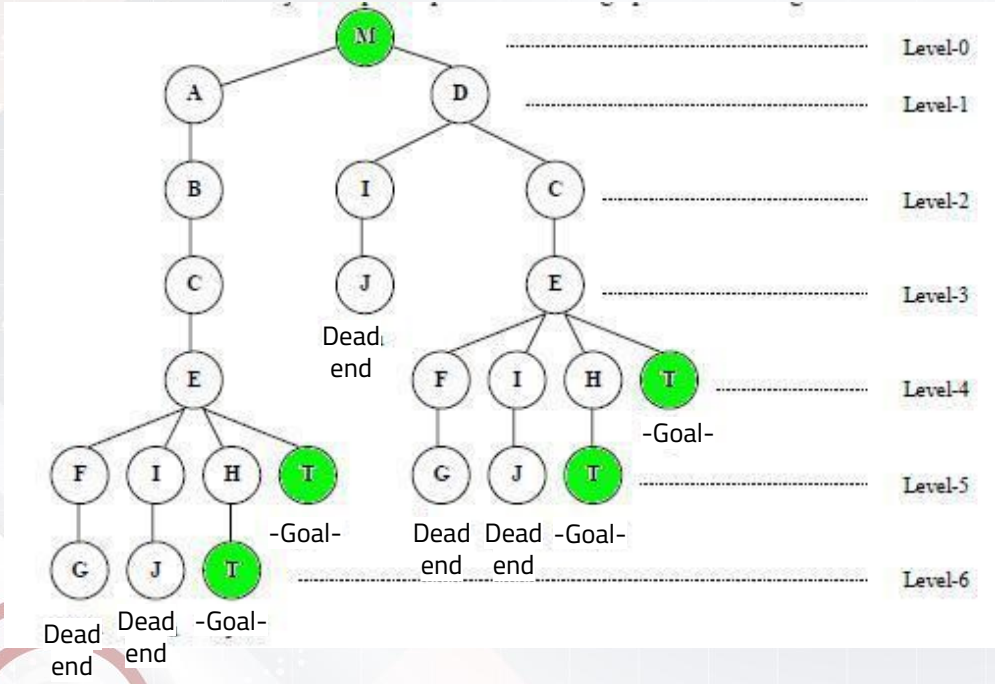
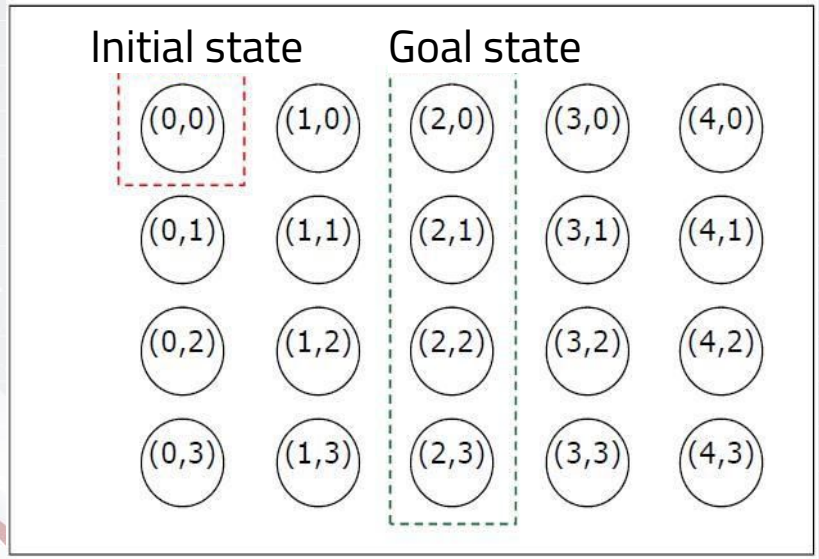
State space representation – Tree

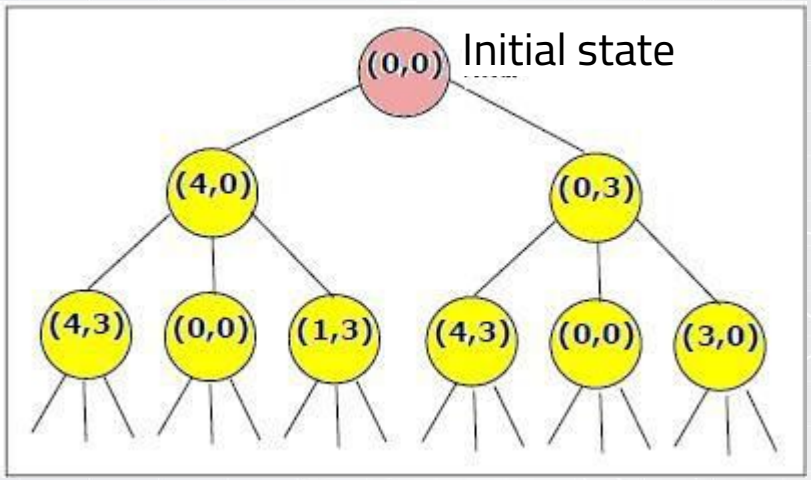


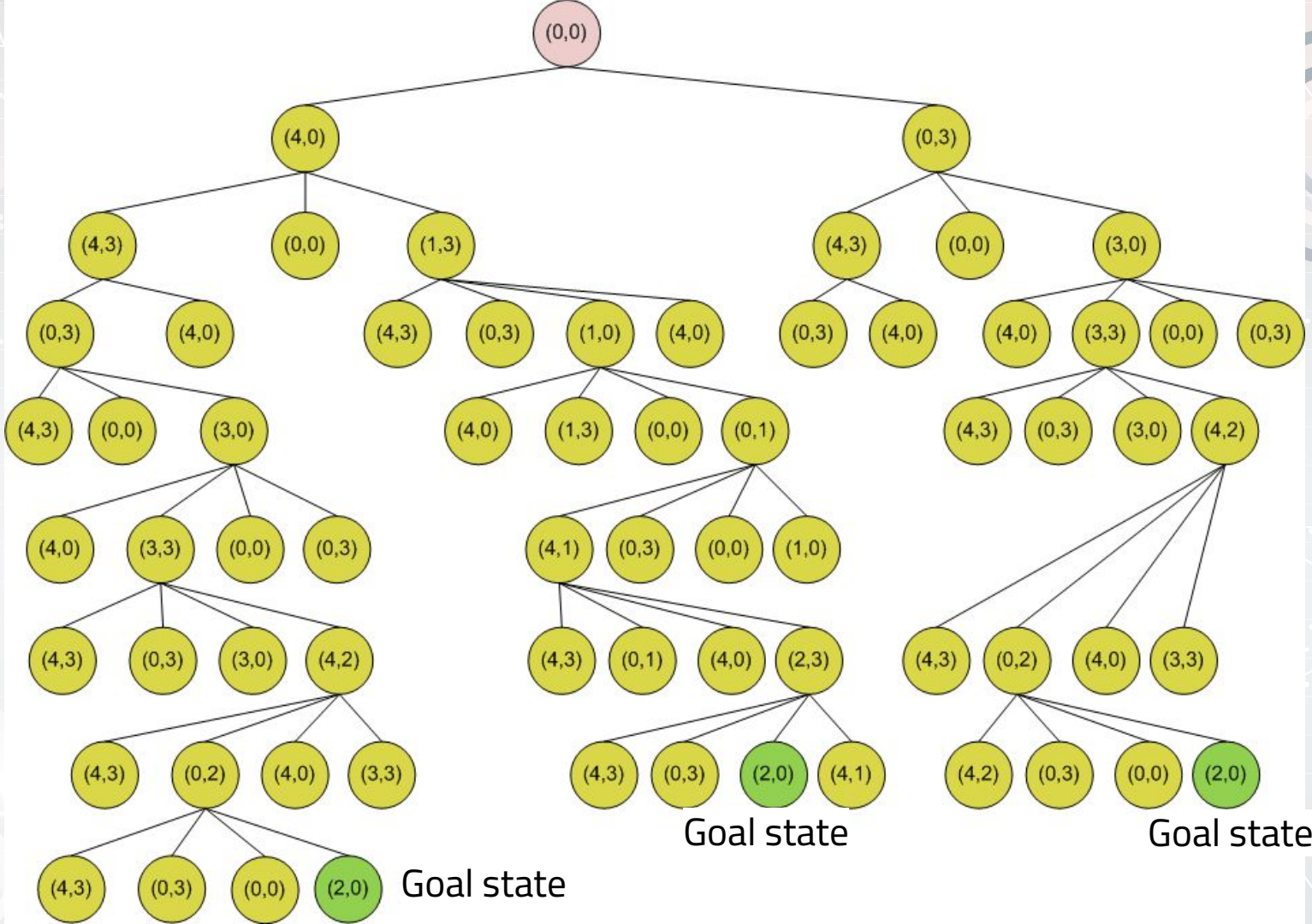
a. The tree structure is used to describe a hierarchical state
b. The node located at level 0 is called the root
c. A node that has no children is called a leaf. The leaf indicates the end of a search which can be a goal or dead end

State space representation – Tree

Water bucket case



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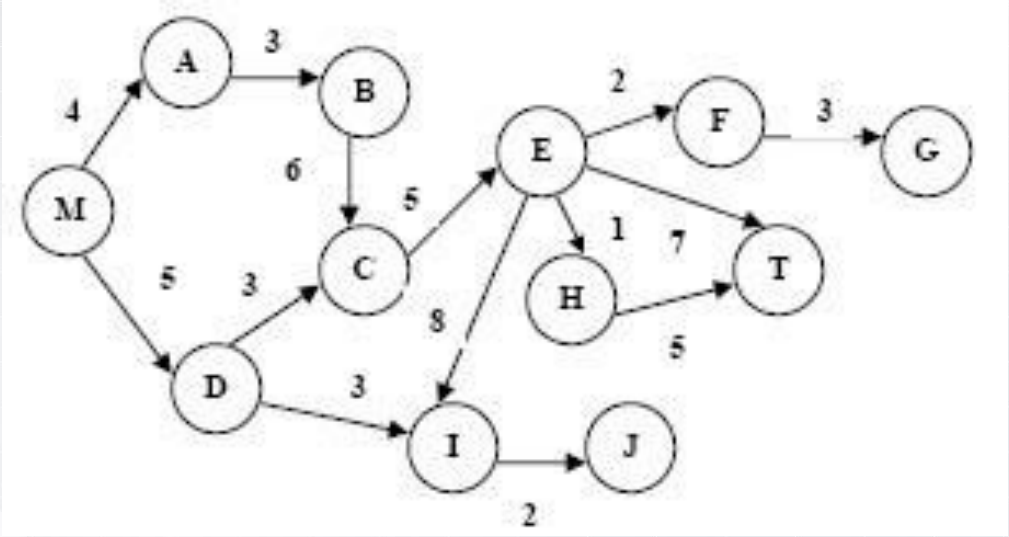
Goal state
Goal state
Goal state

State space representation – **State Graph**

a. Graph consists of nodes that indicate the state which consists of the initial state and the new state that will be achieved using operators
b. The nodes in the state graph are connected to each other by using arcs with arrows to indicate the direction from one state to the next

State space representation – **State Graph**



Initial state: M, **Destination(Goal) state**: T

- **There are 4 paths from M to T**
  M-A-B-C-E-T
  M-A-B-C-E-H-T
  M-D-C-E-T
  M-D-C-E-H-T

- **There are some paths that don't get the destination (T)**
  M-A-B-C-E-F-G
  M-A-B-C-E-I- J
  M-D-C-E- F-G
  M-D-C-E-I-J
  M-D-I-J

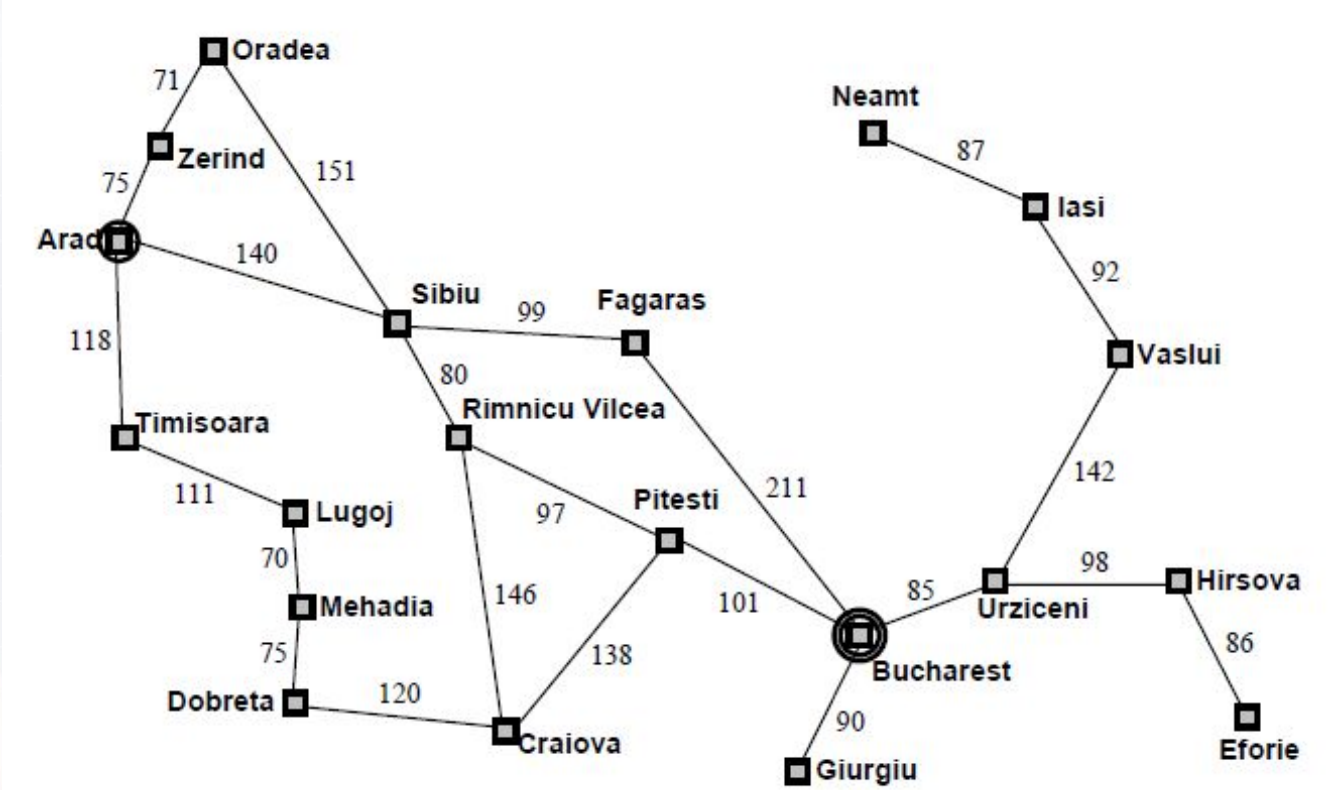
State space representation – State Graph

Rumania Map Case

a. Rudi is on vacation in Romania. His current position is in Arad . He has to fly from Bucharest Airport tomorrow.
b. Initial state: Arad
c. Goal: Bucharest
d. Formulation of the problem:
    - Action: Drive from town to town
    - State: Cities in Romania

State space representation – State Graph

Rumania Map Case



State space representation – State Graph

Rumania Map Case

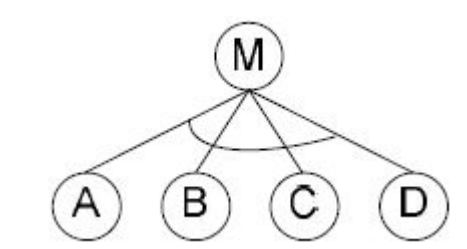
Solution Search: A series of destination cities

a. Arad, Sibiu, Fagaras, Bucharest
b. Arad, Sibiu, Rimnicu Vilcea, Pitesti, Bucharest
c. Arad, Zerind, Oradea, Sibiu, Fagaras, Bucharest
d. Arad, Timisoara, Lugoj, Mehadia, Dobreta, Craiova, Pitesti, Bucharest
e. etc

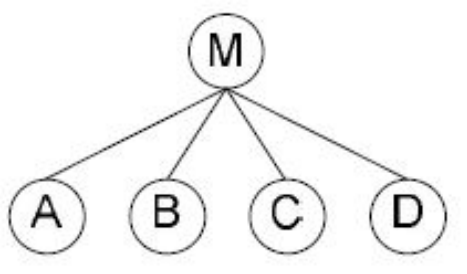
State space representation – AND/OR Tree

An AND/OR tree is a tree whose internal nodes are labeled either "AND" or "OR".

AND/OR Tree expected to shorten the process in achieving the goal.

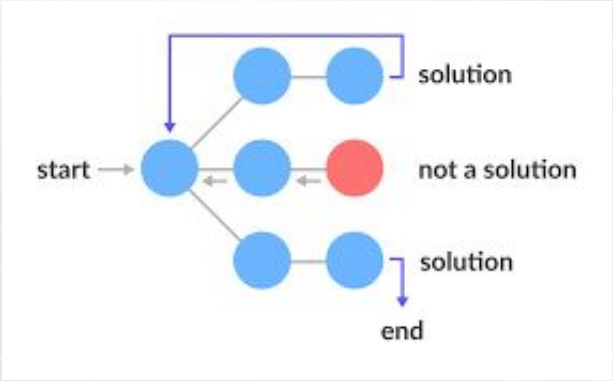


Problem M can only be solved with A AND B AND C AND D



Problem M has 4 possible solutions: A OR B OR C OR D

Searching Methods



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Searching Methods

A process looking for a solution from a problem through a group of possible state spaces.

There are two types of searching methods commonly used:

a. **Blind Searching/ Uninformed Searching**

   There isn't any initial information that can be used in the search process.

   Some examples of blind search methods include: Breadth-First Search (BFS), Depth-First Search (DFS), Uniform Cost Search (UCS), Depth Limited Search (DLS), Iterative Deeping Depth First Search (IDDFS),Bidirectional Search (BS)

Searching Methods

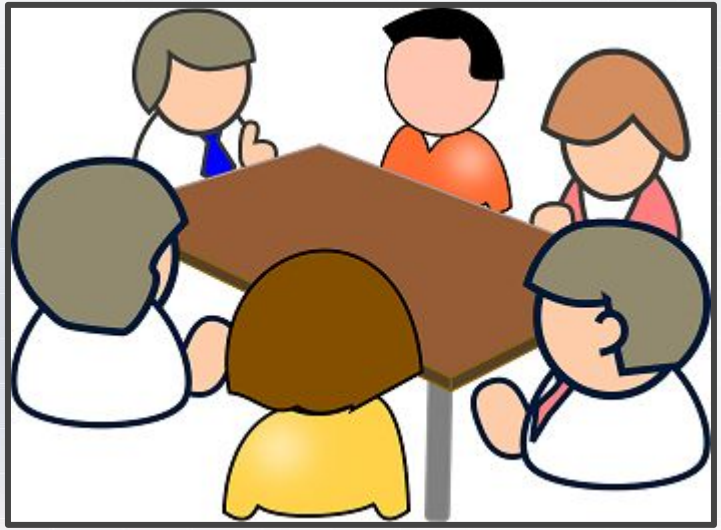
b. Heuristic Searcing/Informed Searching

There is initial information that can be used in the search process.

Some examples of blind search methods include: Generate and Test, Hill Climbing, Best First Search, Alpha Beta Prunning, Simulated Annealing, Min-Max, Local Search Algorithms, Local Beam Search.

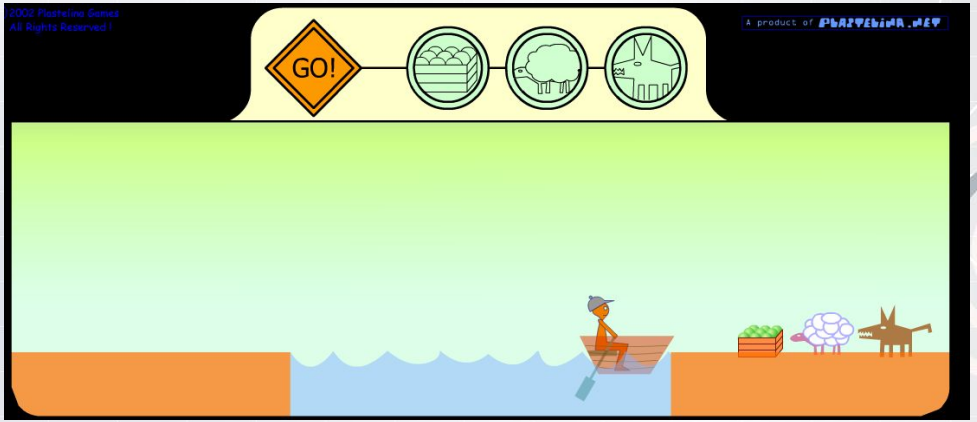
Class Discussion (20 minutes)

1. The class will be divided into several groups
2. One group consists of 4 to 5 members
3. Group discussions are held for 20 minutes
4. The results of the group discussion will be presented in front of the class for 10 to 15 minutes
5. The presenter will get 1 to 2 questions from other groups



Discussion Materials - 02

Solve the following problems
"How can a farmer, a sheep, a wolf, and vegetables cross safely?"



State space identification
Farmer = f, Vegetables = v,
Sheep = s, Wolf= w

Initial State
Origin Area = (f, v, s, w)
Opposite Area= (0,0,0,0)

Goal
Origin Area = (0,0,0,0)
Opposite Area= (f, v, s, w)

Discussion Materials - 02

A Set of Rules

No	Rule
1	A Sheep and a farmer crossing
2	Vegetables and a farmer crossing
3	A wolf and a farmer crossing
4	A sheep and a farmer returned
5	Vegetables and a farmer returned
6	A wolf and a farmer returned
7	A farmer returned

THANKS!

See You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