4/1/2022 AI

State Space Search

State :- Current configuration of Agent.
Abstract Representation of Agent's environment.

Initial State :- Description of starting configuration of agent + environment

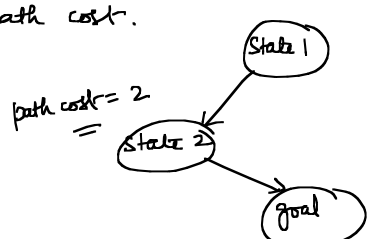
Action (Operator) :- takes agent from one state to another.

A state can have many successor states.

Goal :- Description of set of desirable states of agent + environment.

Plan :- Sequences of Actions.

Path Cost :- Every path has a positive number as label.
Usually sum of steps as path cost.



Problem Formulation

Choosing a relevant set of states to consider and a feasible set of actions (operators) for making transition from one state to another.

Search :- Process of imagining the sequence of actions (operators) applied to initial state and checking which sequence reaches the goal state.

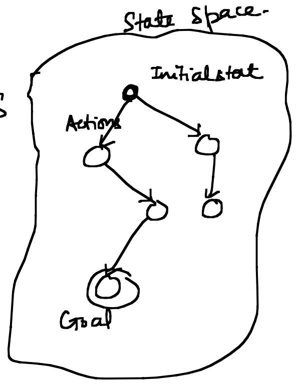
Search Problem

S : Full set of states

S_0 : Initial state , $S_0 \subset S$

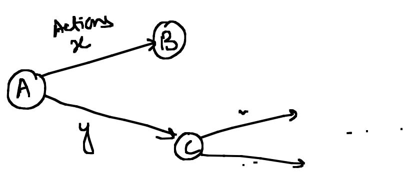
A : $S_1 \rightarrow S_2$ set of operators , $S_1, S_2 \subseteq S$

G : set of final states $G \subseteq S$



Searching process

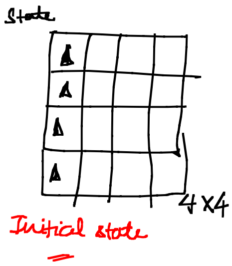
1. Check the current state
2. Execute the allowable actions (operators) to move to next state.
3. Check if new state is goal state
If not then the new state becomes the current state and the process is repeated until we reach goal state.



Problem 1   8-Queens Problem

Place 8 queens on a chessboard such that no two queens are in same row, column or diagonal.

Problem formulation 1:

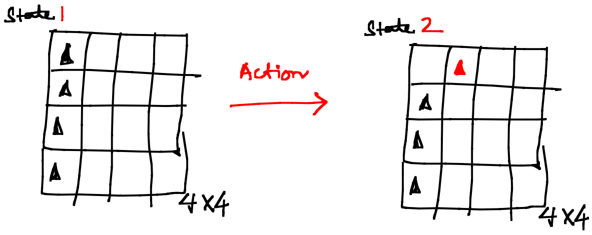


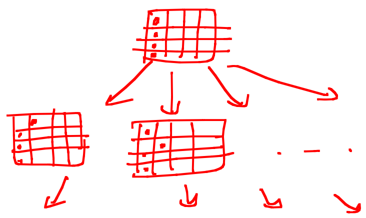
States : Any arrangement of 8 queens on the chessboard.

Initial state : All queens are in first column.

Goal state : 8 queens are placed on chessboard with no attacking possible.

Action/Operators :- Change the position of any queen.





Problem Formulation 2

State :- Any arrangement of 0 to 8 queens on the chessboard.

Initial state :- No queen on the chessboard.

Goal state :- 8 queens on the board with no attack.

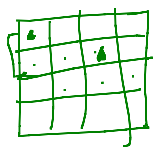
Actions :- Adding a queen in the board. / Moving a queen one position at a time.

Problem Formulation 3

States :- Any arrangement of k queens in first k rows such that no attack is possible. $\boxed{0 \le k \le 8}$

Initial state :- 0 queens on the board.

Goal state :- 8 queens on the board with no attack.



Actions :- Moving a queen one position at a time /

Adding a queen in (k+1)th row such that no queens are in attacking position.

Explicit Search Space

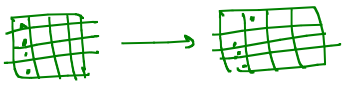
specify all the states/operators (actions) transitions explicitly.

$S_1, A_1 \longrightarrow S_2$

Implicit search space

Generally, we have implicit search space representation.

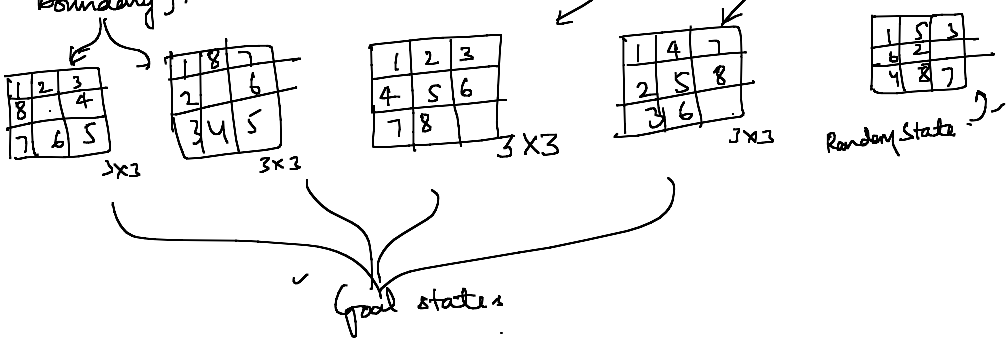
The states and the transitions are implicit and they are represented (generated as and when required.



Problem 2.

8 Puzzle Problem

Given a 3X3 Grid with numbers 1 to 8 are placed randomly over the grid with one cell left as empty (blank). We have to arrange the numbers 1 to 8 in a sequence (either row-wise/columnwise or boundary).



State :- Description of each 8 tiles in each location it occupies

1	2	3
4	5	6
7	8	

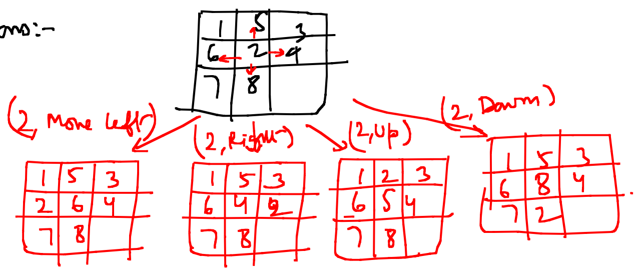
$\Rightarrow \underbrace{(1, 2, 3, 4, 5, 6, 7, 8, B)}_{S_1}$

3	2	8
6	1	
7	4	5

$\Rightarrow \underbrace{(3, 2, 8, 6, 1, B, 7, 4, 5)}_{S_2}$

Initial state :- Any random permutation of (1..8, B).

Actions:-



Water- Jug Problem

You have three jugs measuring 12 gallons, 8 gallons and 3 gallons and a water tap having infinite supply of water. You have to measure exactly 1 gallon of water in any of the available jug.

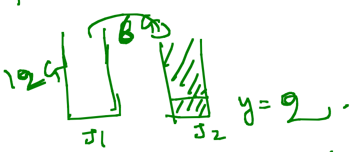
State Representation : $\overset{J_1}{(x}, \overset{J_2}{y}, \overset{J_3}{z)}$, $0 \le x \le 12$, $0 \le y \le 8$, $0 \le z \le 3$

Initial state :- $(0,0,0)$

Goal states : $(1,y,z)$, $(x,1,z)$, $(x,y,1)$

Actions / operators

1. Filling of empty J1 : $(0,y,z) \longrightarrow (12,y,z)$
2. Filling of empty J2 : $(x,0,z) \rightarrow (x,8,z)$
3. Filling of empty J3 : $(x,y,0) \rightarrow (x,y,3)$
4. Filling of J1 : $(x,y,z) \rightarrow (12,y,z)$
5. Filling of J2 : $(x,y,z) \rightarrow (x,8,z)$
6. Filling of J3 : $(x,y,z) \rightarrow (x,y,3)$
7. Empty J1 : $(x,y,z) \rightarrow (0,y,z)$
8. Empty J2 : $(x,y,z) \rightarrow (x,0,z)$
9. Empty J3 : $(x,y,z) \rightarrow (x,y,0)$
10. Transfer from J1 to J2 : $(x,y,z) \rightarrow (x - \min(x, 8-y), \min(8, y+x), z)$

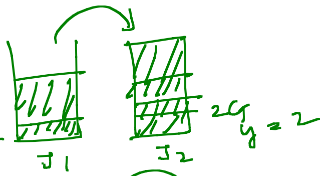


$y = 2$

$12 - 6$

x

$(8-y) = 6$



$y = 2$

$x = 1$

$x = 1 - 6$

$8-y$

6

11. Transfer from J1 to J3 : $(x,y,z) \rightarrow (x - \min(x, 3-z), y, \min(3, x+z))$
12. Transfer from J2 to J3 : ..

J2 to J1 :-

J3 to J2 :-

J3 to J1 :-

in same fashion.

A1 $(0,0,0)$

Fill J1

$(12,0,0)$

A2 Fill J2 $\rightarrow$ $(12,8,0)$

Transfer from J1 to J2 $\rightarrow$ $(4,8,0)$

Transfer from J1 to J3 $\rightarrow$ $\boxed{(1,8,3)}$