

Tutorial 2 : To understand state space problem  
formulation

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## Tutorial 2: To understand State Space Problem Formulation.

### Aim:-

To understand State space based problem Formulation of AI problems so that Problem Solving Agent Can be Applied.

### Theory:-

First we understand the problem solving agent. Algorithm shown in figure 3 shows agent program for problem solving agent. Agent first formulates goal and problem; then determines or rather searches an action sequence after which it returns the next action to be executed in a sequential manner.

Function SIMPLE-PROBLEM-SOLVING-AGENT (percept)  
returns an action.

Static: seq, an action sequence, initially empty.  
static, some description of the current world state.

goal, a goal, initially null

problem, a problem formulation.

State  $\leftarrow$  UPDATE-STATE (state, percept)

if seq is empty then do.

goal  $\leftarrow$  FORMULATE-GOAL (state)



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Problem ← FORMULATE - PROBLEM (state, goal)
Seq ← SEARCH (problem)
Action ← FIRST (Seq)
Seq ← REST (Seq)
Return action
```

Figure 3 : Problem Solving Agent Architecture.

Defining the problem is referred to as Problem Formulation. It involves defining following five things.

**Initial State :** It is the starting state that the problem is in.

**Actions :** It defines all possible actions available to the agent, given it is in some state  $s$  currently. It is a function  $Action(s)$  that returns list of all possible action.

**Transition Model :** also known as Successor function which define which state/s the system tend to move to when a particular action is executed by the agent. Successive application of transition model gives rise to what is known as State space.



Goal Test This act as a stopping condition when the state passed to this function is goal state it will return true and searching would stop.

Path cost It is accumulated cost of performing certain sequence of actions. The can help in determining weather the action sequence under consideration is optimal.

Thus a Problem can formally specified by identifying initial state, actions (operator), transition model (successor function), goal test and path cost. In term of problem solving agent solution is the path from initial state to a goal state, optimal solution is the lowest path cost of all solutions. Process of finding a solution is called search.

Working:-

Based on understanding of problem formulation students need to formulate following problems. They will clearly show state space up to depth level 3 or till goal node which ever is shallowest.



## i) 8 puzzle problem:

The 8 puzzle consists of eight numbered, movable tiles set in a  $3 \times 3$  frame. One cell of the frame is always empty thus making it possible to move an adjacent numbered tile into the empty cell. Such a puzzle is illustrated in following figure.

2	8	3
1	6	4
7		5

Initial state

1	2	3
8		4
7	6	5

Goal State

Fig. Example of 8 puzzle.

This program is to change the initial configuration into the goal config. A solution to the problem is an appropriate sequence of moves, such as "move tile 5 to the right, move tile 7 to the left, move the tile 6 to the down" etc.

To solve a problem, we must specify the global database, the rules the control strategy for the 8 puzzle problem that corresponds to 3 components. to 3 components

These elements are the Problem States moves and goal. In this Problem each Pile tile Configuration is a state the set of all possible Configuration in the Problem space, consists of 3,62,880 different Configurations of the 8 tiles and blank space.

For the 8-puzzle a straight forward description is a  $3 \times 3$  array of matrix of numbers. Initial global database is this description. of the initial problem state ~~at~~ virtually any kind of data structure can be used to define, describe states.

A move transforms one problem state into another state the 8-puzzle is converting interpreted as having the following for moves:

- Move empty space (blank) to the left, move blank up move blank to the right and move blank down.
- These moves are modeled by Production rules that operate on the state descriptions in the appropriate manner.

The goal Condition from the basis for the termination. The Control Strategy repeatedly applies rules to state descriptions



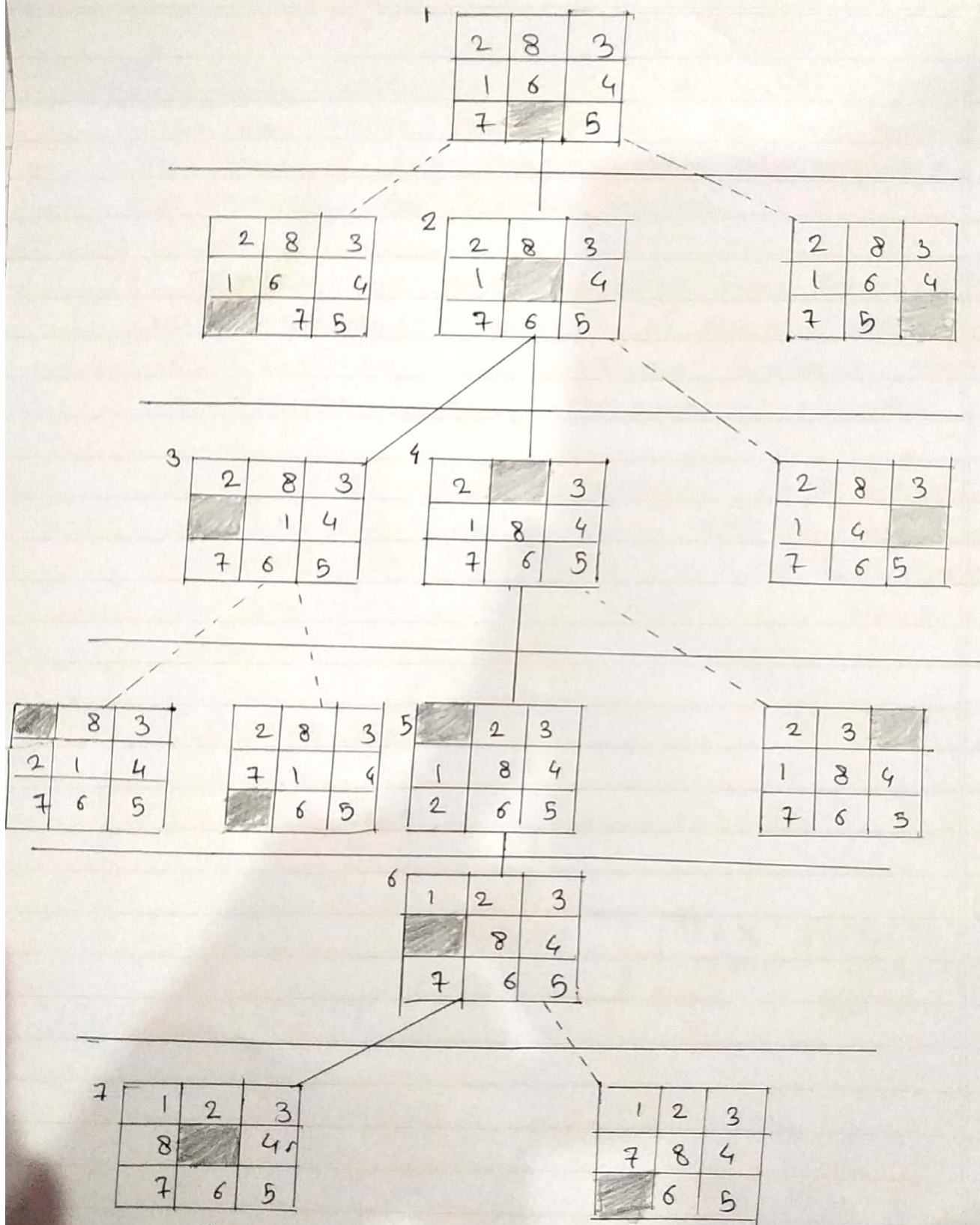


fig. Solution of 8 puzzle Problem

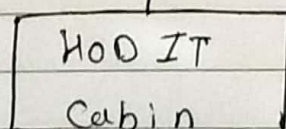
until a description of a goal state is produced. It also keeps track of rules that have been applied so that it can compose them into sequence representing the problem solution.

- ii) Navigate to KGCE Workshop from HOD IT Cabin with minimum number of moves, moves can be climbing or alighting staircase, turning left, right, walking through a corridor.

States :- It can be represented as a top view of the agent along with across its directions left, right, forward and backwards. We are 'Climb' and 'alight' you ~~are~~ moving through ~~the~~ staircases.

1) Initial State.

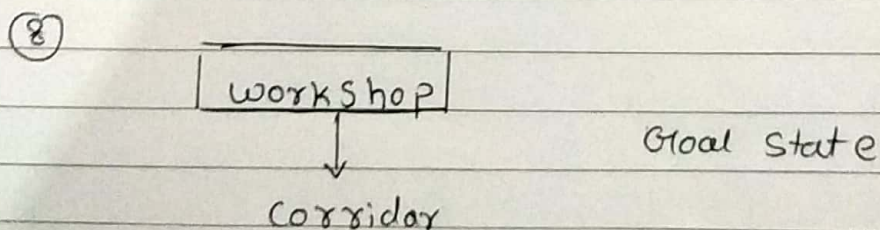
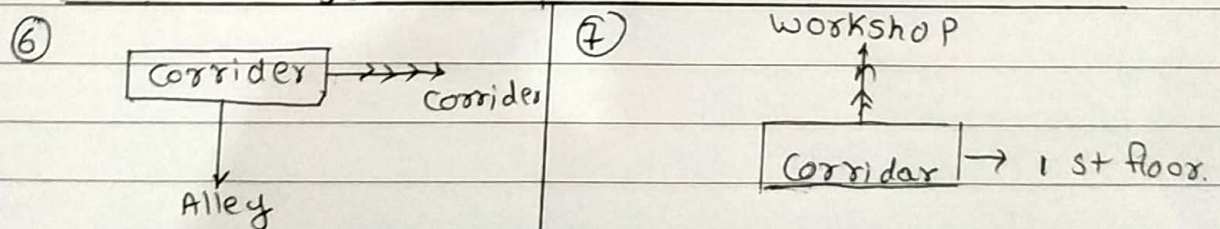
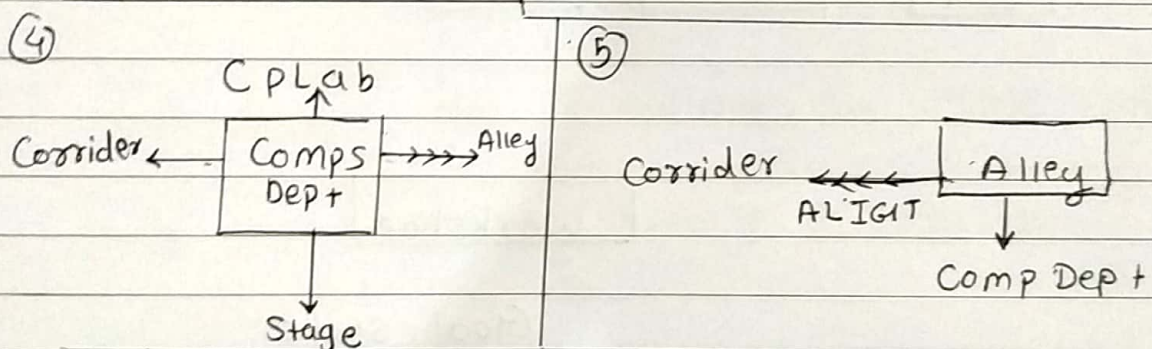
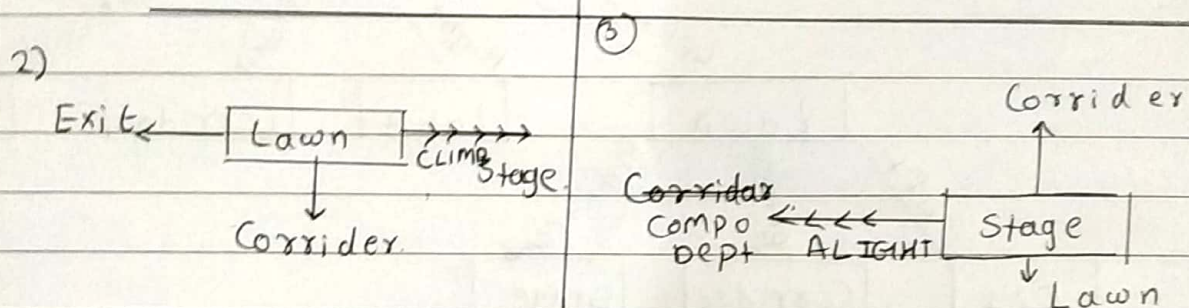
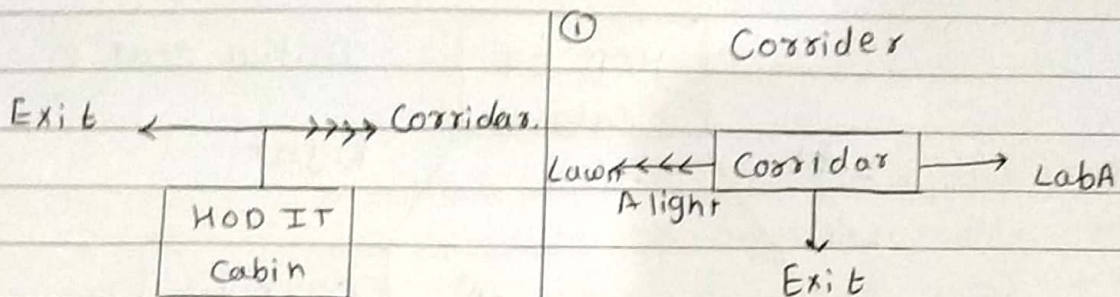
Exit ← → Corridor



Box represents current location of agent

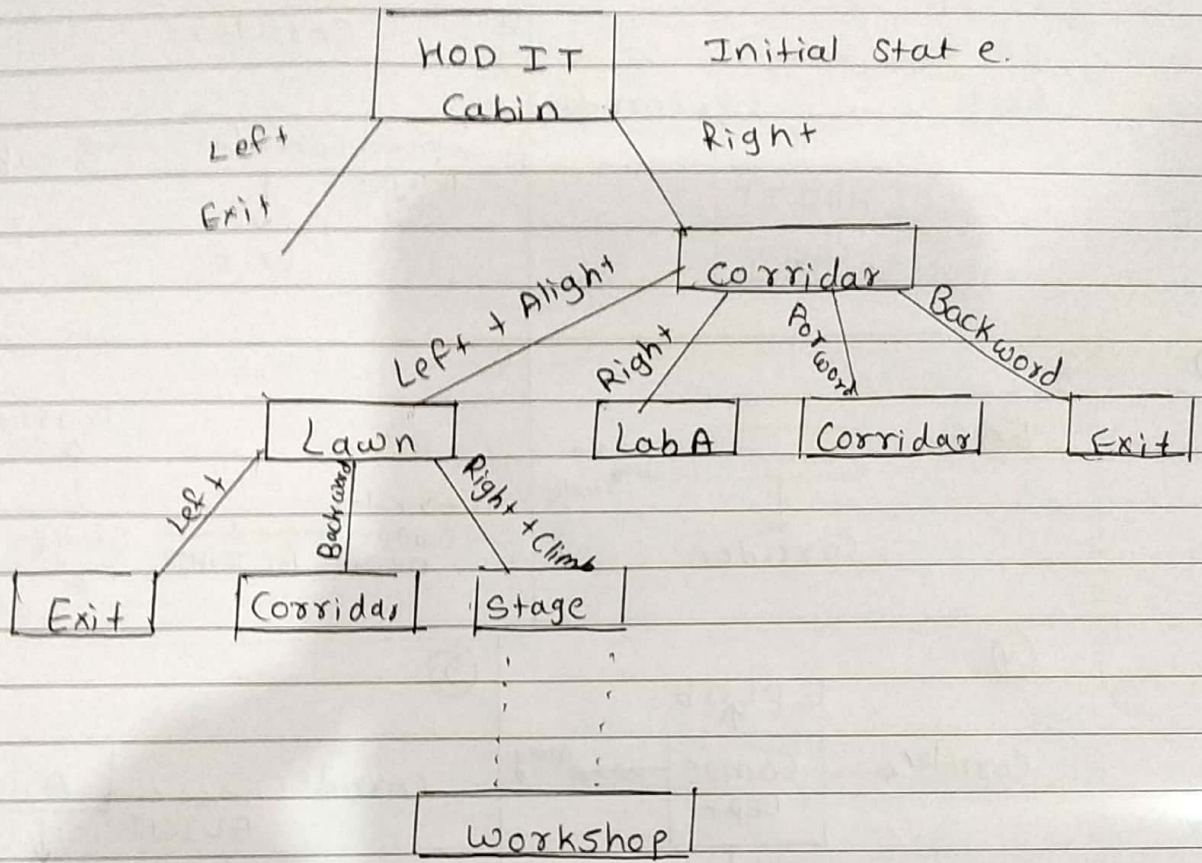


# HOD IT → KGCE Workshop Solution





State space.



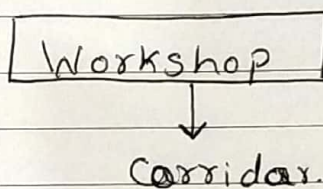
Goal state.



2. Actions :- The agent moves in left, right, forward and backward directions along with alighting and climbing the stairs (if any)

3. Successor function : IF we apply 'right' operation to the start state, the agent enters the Consider - the first step forwards goal state.

4. Goal test



5. Path Cost : No. of actions to search the Workshop.

$$\begin{aligned}\text{Path cost} &= 8 \text{ directions} + 4 \text{ staircases} \\ &= 12\end{aligned}$$