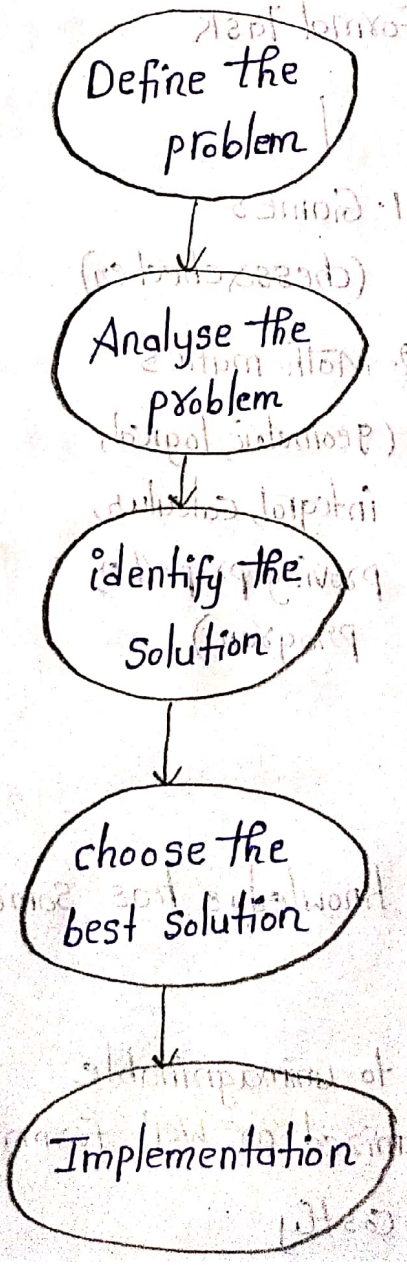
UNIT-I

Introduction to AI problem:

→ To build a system to solve the particular problem we need to do 4 things

1) Define the problem precisely (initial state, final state)
2) Analyse the problem (techniques to solve it)
3) Isolate and represent the task knowledge that is necessary to solve the problem
4) choose the best problem solving technique and apply it to the particular problem

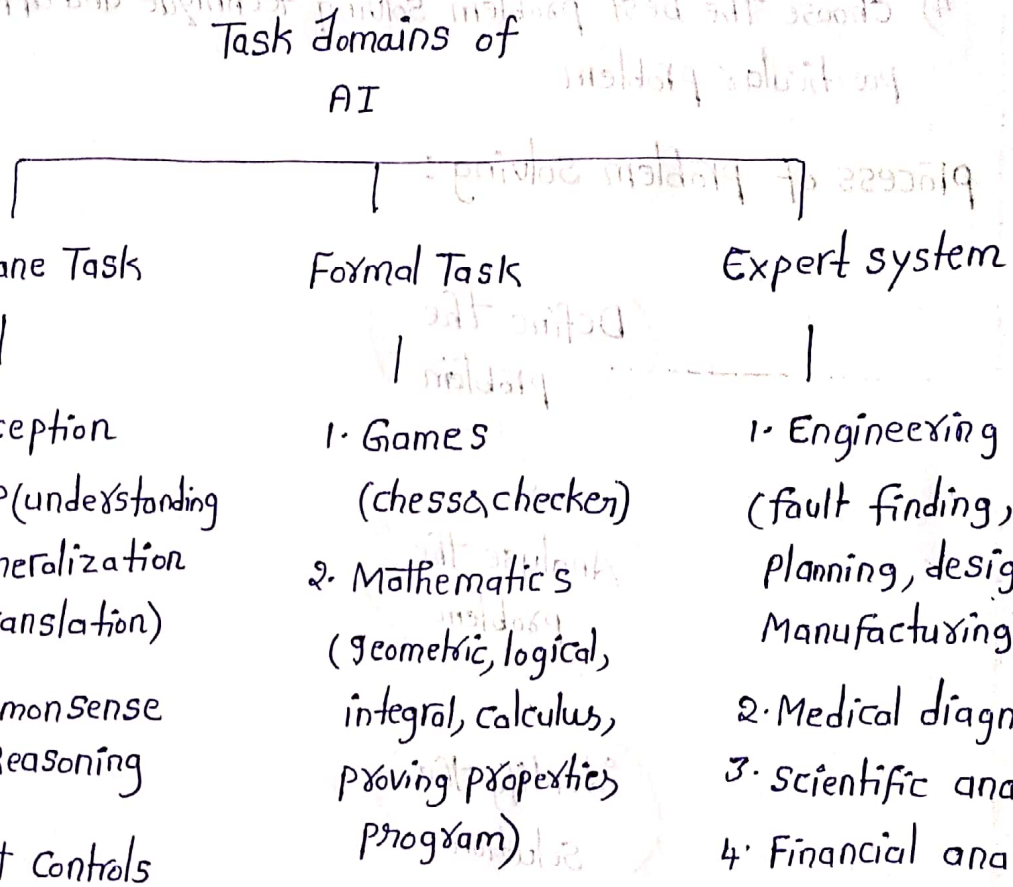
process of problem Solving:



AI problems :

1) Game playing
2) Theorem proving
3) Common sense reasoning
4) perception (vision & speech)
5) Natural language process understanding

There are 3 categories of Tasks :



AI Techniques :

In the real world the knowledge has some unwelcomed properties

1. Volume is huge next to unimagninable
2. It's not a well organized or well formatted
3. It keeps changing costly

AI Technique is a manner to organize the and use the knowledge efficiently in such a way that

- It should be preseivable by the people who are providing
- It should be easily modified to correct the errors
- It should be useful in many situations though it is incomplete or inaccurate

There are 3 important AI techniques:

1. Search
2. Use of knowledge
3. Abstraction

1. Search:

This technique provides a way of solving problems for no more direct approach is available as well as frameworks in to which any direct technique that are can be embeded

2. Use of knowledge:

This techniques provides a way of solving complex problems by exploiting the structure of the objects that are involved

3. Abstraction:

This technique provides a way of separating important features and variation from the many unimportant one it hides the details of something

Ex: if you want to compute the square root of a number then we simply call the function sqrt we dont need to know the implementation details of the function

Criteria for Success:

→ Targetted Goal to be acheived

problem, problem space and search :

problem :

→ it is the question which is to be solved for solving the problem it needs to be precisely defined.

→ The definition means defining the start state, goal state, Invalid states, Valid and transition state

→ The scenario which is given to solve is called problem

problem space :

The steps to reach from initial state to Goal state is called as a problem space and it consist of set of states of a problem and set of operations that changes the state

State :

It is a combination of all the possible states that you can take. It is a symbolic structure that represents the single configuration of the problem with sufficient details is allow problem solving to proceed

Operators :

It is the combination of all the possible legal moves that you can take it is a function that take a state that map to another state

Search :

The steps we follow to reach from initial state to Goal state called as search

A problem may Consists of :

1) problem state
2) Initial state
3) A set of goal state
4) A solution (sequence of operations)

Water jug problem :

We are give 2 jugs 4G and 3G. There is a pump that can be used to fill the jugs with the water. How can you get exactly 2G water in to 4G jug

4G 3G
initial state (x 0 , y 0)

Goal state (2 , y)

Conditions :

1) Water can be pour out of jug on the ground
2) We can pour water from 1 Jug to another and there is not measuring equipment available

SNo	Current state	Next state	Description
1	(x,y) if (x<4)	(4,y)	fill 4G Jug
2	(x,y) if (y<3)	(x,3)	fill 3G Jug
3	(x,y) if (x>0)	(0,y)	empty 4G on Ground
4	(x,y) if (y>0)	(x,0)	empty 3G on Ground
5	(x,y) if (x+y) ≥ 4	(4, y-(4-x))	pour water 3G Jug into 4G jug until it fills
6	(x,y) if (x+y) ≥ 3	(x-(3-y), 3)	pour water 4G Jug into 3G Jug until it fills
7	(x,y) if (x+y) ≤ 4	(x+y, 0)	pour all water from 3G to 4G Jug
8	(x,y) if (x+y) ≤ 3	(0, x+y)	pour all water from 4G to 3G Jug
9	(0,2)	(2,0)	Pour 2G from 3G to 4G
10	(2,y)	(0,y)	empty 2G water from 4G in the ground

Water in 4G	Water in 3G	Rule applied
0	0	2
0	3	7
3	0	2
3	3	5
4	2	3
0	2	7
2	0	goal state

Define a problem as a state space search:

→ A state space representation allows for the formal defini of a problem which makes the movement from initial state goal state quite easily

→ So we can say that various problems like planning, learnin theorem proving etc., are all essential search problems only

→ State space search is a process used in the field of Computer science including AI in which successive configuration or states of instances are considered with the goal of finding a goal state with state with the desired property

→ In state space search, a state space is formally represente in tuple

$S = \{ s, A, Action(s), Result(s,a), Cost(s,a) \}$

Where

s is the set of all possible states

A is the set of possible actions not related to particular state But regarding all the states (set of all operations)

Action(s) is the function that establish which action is possible to perform in certain state

Result (s,a) is the function that returns the state reach performing action 'a' in state 's'

Cost (s,a) is the cost of performing an action a in s. In many state spaces is a constant, but it is not true general

In AI, A state space consists of following elements

a (Possible infinite) set of states :

1) out of possible states, 1 state represents start state, that is initial state of the problem
2) Each state represents some configuration so that it is reachable from start state
3) out of the possible states, some states may be goals

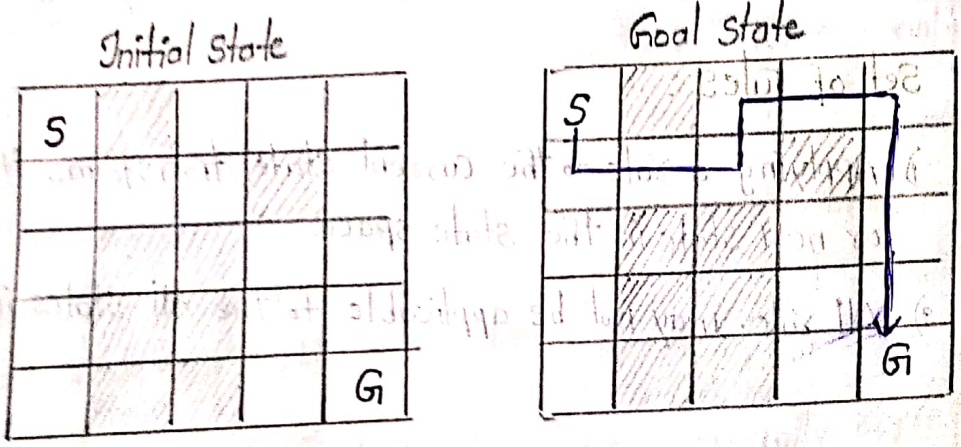
Set of rules :

1) Applying a rule to the current state, transforms it to another or new state in the state space
2) All rules may not be applicable to the all states in state space

General Process followed in solving problem using state space search:

1) first select some way to represent states in the given problem in an unambiguous way
2) Next formulate all actions/operations that can be performed in states including their preconditions & effects
3) Represent the initial state or states of the problem
4) Formulate, precisely when a state satisfying the goal of our problem
5) Activate the production rules on initial state and its decendent until a goal state is reached

Ex: MAZE problem can be represented as state space



A set of states:

→ each state represents "where you are" that is current position in the MAZE
→ The start state or initial state represents at starting position
→ The goal state represents the exit from the MAZE

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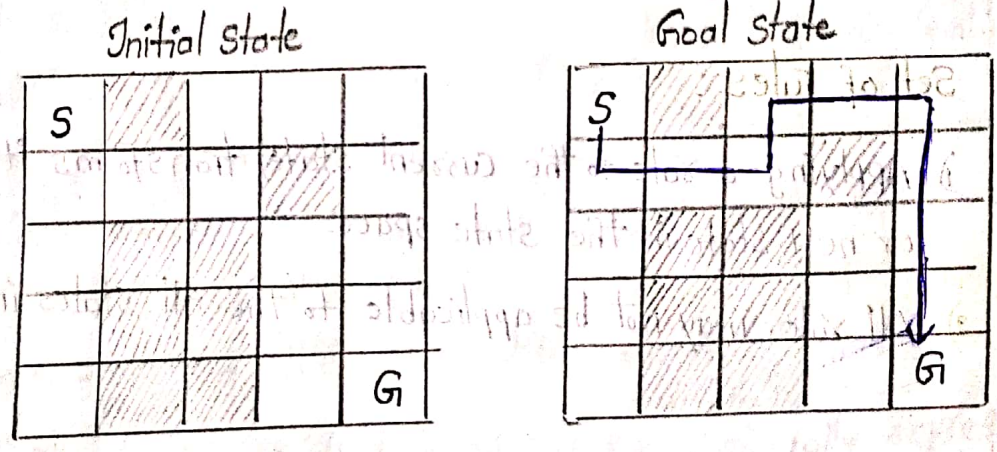

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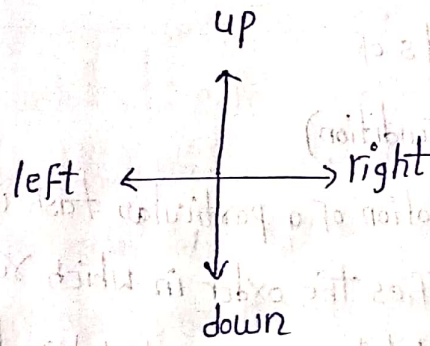
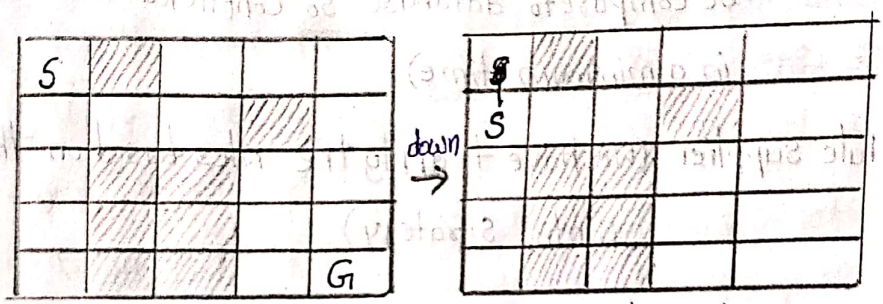
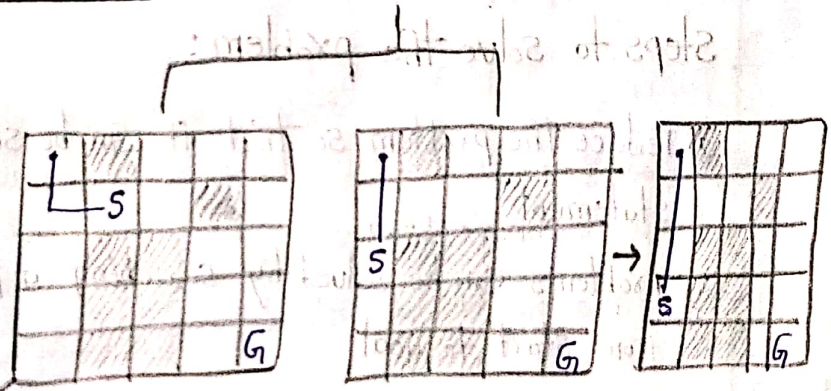
Rules :

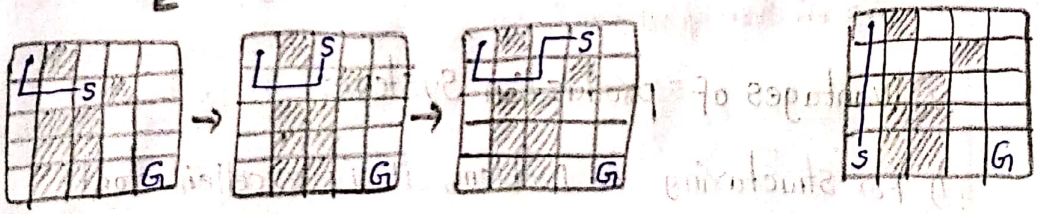
→ move left, right, up, down

→ Each rule takes u to new state









initial

1	4	3
2		5
8	6	7

goal

1	2	3
8		4
7	6	5

Action, rules → production rules

Actions, operations → production rules

1		3
2	4	5
8	6	7

1	4	3
	2	5
8	6	7

1	4	3
2	5	
8	6	7

1	4	3
2	6	5
8		7

Production As a system:

→ It helps in structuring AI program in a way that facilitates describing and performing in such process

→ production system consists of

1) set of rules (if then condition)
2) knowledge base (information of a particular task will be stored)
3) Control strategy (it specifies the order in which rules need to be compare to database. So Conflicted can be resolved in a minimum time)
4) rule supplier (we have to apply the rules based on the control strategy)

Steps to Solve the problem:

1) reduce the problem so that it can be shown in the perseive statement
2) problems can be solved by searching a path through a space from start to goal
3) Solving process can be moduled through a production system

Advantages of production System:

1) For structuring AI problem, it is excellent tool
2) Highly modular i.e, rules can be added, remove, change
3) Rules are expressed in natural form. So it is easy to understand

Characteristics of production System:

① Monotonic production system:

- Application of rule never prevents later application of another tool
- Rules are independent in each other
- No Rule effect the other rules

② Non monotonic production system:

- This production system increases the problem solving efficiency of the machine & eliminates previous records However, since this production system does not allow backtracking the previous record
- It is believed to be mostly used for solving ignorable problem (Theorem proving)

③ partially Communicative production system:

- In this production system, when 2 or more rules are used to derive as a result any combination of the same rules produces the same results
- simply put it means any permutation & combination of set of rules will produces similar result every time.

④ Communicative production system:

- A communicative production system is utilized for problems in which changes can reverse the outcome i.e, the same sequence of the operation is not critical in this class of production system
- both monotonic & partially communicative is called as communicative production system

production System Categories:

	Monotonic	Non-Monotonic
partially Communicative	Theorem proving	Robot Navigation
Non-partially Communicative	chemical synthesis	Bridge

→ partially communicative & monotonic production systems a useful for solving ignorable problems that involves cre new things rather than changing the old one's or generally ignorable

→ Non Monotonic & partially communicative production systems a useful problems in which changes occur that can be reversed and in which order of operation is not critical

→ non partially & monotonic production systems are useful for inreversable changes occur the order in which they perform can be very important in determining the final output

→ non partially & non monotonic production systems are useful in which reversable changes occur order does not matter

problem characteristics:

⇒ In order to choose the most appropriate method for a particular problem, it is necessary to analyze the problem along several key dimensions

1) Is the problem decomposable into a set of independent smaller or easier sub problem?
2) Can solution step to ignore or atleast undone if they prove unwise?
3) Is the problems universe predictable?
4) Is a good solution to the problem, obvious without comparision to all other possible solutions?
5) Is the desired solution a state of the world or a path to a state
6) Is the large amount of knowledge absolutely require to solve the problem or is knowledge important only to constraint the search?

→ partially communicative & monotonic production systems are useful for solving ignorable problems that involves creating new things rather than changing the old one's or generally ignorable

→ Non Monotonic & partially communicative production systems are useful problems in which changes occur that can be reversed and in which order of operation is not critical

→ non partially & monotonic production systems are useful for irreversable changes occur the order in which they perform can be very important in determining the final output

→ non partially & non monotonic production systems are useful in which reversable changes occur order does not matter

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7) Can a computer i.e, simply given the problem written the solution or will the solution of the problem require interaction b/w the computer & person

Is the problem is decompossable :

- whether the problem can be decomposed into smaller problem
- using the technique of problem decomposition, we can often solve very large problems easily

Can Solution steps be ignore or undo ?

→ suppose we are trying to prove a math theorem, we can prove a lemma, if we find lemma is not of any help we can still continue the problem.

→ 8 puzzle problem → recoverable

→ chess, a move can't be takes back

→ important classes of problems

- Ignorable → Theorem proving
- Recoverable → 8 puzzle
- Irrecoverable → chess

Is the Universe predictable ?

→ certain outcome ex : 8 puzzle

→ uncertain outcome ex: bridge

→ for certain outcome problems, open loop aproach without feedback will work fine

→ for uncertain outcome problems, planning can be a least generate a sequence of operators that has a good probability of leading to a solution

→ we need to allow for a process of plan revision to take place

A good solution absolute or relative ?:

→ Any path problem

→ Best path problem

→ Any path problem can often be solved in a reasonable amount of time by using heuristic that suggests good path to explore

→ Best path problems are computationally hard

Is the solution a state or a path ?

→ finding a consistent interpretation for the sentence

① Ex: The bank president ate a dish of pasta salad with the fork

We need to find the interpretation but not the record of processing

② Ex: Here it is not sufficient to report that we have solve but the path that we found of state (3,0) is the statement of a solution to this problem must be sequence of operations that produces the final state.

What is the role of knowledge ?

→ chess, knowledge is required to constrain the search for a solution

→ Newspaper story understanding, lot of knowledge is required even to be able to recognize the solution.

Does the task require interaction with the person ?

→ The program requires intermediate interaction with people for additional i/p & to provide reassurance to the user

→ There are 2 types of programs

① Solitary

② Conversational

→ Decision on using one of this approaches will be important in the choice of problem solving method