7.25

PAGE NO.:
DATE:

Why AI?

⇒ with the help of AI we can able to create softwares or devices in order to solve real world problems like health issues, traffic issues, etc.
⇒ with the help of AI we can able to create assistants like google assistant, siri, cortana.
⇒ with the help of AI we can build robots which can able to work in the environment where human life is at risk.

Goals of AI:-

⇒ with AI the knowledge representation can be interpreted so that the information can be easily understood by the machine.
⇒ AI aims at developing intelligent machines that can learn by its own. It does not need any human intervention.
⇒ with AI all the human understandable languages should be acceptable with the help of Natural Language Processing (NLP).
⇒ The AI can able to develop a system where the sensors receives the inputs, process it and provide the required output.

History of AI:-

In 1958 John Mc Carthy has started the concept of AI in his MIT Lab. In 1997 Deep Blue an AI based system has defeated world chess champion Garry Gasparov. In 2002 iRobot invented MIT Artificial Intelligence Lab started vaccum cleaning and it has been sold in 2 million Dollar

PAGE NO.:
DATE:

AI Programming languages :-

→ In 1958 John mc carthy has started the AI programming language called LISP Processing which utilises only data manipulation.
→ In 1970 PROLOG Programming logic has utilised symbolic and non-numeric data for processing.
→ In 2000, the object oriented languages like Smalltalk, objective C, c++ has been utilised for object based system.
→ Recently Python is widely used for AI language as it holds the applications of machine learning, Data science, Natural Language Processing, General AI, etc.

13.3.25

Advantages of AI :-

① High accuracy :- The AI machines are prone to little margin of error with high accuracy as it depends on pre-experienced data.

② High speed :- The AI systems are very high speed in decision making. That is why AI is being utilished in gaming purposes to create a better opponent.

③ High Reliability :- The AI machines are highly Reliable as they perform the same actions many times with high accuracy

④ useful for risky areas :- The AI system are helpful in the situations like exploring the ocean floor, diffusing the bomb, deployed as an astronotes where human life is risky.

PAGE NO.:
DATE:

⑤ Digital assistant :- The AI system is very useful to provide digital assistant to the users used in E-Commerce websites for recommending as per the requirement of the customer.

Limitation of AI

① High cost :- The hardware and software requirements of AI are very costly and needs regular maintenance to meet the world's requirement.

② No emotions :- As the AI system does not have emotions, so it can not think out of box. The AI systems are lacking with creativity and new ideas.

Applications of AI :-

① AI with astronomy :- AI is very useful in solving complex problems. It can be helpful in understanding the different elements of universe and its origin.

② AI in healthcare :- In the last 5 to 10 years AI is becoming advantagious in the health industry. In the health care industry, it can able to diagnose the patients and help the doctors. Along with it can help the technitions in doing the monotineous jobs for getting a test report.

③ AI in gaming :- The AI system can be utilished for strategic games where the number of ways to defeat the opponent is quite high. In AI games the adaptive intelligence is also applied.

PAGE NO.:
DATE:

15.7.25

(5) AI in Finance :- AI in Finance industry is utilished for trading algorithms, adaptive intelligence, automation in financial Process, etc.

(6) AI in Data security:- The security of data is crucial for every company as the cyber attackers are growing rapidly for accessing the sensitive data. So AI is utilished to make the data more safe by utilishing the platforms like AEG Bot, AI2, etc to determine the software bug or cyber attack.

(6) AI in social media:- The social media like facebook, tweeter, snapchat, Instagram, etc contains billions of users, so managing the users through AI is an efficient way. AI is also Providing latest trend applications, requirement of different users in social media.

(7) AI in travel and transport:- The AI is becoming demanding in travel industry. It is capable of doing various travel managements like booking hotels, providing the locations to visit and the flights availability to the destination. The AI industry is using the Chatbot named "Human-Ai" for travel industry.

8 AI in automotive industry:- This industry is utilishing AI to provide virtual assistants for better performance. For example the self-driving cars which can make the journey safe and secure, Provide better response.

PAGE NO.:
DATE:

(9) AI in Robotics :- Usually the robots are programmed to do repetative tasks. Inorder to provide intelligence, the scientists have started humanoid which can able to behave like human and take intelligent actions.

(10) AI in Entertainment :- AI is utilished in Entertainment services like Netflix/amazon which uses machine learning to recommand a proper type of programs as per the customers need.

(11) AI in E-Commerce :- AI is providing a competative edge to E-commerce industry. The AI helps the customer to find the associated products ~~which~~ with recommanded size, color or brand.

(12) AI in agriculture :- Agriculture is the area where resources like ~~weather~~ labour, money, time is utilished. Now the AI in agriculture field are helping in crop monitoring and suggesting the best crop for that type of soil.

Types of AI :-

(1) Weak AI / Narrow AI :- This type of AI system depends on the trained inputs and provide the output for the specific tasks. It used to perform some dedicated tasks. Apple Siri is an example of narrow AI which operates with predefined functions. Some other examples of narrow AI self-driven car, playing chess, speech recognisation, etc.

PAGE NO.:
DATE:

② General AI :- This type of AI provides intelligence to perform intellectual tasks. The general AI is better as it can smartly think, like humans.

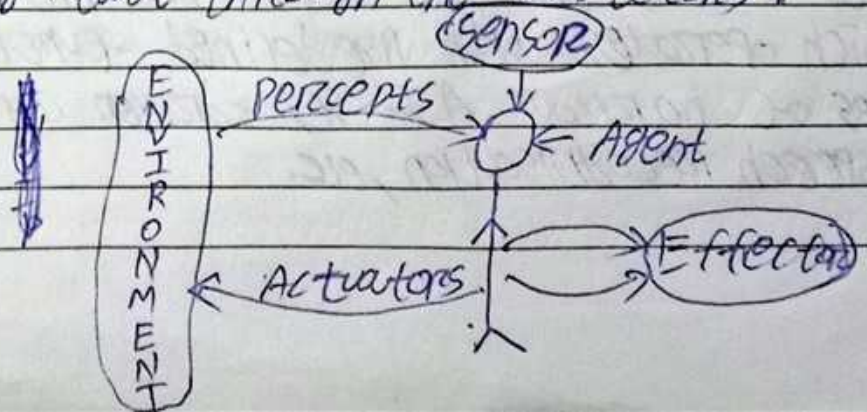
~~③ Super AI :- Super AI can able to suppress~~

③ Super AI :- The level of intelligence in machines can able to suppress human minds. For example solving puzzels, taking judgements, communicate by itself, etc.

Future of AI :-
AI is driving the emerging technologies like big data, robotics, IOT, etc in various industries like :-
① manufacturing industry
② transportation industry
③ Healthcare industry
④ media industry
⑤ Education industry.
⑥ customer service industry

16.7.25

Agents of AI :-
An agent is the object which ~~perceives~~ percepts the inputs through the sensors from the environment, process it and react through the actuators.



PAGE NO.:
DATE:

An agent can be of 3 types :-

(1) Human agent :- In a human agent eye, ear, nose, tongue and [illegible] are the sensors and hand, leg are the actuators through which action can be provided.

(2) Robotic agent :- In this type of agent camera, Infrared rays and NLP are treated as sensors and various motors are monitored are treated as the actuators.

(3) Software agent :- In this type of agent files, keystrokes are the sensors and the display monitor is the actuators for providing the output.

Sensor :-
It is a device which detects the change in environment and sends the information to the agent. An agent observes the environment through the sensors.

Actuators :-
These are the component of machines which helps in controlling or moving the system. For example motor, gear, accelator, etc.

Effector :-
It is the device that affects the environment and helps the actuator to do the action.

PAGE NO.:
DATE:

① Intelligent Agent :- This is an autonomous entity which is acting in environment using sensors and actuators for achieving the desired goal. The intelligent agent also learn from the environment.

Some rules for intelligent agents are :-

A. The intelligent agent have the ability the perceive from the environment.
B. The observations must be used to take decisions.
C. Decisions should result in action.
D. Action taken by the agent should maximise the result.

2 Rational Agent :- this type of agent has clear preferances, model uncertainity, acts to maximise the performance

PEAS Representation :-

→ PEAS is a type of model on which the AI agents are working.

→ P stands for Performance measure
E stands for Environment
A stands for Actuators
S stands for Sensors.

Example 1 :- Self-driven car
Performance measure :- safety, legal drive, maximise the profit
Environment :- Road, traffic signal, Pedestrian, Shops

PAGE NO.:
DATE:

Actuators:- Accelactor, breaak, clutch, gear, steaking, horn, indicator.
sensors:- camera, sonars, speedometer, gps, Engine sensor, Fuel sensor

Example 2:- Part picking Robot
performance measured:- percentage of parts in correct bas
Environment:- Garbage, bean
Actuators:- Robot hand
sensors:- camera

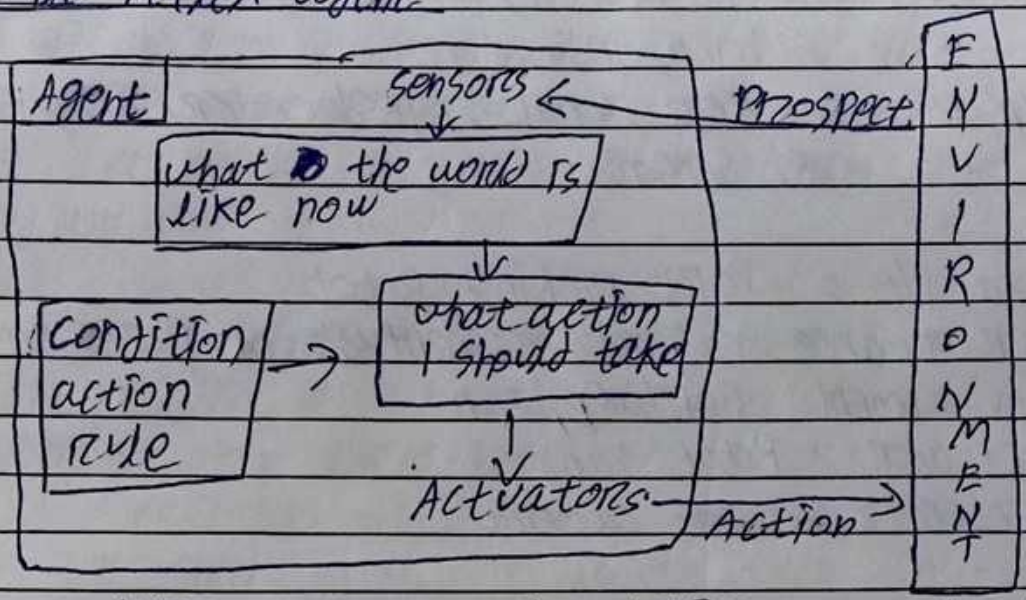
Example 3:- Interactive tutor
performance measured:- maximise the score of student in set of the examination.
Environment:- students
Actuators:- Display, microphone, speakers
sensors:- mouse, camera

we have 5 type of Intelligent Agents:-
① Simple reflects agents
② Model based reflects agents
③ Goal based agents
④ Utility based agents
⑤ Learning agent

22.7.25

PAGE NO.:
DATE:

① Simple reflex agent



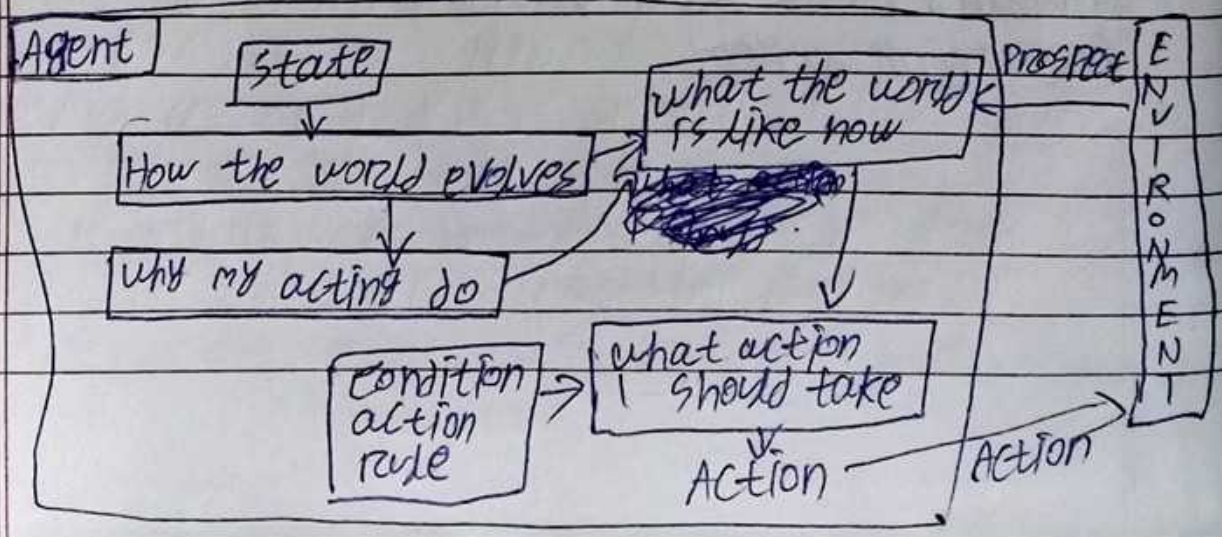
⇒ These type of agents takes decisions on the basis of current prospect and ignore the prospect history.

⇒ These type of agents are similar to the body reflex actions which prompts us to respond for every action.

⇒ These type of agent work on condition action rule which is a mapping from the state to action.

⇒ For example : a room cleaner agent cleans the room irrespective of any type of dirt.

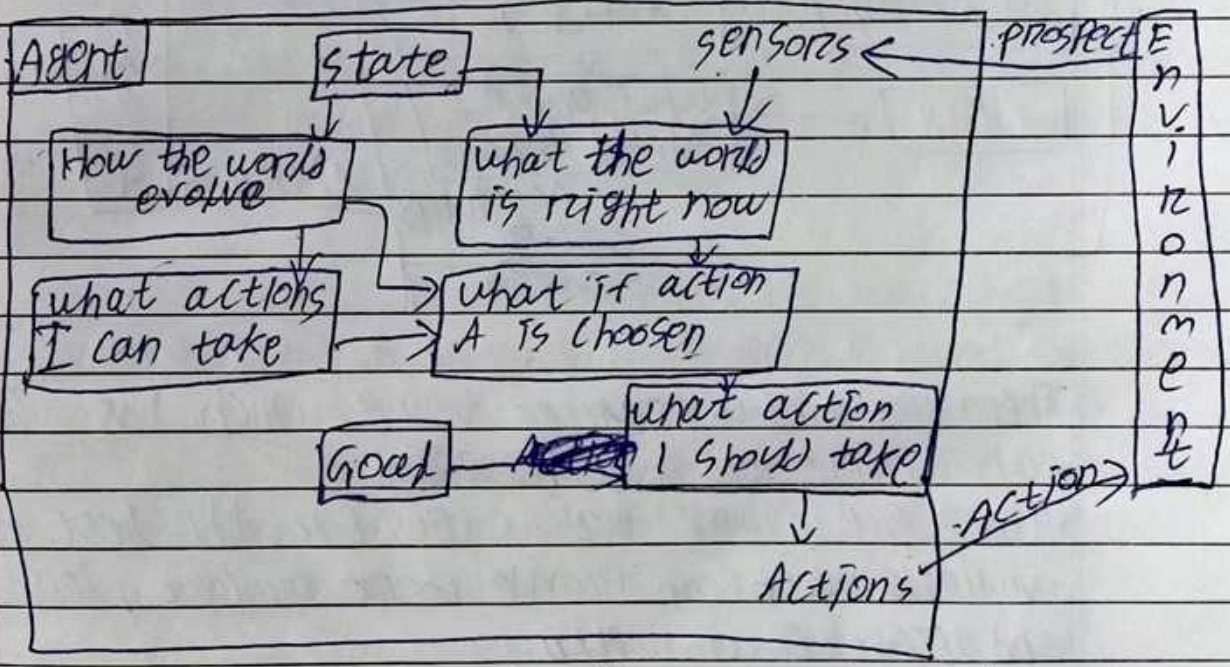
2 model based reflex agent :-



PAGE NO.:
DATE:

→ These type of agents are having memory it stores the information about previous state and current state in the memory.
→ It takes decision by analysing the model and the rule regarding the condition.
→ For example in a driverless car if the car wants to make to change the route then it should check the vehicle coming from the back. It will give signal for moving left or right and take decision.
→ Here the model is how the things are happening in the world or the rules of a knowledge system.

(3) Goal based Agent :-



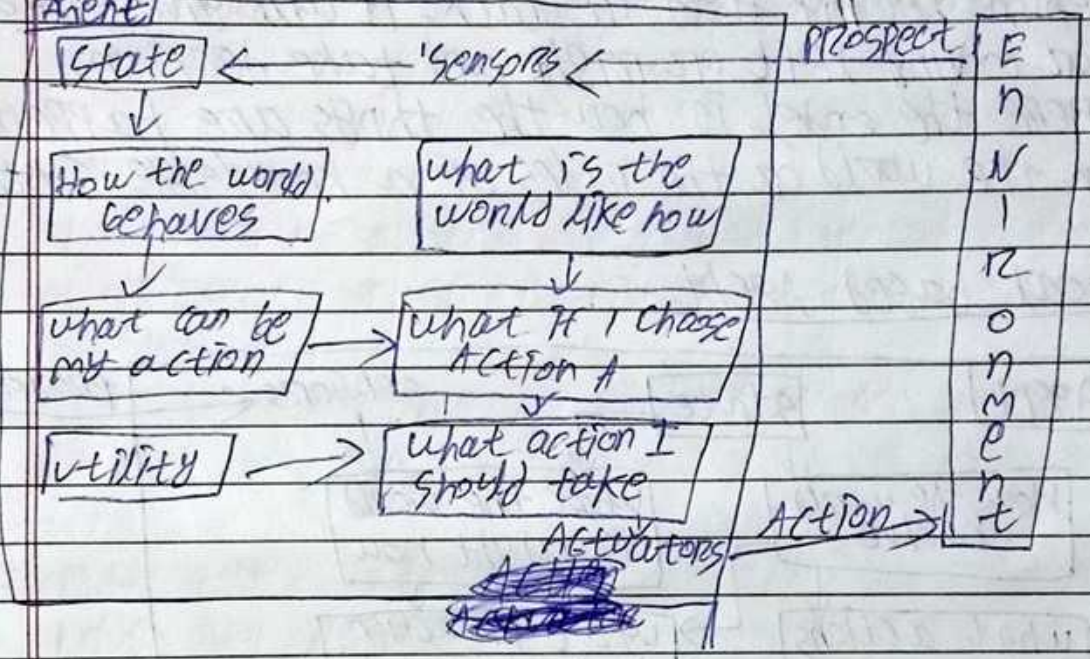
→ In some circumstances the current state may not help you in taking the right direction.
→ If the goal is known to you, you can choose different options to reach it.

PAGE NO.:
DATE:

→ For ex:- In a driverless car if any route to the destination is having any issue, it can switch to the nearest route to reach the destination. So it is flexible in nature for taking wise decision.

25-7-25

④ Utility based agents:-



→ There are various sequences using which the agent can achieve the goal.

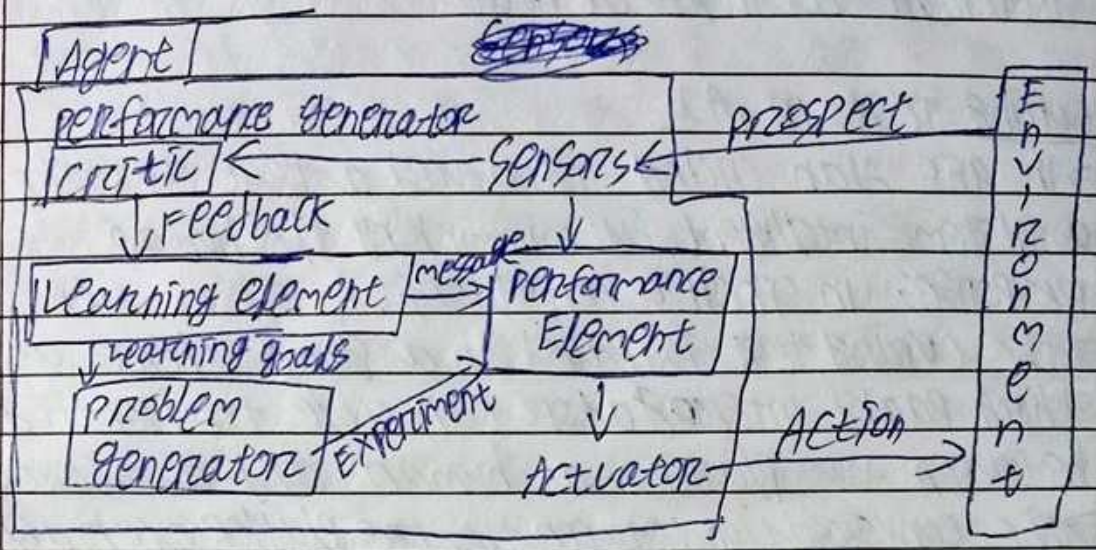
→ The agent always try to go for the best option available which can provide more comfort, less cost and less time consumption.

→ The success of it, depends on the utility agents preferance.

→ The utility function maps the degree comfortableness for the agent and the output accuracy

PAGE NO.:
DATE:

Learning Agent :-



→ The learning agent in AI which can able to learn from its past experiences can work based on four components

1. Critic :- Learning elements takes feedback from the critic which describes how well the agents can able to improve.

2. Learning element :- It is responsible for making improvements by learning from the critic and environment.

3. Problem generator :- This component is responsible for suggesting different actions which will lead to innovative experience.

4. Performance element :- It is responsible for selecting the proper action of the agent.

For example : In A self driven car the learning element gets various inputs from the critic. Accordingly it modifies

the learning system to adapt itself for different conditions of road.

Curing Test in AI :-

⇒ In 1950 Alan Curing introduced a test to make a system intelligent by mimicking the human responses in specific conditions.

⇒ The curing test is based on a game where a third party interogator can able to identify between two players - a human and a system.

⇒ The conversation between the two players can able to identify who is a system and who is a human.

⇒ The interogator provides a multiplication of two 9 digit numbers. The answer from human was judged as wrong but the system replied 'no'.

29.7.25

Levels of AI model :-

Level 1 :- In first level of AI the computer solves the problem by using the existing or available knowledge.

Level 2 :- The second level of problem attempts to solve which are non-trivial in nature. That means which can able to provide more than one options to select.

PAGE NO.:
DATE:

~~Problem~~ :-

What is a Problem :-

A problem is characterised by 3 things :-

① A set of goals which needs to be achieved by the client.

② The set of objects/tools using which the client can achieve the goal.

③ The operations through which the goals can be achieved

To find the solution of a problem we need to

① defined the problem precisely.

② Analyse the problem which is the most crucial part for getting a solution.

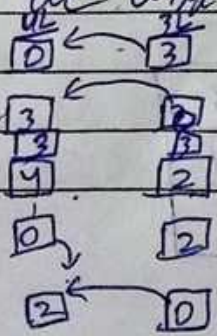
③ Finding the route from input to output.

④ Isolate or finalize the most efficient route.

Water Jug Problem :-

In this problem we have two containers or jugs a 4liter and a 3 liter jug. Neither of the jugs has measuring marker on it. How can we get exactly 2 liter of water in the jug.

Ans First we will fill the 3L jug and store that 3L water in 4L jug, so that in 4L jug there will be 3L. Then Again we fill the 3L jug and again pour the water from 3L to 4L jug. As previously we had 3L water in 4L jug, then after pouring 1L from 3L jug we will 2L in 3L jug and then we will empty the 4L jug and pour the 2L in it.



4L	3L
4	0
1	3
1	0
0	1
4	1
2	3

PAGE NO.:
DATE:

Process 2:-
First we will fill the 4L jug and store this 4L water in 3L jug that there will be 1L in 4L jug and 3L in 3L jug. and empty this 3L jug and store the 1L in 3L jug. Then again fill the 4L jug and pour this 4L to 3L liter so that there will be 2L water in 4L jug.

30.7.25

8-puzzle problem :-

2	8	3
1	6	4
7		5

→

1	2	3
8		4
7	6	5

In this problem it consist of 8-Numbers and 1 empty place in a 3x3 Array. The empty cell can be swapped to move up, down, left or right.

Step 1:-

2	8	3
1		4
7	6	5

Step 2:-

2		3
1	8	4
7	6	5

Step 3:-

	2	3
1	8	4
7	6	5

Step 4 :-

1	2	3
	8	4
7	6	5

Step 5 :-

1	2	3
8		4
7	6	5

PAGE NO.:
DATE:

process :-

step 1 :- First move the middle 6 to the down(2,2)

step 2 :- move 8 from the (1,2) to the down(2,2)

step 3 :- move 2 from the (1,1) to the Right(1,2)

step 4 :- move the 1 from

step 1 :- swap 6 with blank (UP)

step 2 :- swap blank with 8 (UP)

step 3 :- swap blank with 2 (left)

step 4 :- swap blank with 1 (down)

step 5 :- swap blank with 8 (right) to get your final goal

1	4	3
7		6
5	8	2

→

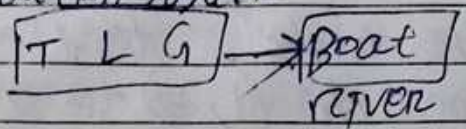
1	4	
5	8	2
7	6	3

step 2 :-

step 2 :-

PAGE NO.:
DATE:

~~Production System~~



Step 1 :- cross the goat to the other part of the river.

Step 2 :- ~~Take~~ The boat will bring tiger to the side 2 it will take goat with it.

Step 3 :- bring the leaf to side two

Step 4 :- bring the goat to side two.

Production System in AI :-

A production system is an architecture which is used to implement the rule based algorithms and replicate the human problem solving skills. It consist of two parts : (i) condition or rule (ii) Action

(1) Condition or rule :-

It provides a combination of factors for a particular condition.

~~Left Right~~

(2) Action :-

Action is the knowledge to deal with the condition.

The Features of production system :-

(1) Simplicity :- Due to the use of if-then structure each sentence is having unique value. It provides an unique action for individual production rule.

PAGE NO :
DATE:

(2) Modifiability :-
This feature allows for modification in the production rules according to the requirement.

(3) modularity :-
The knowledge available is coded in individual pieceses which makes it easy to add, delete or modify the operation without affecting other production rules.

(4) Knowledge intensive :-
This feature of production system stores the knowledge from the given production rules.

(5) Characteristics of production system :-

(i) monotonic production system :-
In the production system the application of a rule never prevents another application to be applied for any modification.

(ii) Commutative system :-
In this characteristics the production rule depends on another production rule for its operation and decision making.

1-8-25

PAGE NO.:
DATE:

State space:-

What is search?

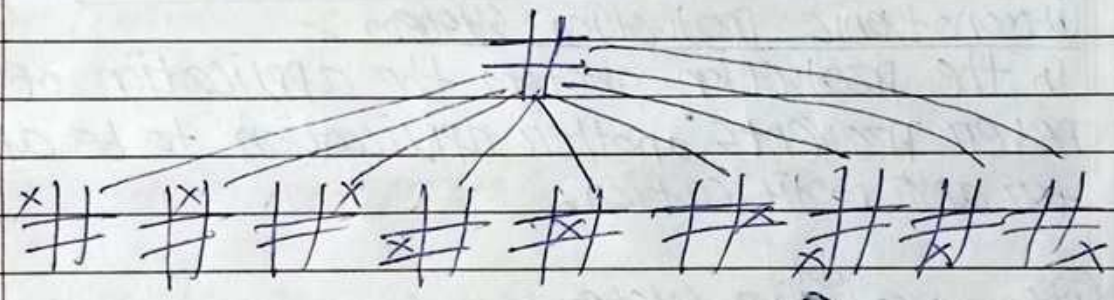
It is the problem or activity to trace/track the required solution in the given search space/ state space.

State space / search space:-

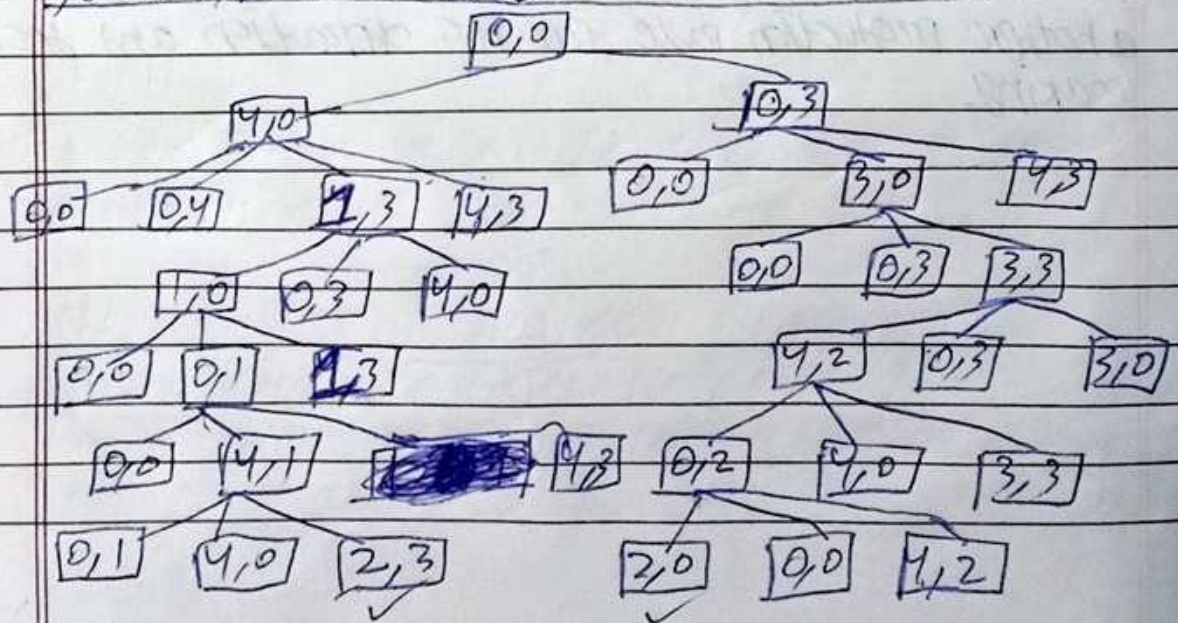
The search space / state space consist of all possible solutions or states present in the problem.

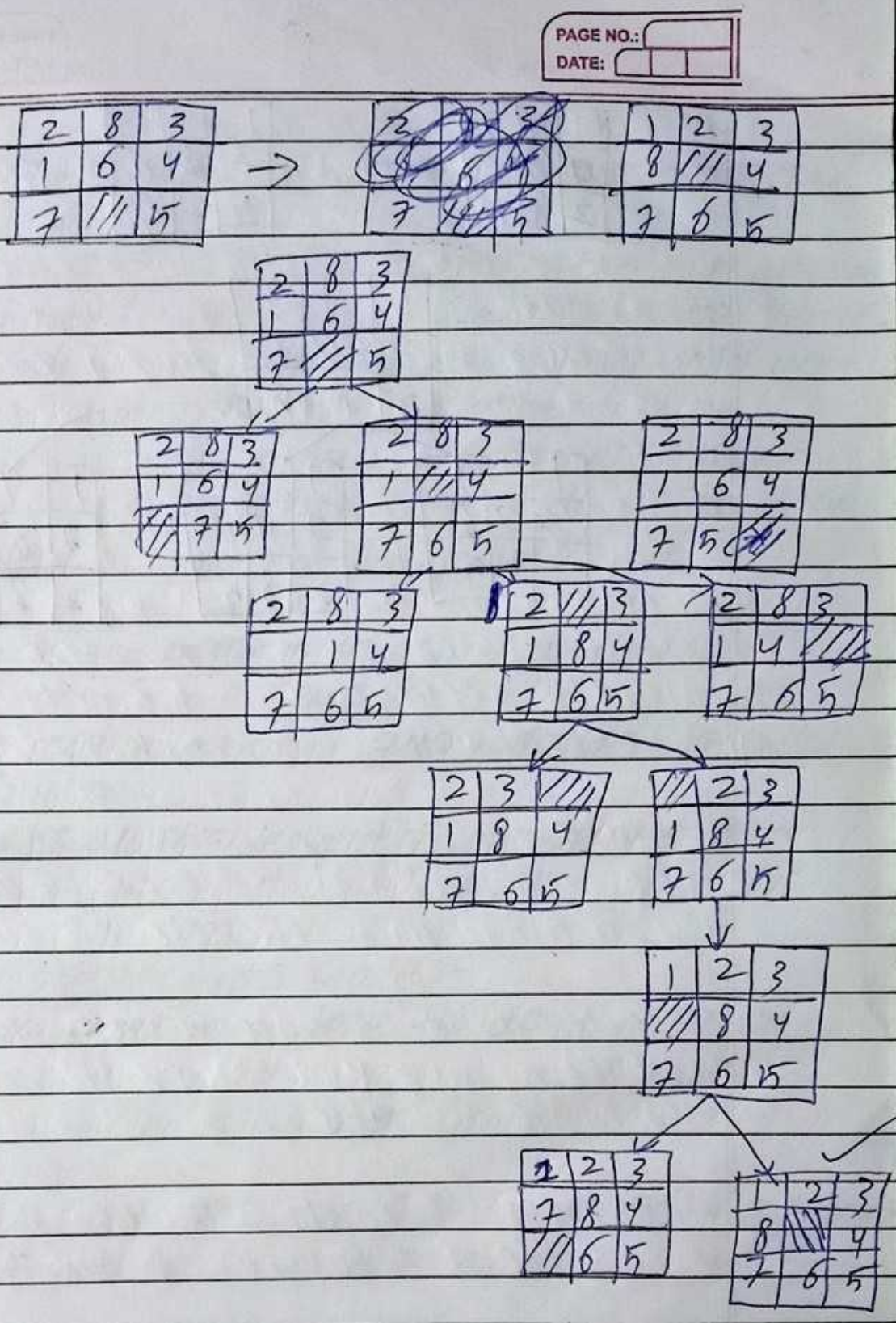
It looks like a tree structure connecting with its previous states.

For example- The state space or search space of a tic-tac-toe problem is

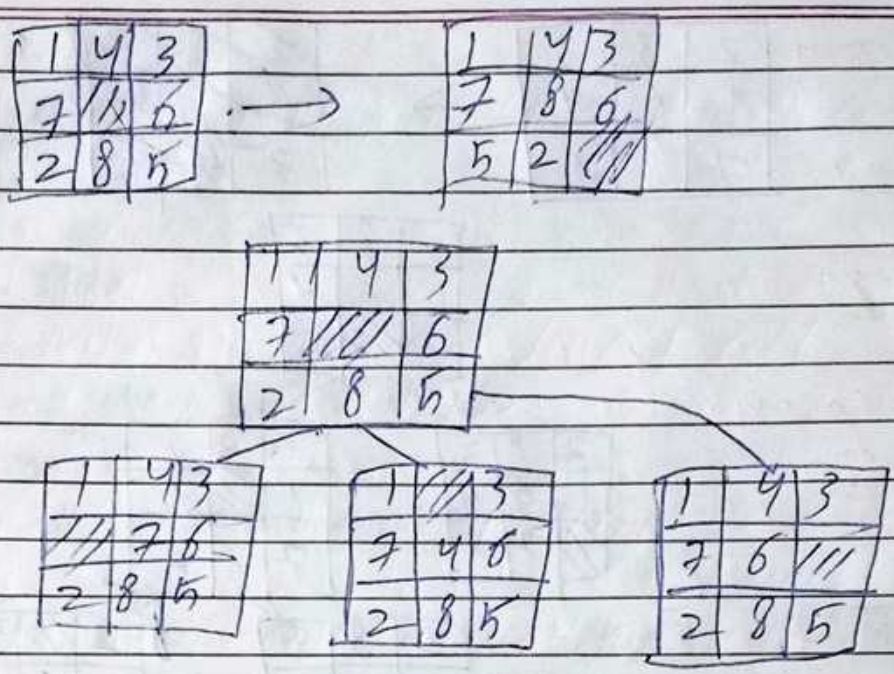


State space of water-jug problem:-





PAGE NO.:
DATE:



5.8.25

PAGE NO.
DATE

Issues in designing search algorithm :-
During the searching algorithm the tree traversal plays a vital role.

(1) The tree can be searched in either top-down approach or bottom-up approach for finding the goal state.
(2) From various rules of searching which rule is more efficient that needs to be checked.
(3) The factors required to use during searching plays a vital role whether it is a graph or a tree.

The basic terminology in search Algorithm :-

(1) Search tree / state space :-
⇒ A tree representation of search problem is called search tree.
⇒ It provides all possible solution available in the system.

(2) Initial state / start state :-
It is the state from where the agent begins the search.

(3) Goal state
It is the state where the solution lies and there are multiple goal states in a search tree.

(4) Action state :-
It gives the description of all available actions of the agent

PAGE NO.:
DATE:

⑤ Path cost:-
It is the function which assigns a numeric cost to each path.

⑥ optimal path :-
This solution provides the lowest cost among all available solutions.

Properties of search Algorithm:-
In sorting algorithms the object is 4 types
① Strictly increasing :- 1, 2, 4, 5, 6
② Non-decreasing :- 1, 2, 2, 3, 3, 4, 5
③ Strictly decreasing :- 8, 6, 5, 4, 3
④ Non-Increasing :- 8, 8, 6, 5, 5, 4, 4, 3

Properties :-
① Time complexity:- It is the measure of time for an algorithm to complete its task

② Space complexity:- It is the storage space required at any point during the search used by the variables.

③ Completeness:- A search algorithm is said to be complete if it garentess to give a solution.

④ Optamility :- If a solution found through the algorithm is garented to be the best solution (lowest path cost) among all other solutions then it is called optimal solution.

PAGE NO.:
DATE:

Types of search algorithm :-
Based on the search problem we classify the search algorithm into 2 types :-

(i) Uninformed search / Blind search :-
In this type of searching algorithms, the agent does not contain any domain knowledge regarding the location of goal.
It operates in a brute force way to find the goal state by traversing the tree.
The Examples of uniformed search / Blind search are :- (i) Breadth first search
(ii) Depth first search
(iii) Uniform cost search
(iv) Bi-directional search
(v) Itterative search

(ii) Informed search / Heuristic search :-
In this type of search algorithm the agent got the domain knowledge regarding the goal.
The objective of informed search is to find a solution which is more efficient.
Ex :- (1) Greedy search
(2) A* search

12.8.25

PAGE NO.:
DATE:

Knowledge :-

→ It is the information about a domain that can be used to solve a problem in that domain.
→ It is the ability to improve intelligence.
→ So knowledge is a collection of well specified inference rule and facts.

knowledge representation :-

It describes the utilization of knowledge to solve complex real life problems like communicating with human beings using NLP and behaving intelligently like human is a tough task.

knowledge base :- (KB)

We have various kinds of knowledge base to be represented in AI system.

① Object :- All the facts or knowledge can be created using the objects like strings in gitar creates different lyrics by its proper utilizatio

② Event :- These are the actions which occur in the real world to improve the knowledge-base.

③ Performance :- It describes the behaviour which involves the knowledge how to do the things.

④ Meta knowledge :- It is the knowledge about the source of knowledge. It is the knowledge about what we know.

PAGE NO.:
DATE:

⑥ Fact :- This the truth in the real world which never changes.

Knowledge Based Agent (KBA) :-

→ It includes knowledge base and the inference system which creates new sentences.

→ The agent utilises the knowledge base for its operations.

operations of knowledge based agent :-

KBA performs 3 types of operations.

① TELL :- This operation tells the knowledge base what it understands from the environment.

② ASK :- This operation asks the knowledge base what are the actions available to perform.

③ PERFORM :- It performs the selected option.

Inference system :-

It derives new sentences from the same inputs and utilising the knowledge base.

It allows to add logical rules to create new information.

PAGE NO.:
DATE:

Types of Knowledge:-

(1) Declarative Knowledge:- This type of knowledge is very simple.
→ It includes concepts, facts and agenda which needs no proof.

(2) Procedural Knowledge:-
This is a type of knowledge which is responsible for knowing how to do the things.
It includes rules, strategy or a structure to get the knowledge.
It depends on the task on which it is going to be applied.

(3) Meta Knowledge:-
This is the knowledge regarding the sources of knowledge like youtube, google, etc.

(4) Heuristic Knowledge:-
The knowledge obtained from the experts of that field is called heuristic knowledge.
It is obtained previous experience, works done in that field or awareness regarding approach.

(5) Structural Knowledge:-
It is the basic knowledge of problem solving.
It provides the relationship between different statements and provides a structure how to solve the problem.

8.25

PAGE NO.:
DATE:

Approaches of knowledge Representation:-

1. ~~Relational type of knowledge representation.~~
Relational Representation / Relational knowledge Representation :-

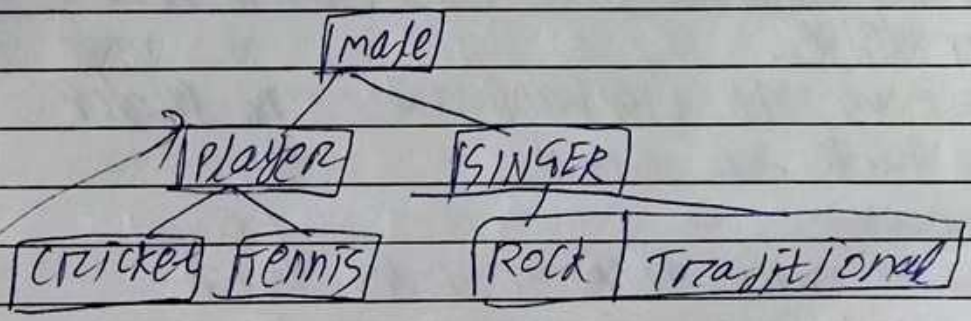
This is simple knowledge representation where the data is represented in the form of rows and columns.

Rows represents the records and columns represent the features/characters of the records.

For EX :-

Id	Name	Roll No	Phone No
101	RR	15	7978
102	SK	06	8482
103	SB	21	6698

II Inheritable knowledge Representation :-



→ In the Inheritable knowledge Representation the data are stored in hierarchal manner (step by step).
→ All the classes which are in upper label provides data / knowledge to the subclasses.
→ In this approach we have objects and values / relations.
EX :-

In this example there are 7 objects and 3 relations.

(3) Intercincial Knowledge Representation:-
This approach represents the knowledge in the form of formal logic which derives new knowledge by utilishing the existing knowledge.
For ex:- Ram is a Human.
All Humans are mortal.
Ram is mortal

(4) Procedurial Knowledge Representation:-
This knowledge Representation contains if-then rule.
In this knowledge representation the procedure of two different statements create new knowledge.
It is used by LISP language and prolog language.
For ex:-
If it rains then tadPoles born
If tadPoles born Then snake come.
If it rains then shake come

(5) Requirements of knowledge Representation:-
i Representational Accuracy:-
The knowledge Representation system should have the abilfty to Represent all kinds of required knowledge.

PAGE NO.:
DATE:

ii Inferiancial Adequacy :-
The knowledge representation system should be able to produce all types of inferiancial knowledge from the given knowledge base.

iii Inferiancial Efficiency :-
It is the ability to check the inferiancial knowledge which are more productive to be stored.

iv (Storage) Acquisitional Efficiency :-
This approach keeps track of the inferiancial knowledge that is created by the system.

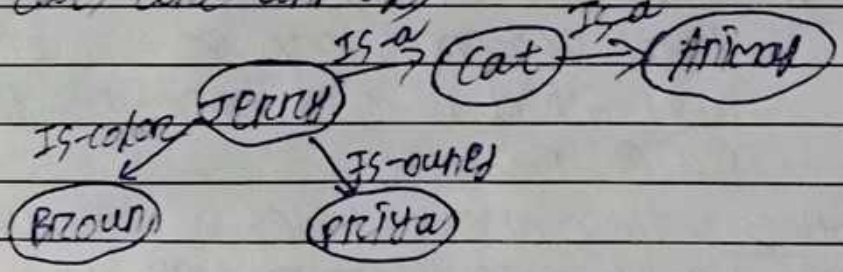
⑥ Techniques of knowledge Representation :-
i Logical Representation :-
The logical representation is the language which deals with propositions and has no ambiguity in the representation.
The logical representation is translated into 2 parts
A. Syntax :- These are the rules which decide how the legal sentences can be created. It determines which symbol to be utilished in appropriate place. EX :- int a=10 ;
B. Semantices :- these are the rules by which we can interpret the sentence in proper logic. It assignes a meaning to each sentence. For EX :- int b=-5;
int d=sqrt(b);
It is classified into 2 different logics :-
① Propersitional.
② Predicted

PAGE NO:
DATE:

Advantages of Logical representation:-
This representation provides logical meaning to the propositional statements.
Limitation of this representation:-
This techniques have some restrictions to infer different logic

12.8.25

Symantic network representation:-
In this technique we represent our knowledge in the form of graphical network.
The network consist of:-
① Nodes representing the objects
② Arcs representing the relationship between the objects.
For example we have some statements to represent in symantic network.
① Jerry is a cat
② Jerry is owned by Priya
③ Jerry is brouned colored
④ all cats are animals



The limitation of this technique:-
⇒ This representation takes more computational time as it has to cover the complete tree to gain the knowledge.
⇒ It utilises more memory as the objects and

relationship consume more memory.

Advantage :-
This very simple to understand as it is the natural representation of knowledge

(3) Frame representation :-
→ It is a record like representation where it has two parameters, attributes and values.
→ This also called as slot-filter representation.
→ For example :-

Slot	Filter
Title	AI
Author	P. Genric Norvey
Genric	CSE
Edition	5th
Year	1996

Advantages of frame representation :-
→ It makes the programmer easier to group the related data.
→ It is easy to modify the slotes or attributes for our requirement.

Limitation :-
In this representation inference mechanism is not working

PAGE NO.:
DATE:

4 Production rule representation :-

This rule consist of condition-action pair means if condition then action.
It has mainly 3 parts :-
① set of production rules
② working memory
③ recognisiable cycle.

In production rule, the agent checks for the condition and if the condition exists then it fires the action.

For example :- rule 1 :- if (bus arrives at the bus stop) then (get into the bus)
rule 2 :- if (on the bus and unpaid the ticket) then (pay the charges)
rule 3 :- if (on the bus and paid charges and empty seat) then (seat down)
rule 4 :- if (bus arrives at destination) then (get down from the bus)

Advantages of production rule :-

→ This expressed in natural language.
→ It can be modified according to the requirement

Limitation of production rule :-

If the number of rule base are more it will check the efficient production rules.

PAGE NO.:
DATE:

Propositional logic:-

Propogistion is a declarative statement which returns either true or false.

For example:- $3+3=7$ is a false propogistion.

Today is tuesday is true propogistion

Types of Propogistion:-

There are two types of propogistion:-

① Atomic propogistion:- This is the simple propogistion consiting of only one statement. For ex- sun is cold (is a false propogistion)

② Compound Propogistion:-

This type of propogistion is constructed by combining two different proposition. By using logical connectives.

For example:- P is a proposition it is raining.

Q is another proposition:- The roads are wet.

If it is raining then the roads are wet

EX 2:- P:- ankit is a doctor

Q:- ankit is an engineer.

Ankit is a doctor or he is an engineer.

Connectives / logical connectives:-

→ Negation:- It is symbolished by '¬' and represents the negative of the proposition.

For ex:- If P it is raining

¬P it is not raining

Truth table:-

P	¬P
T	F
F	T

PAGE NO.:
DATE:

Conjuction :-
If there are two propositions P and Q then conjuction is symbolised by '∧'.
For example :-
P : Ankit is a Doctor
Q : His clinic is in mumbai
P ∧ Q :- Ankit is a Doctor and his clinic is in mumbai.

P	Q	P ∧ Q
T	T	T
T	F	F
F	T	F
F	F	F

3. Dis-Junction :-
If P and Q are two different propositions then P or Q is symbolised by 'V'.
For example :-
P : Sam is a Doctor
Q : He is a Painter
P V Q : Sam is a Doctor or he is a Painter.

P	Q	P V Q
T	T	T
T	F	T
F	T	T
F	F	F

PAGE NO.:
DATE:

Implication :-

If P and Q are two propositions, then $P \xrightarrow{\text{implies}} Q$ is symbolised by $P \to Q$ which gives if then condition.

EX:- P: It is raining
Q: the roads are wet
$P \to Q$: If it is raining then the roads are wet

P	Q	$P \to Q$
T	T	T
T	F	F
F	T	T
F	F	T

Double implication (By conditional) :-

If P, Q are two proposition then P 'double implication' Q provides the by-conditional connecting.

For EX:- P: I am breathing
Q: I am alive
$P \leftrightarrow Q$: If I am breathing then I am alive and if I am alive then I am breathing.

P	Q	$P \leftrightarrow Q$
T	T	T
T	F	F
F	T	F
F	F	T

20.8.25

PAGE NO.:
DATE:

Q $(P \wedge Q) \rightarrow (P \vee \neg R)$

P	Q	R	$\neg R$	$P \wedge Q$	$P \vee \neg R$	$(P \wedge Q) \rightarrow (P \vee \neg R)$
0	0	0	1	0	1	1
0	0	1	0	0	0	1
0	1	0	1	0	1	1
0	1	1	0	0	0	1
1	0	0	1	0	1	1
1	0	1	0	0	1	1
1	1	0	1	1	1	1
1	1	1	0	1	1	1

Properties of connectives:-

1) Commutative :- $P \wedge Q = Q \wedge P$
$P \vee Q = Q \vee P$

If P, Q are two different propogisition then $P \wedge Q = Q \wedge P$
$P \vee Q = Q \vee P$

2) Associative property:-

If P, Q, R are three different propogisitions then $P \wedge (Q \wedge R) = (P \wedge Q) \wedge R$
$P \vee (Q \vee R) = (P \vee Q) \vee R$

3) Distributive property:-

If P, Q, R are three different propogisitions, then
$P \vee (Q \wedge R) = (P \vee R) \wedge (P \vee R)$
$P \wedge (Q \vee R) = (P \wedge Q) \vee (P \wedge R)$

PAGE NO.:
DATE:

(4) Demorgans law :-
If P,Q are two different propogisitions, then
$\neg(P \wedge Q) = \neg P \vee \neg Q$
$\neg(P \vee Q) = \neg P \wedge \neg Q$

(5) Identity property :-
~~If P, Q are two different~~
If P is a propogisition then $P \wedge T = P$
$P \vee T = T$

Limitation of propogisitional logic :-
In propogisitional logic we can use limited no. of propogisitions but if the numbers is high, you have to go for predicate logic

Predicate logic or first order logic (FOL) :-
The predicate logic developes the information about the objects in a more convenient way by using objects, relations and functions.

Syntax of predicate logic :-
The syntax of FOL determines which collection of symbols is providing the logical expression.
constant → 1, 2, 3, a, b - - - cat, dog - -
variable → x, y, z, a, b - - -
predicates → Brother, father, sister - - -
Functions → sqrt, ABS, sum - - -
connectives → $\wedge$, $\vee$, $\rightarrow$, $\leftrightarrow$
quantifier → $\forall$, $\exists$

There are 3 components of Predicate logic:-

① Predicate:-
The symbol which is used to represent the properties or relationship between the objects is called Predicate. For ex:-
[Is locate] (Delhi, India)
Here the Predicate is "Is located in"

② Variable:-
The symbol used to represent the objects are called variable.
For ex:- Delhi and India are the variables.

③ Quantifier:-
This symbol in logical statement is used to determine the scope of the variable.
~~① Existential quantifier~~
① Existential quantifier (∃) :-
→ This quantifier is used to determine the no. of objects are limited or some.
→ It is denoted by (∃).
→ For Example:-
Some mammals are animals
$\exists x, (m(x) \wedge A(x))$ where
$m(x)$ represent the set of mammals
and $A(x)$ " " " " Animals.

Ex2:- Some boys are intelligent
$\exists x, (B(x) \wedge I(x))$
where $B(x)$ represent the set of boys
and $I(x)$ " " " " Intelligent persons.

Some boys like football
$\exists(x), (B(x) \wedge Like(x, football))$

Some people eats fish
$\exists(x), (P(x) \wedge eats(x, fish))$

Universal quantifier :-
This is the symbol used to represent all the variables and is represented by the symbol '$\forall$'. which utilises implication for its operations.
Ex: All mammals are warm blooded.
$\forall x, M(x) \rightarrow W(x)$
$m(x)$ represent the set of mammals
$W(x)$ // // // // warm blooded animals

All man drink coffee.
$\forall x, (m(x) \rightarrow Drink(x, coffee))$
where $m(x)$ represent the set of mans
Drink() is the relation.

All man respect there Parent
$\forall x, (m(x) \rightarrow respect(x, Parent))$

Not all students like both mathematics and science
$\neg \forall x, (S(x) \rightarrow Like(x, math) \wedge Like(x, science))$

PAGE NO.:
DATE:

Characteristics of predicate logic :-

1. It is used to represent the complex relationships.
   It can represent all types of logical connectives.
2) It consist of well defined rules and proper syntax to represent the relationships.
3) It is widely used in AI because it has the capability to represent the facts and relationship in a structural form.

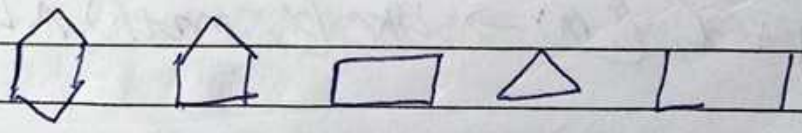
26.8.25

Reasoning

Reasoning is the mental process of deriving logical conclusion and making prediction from the available knowledge.
In AI the reasoning is essential to make the machine think and perform like a human brain.

Types of reasoning :-

1) → Symbolic Reasoning :- This type of reasoning derives the conclusion by utilising the properties of the existing symbols.
It recognises the patterns of previous symbols and able to predict the next symbol.
For ex :-



2 Logical reasoning :- It is the collection of rules which provides the output by utilising the rules of inference, it is of two types :-

PAGE NO.:
DATE:

(1) → Formal logical reasoning
(2) → Informal logical reasoning

(1) The formal logical reasoning provides a particular formula or pattern, to predict the conclusion.
For ex:- 2, 5, 10, 17, 26, 37, 50 65
Pattern:- x^2+1

(2) The informal logical reasoning is created through the various inference rules.
Ex:- 1, 2, 3, 4, 5, - - - -
10, 9, 8, 7, 6, 5, - - - -

(3) Monotonic Reasoning :-
In monotonic reasoning, the conventational logic based system is provided.
This type of reasoning needs no proof as these are all facts and regularly going on.
For ex:- Earth moves around the sun but we do not know wheather earth is moving or not.

Advantage of monotonic reasoning :-
This type of reasoning remains always valid and needs no proof for its validity.

Limitation :-
Some hypothetical knowledge which comes under this type of reasoning has exception.
Ex:- birds can fly with exception ostrich, penguin, etc.

PAGE NO.:
DATE:

4) Non-monotonic Reasoning:-
→ In this type of reasoning, the conclusion may be derieved from the previous sentences or knowledge.
→ It deals with the inference outcome of the existing knowledge.
Ex:- Pitty is a bird
bird can fly
Conclusion: Pitty can fly.

5 Default Reasoning:-
→ This type of reasoning is by-default true.
→ It does not need any rules to satisfy
some classical examples are:-
Birds can fly with some exceptions. But 99.9% data provides the true of this statement.

6 Deductive Reasoning:-
Deductive reasoning provides new information from the logically connected informations.
In this type of reasoning the truth of the premices should be true.
Ex:- All human eats vegetables.
Ankit is a human
Conclusion: Ankit eats vegetables

7 Inductive reasoning:-
This type of reasoning provides the conclusion using limited set of facts by the process of generalization.
Ex:- All the peoples we have seen in the zoo are white.

PAGE NO.:
DATE:

Conclusion:- we can expect all the region to be white.

8) Abductive reasoning:-
This form of logical reasoning is the outcome of single or multiple observations.
Ex:- If you put the hand on the fire, it will burn.
Ex2:- one person can not be present at the same time in two different places.

12.8.25

9) Forward Reasoning:-
→ The solution of a problem generally includes the initial data and facts inorder to arrive at the solution.
→ These information is used to provide the required result.
→ For ex:- A patient with certain disease has visited the doctor. The doctor finds the symptoms and prescribe the required test.
After proper verification of reports, the doctor can come to a conclusion the exact disease and provide the medicine.

10) Backward Reasoning:-
It is the inverse process of forward reasoning in which goal or solution is analysed to create the rules.
For ex:- the doctor tries to diagonise the patient with certain medicine but if it is not effective then the doctor prescribed the tests and finally revise the medicine.

PAGE NO.:
DATE:

Searching algorithm:-

Breadth First Search (BFS):-

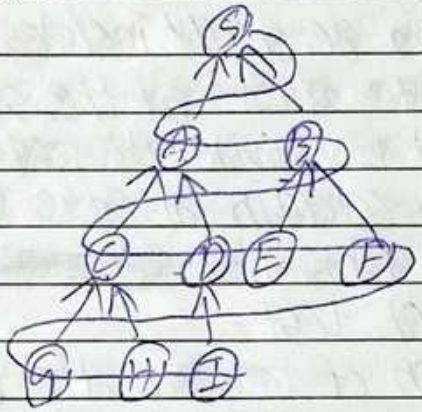
⇒ It is the most common searching strategy for traversing the tree.

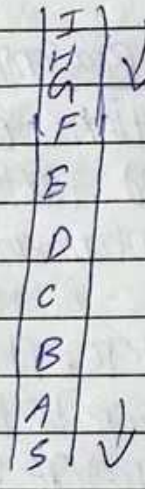
⇒ It searches the target breadth or level-wise.

⇒ BFS algorithm starts searching from root node and expands till the last node

⇒ It is implemented using FIFO or queue data structure.

For ex:-





The time complexity of BFS if
d is the depth of the tree and
b is individual node traversing time, then
the time complexity = O(b^d)

BFS provides a solution if it exists in the tree with minimal post

Limitation: It requires a lot of memory as each level of tree must be saved in the memory.

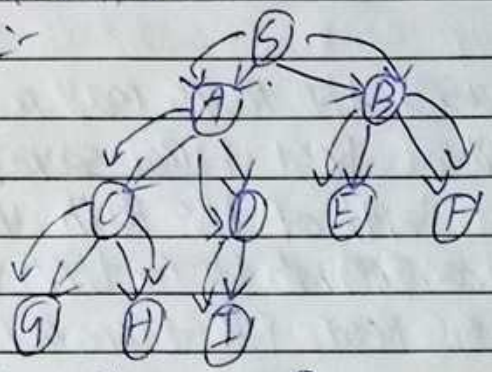
O - worst
θ - average
Ω - best

PAGE NO.:
DATE:

DFS (Depth-First Search):-

→ It is a recursive algorithm for traversing the tree.
→ It starts from the root node and follows each path to its greatest depth before switching to the next path.
→ DFS utilises stack data structure for its implementation.
→ Backtracking is the major technique DFS is utilising during recursion.

For ex:-



S → A → C → G
S → A → C → H
S → A → D → I
S → B → E
S → B → F

G	H	I
C	C	D
A	A	A
S	S	S

The time complexity of DFS if
m is the maximum depth of any path and
n is the node timing then the time complexity is
O(nm)

advantage:- It requires less memory as it has to store only the size of maximum path.
It takes less time in general with DFS.

Limitation:-
→ DFS goes deep for searching for a infinite loop and it repetadely checks those nodes which are already verified.

PAGE NO.:
DATE:

3 Best First Search :-

→ In this algorithm the repeated nodes are not going to be verified again and again. So it saves time. But there is no particular rule how many nodes will be repeated in the next path.
So this algorithm is working well for limited no. of nodes.
If the nodes increases the rules may not works.
The time complexity of Best First search if m is the maximum depth of the path and b is the node traversing time, then the time complexity of Best First search is O(bm).