

## Assignment No. 1

Page: \_\_\_\_\_

Date: \_\_\_\_\_

Ques. 1(a) Define AI and Applications of AI.

- ① Artificial intelligence is the simulation of human intelligent processes by machines, especially computer systems.
- ② AI is the study of how to make computers to think which at the moment people do better.

\* Applications of AI: →

- ① AI in Astronomy: It can be very useful to solve complex universe problems. It can be helpful for understanding the universe such as how it works, origin etc..
- ② AI in healthcare: Healthcare Industries are applying AI to make a better and faster diagnosis than human.
- ③ AI in Gaming: The AI machines can play strategic games like chess, where machines needs to think of a large number of possible places.
- ④ AI in Finance: The finance industry is implementing automation, chatbot, machine learning into finance processes.
- ⑤ AI in Data security: The security of data is crucial for every company and cyber-attacks are growing very rapidly in digital world. AEG and AI2 are used to determine software bugs and cyber attacks in a better way.
- ⑥ AI in Robotics: Generally robots are programmed such that they can perform some repetitive task, but with help of AI. Humanoid Robots are best example for AI in robotics.

⑦ AI in education : AI can automate grading so that the tutor can have more time to teach. AI chatbot can communicate with students as a teaching assistance.

Ques. 1(b) Give the state space representation of the water jug problem and give one solution to it.

→ The state space for this problem can be described as the set of ordered pair of integers  $(x,y)$  such that  $x = 0, 1, 2, 3$  or  $4$  and  $y = 0, 1, 2$  or  $3$ , where  $x$  represent the no. of gallon of water in  $4$  gallon jug and  $y$  represent the no. of gallons of water in the  $3$  gallon jug.

The start state is  $(0,0)$  and the goal state is  $(n,n)$  for any value of  $n$ , as the problem does not specify how many gallons need to be filled in the  $3$  gallon jug ( $0,1,2,3$ ). So the problem has one initial state and many goal states. Some problems may have many initial states and one or many goal states.

①  $(x,y) \rightarrow (4,y)$  ... fill the  $4$  gallon jug  
if  $x < 4$

②  $(x,y) \rightarrow (x,3)$  if  $x < 3$  ... fill the  $3$  gallon jug

③  $(x,y) \rightarrow (x-d, y)$  if  $x > 0$  ... pour some water out of  $4$  gallon jug

④  $(x,y) \rightarrow (x,y-d)$  if  $y > 0$  ... pour some water out of  $3$  gallon jug

- ⑥  $(n, 4) \rightarrow (0, n)$  if  $n > 0$  ... empty the 4 gallon jug on the ground
- ⑦  $(n, 4) \rightarrow (n, 0)$  if  $n > 0$  ... empty 3 gallon jug on the ground
- ⑧  $(n, 4) \rightarrow (4, 4(4-n))$   
if  $n + 4 \geq 4$  and  
 $n > 0$  ... pour water from the 3 gallon jug into 4 gallon until 4 gallon jug is full.
- ⑨  $(n, 4) \rightarrow (n - (3-4), 3)$   
if  $n + 4 \geq 3$   
and  $n > 0$  ... pour water from 4 gallon jug into the 3 gallon jug until 3 gallon jug is full.
- ⑩  $(n, 4) \rightarrow (n + 4, 0)$   
if  $n + 4 \leq 4$   
and  $n > 0$  ... pour all the water from 3 gallon into 4 gallon jug
- ⑪  $(n, 4) \rightarrow (11 - n, 0)$   
if  $n + 4 \leq 3$  and  $n > 0$  ... pour all the water from 4 gallon jug into 3 gallon jug
- ⑫  $(0, 2) \rightarrow (2, 0)$  ... pour the 2 gallon jug from 3 gallon into 4 gallon jug
- ⑬  $(2, 4) \rightarrow (0, 4)$  ... empty the 2 gallon on 4 gallon jug on the ground

water in 4 gallon jug (x)	water in 3 gallon jug (y)	Rule applied
0	0	
0	3	2
3	0	9 or 15
3	3	2
4	2	7 (or 10)
0	2	5 or 12
2	0	9 or 11

Ques. 2 a) what is a production system ? what are its characteristics?

- ① A production system is based on a set of rules about behavior.
- ② These rules are a basic representation found helpful in expert system, automated planning and action selection.
- ③ Production system or production rule system is a computer program typically used to provide some form of AI, which consist primarily of a set of rules about behavior but it also includes the mechanism necessary to follow those rules as the system responds to stimuli of the world.
- ④ The major components of production system in AI are:

Global database, set of production rules, a control system.

\* characteristic →

- ① Simplicity: →

The structure of each sentence in a production system is unique and uniform as they use the "IF-THEN" structure.

① modularity: →

This means the production rule code the knowledge available in discrete pieces. Information can be treated as a collection of independent facts which may be deleted or added from the system with essentially no deleterious side effects.

② modifiability: →

This means the facilities for modifying rules. It allows the development of production rules in a skeletal form first and then it is accurate to suit a specific application.

③ knowledge-intensive: →

The knowledge base of the production system stores pure knowledge. This part does not contain any type of control or programming information.

Ques. 2b) Write and explain various AI problem characteristic in short.

→ ① Is the problem decomposable into small sub-problems which are easy to solve?

Example: In this case, the problem is divided into smaller problems.

The smaller problems are solved independently.

Finally, the result is merged to get the final result.

$$\begin{array}{c}
 \int (x^2 + 3x + \sin^2 x \cdot \cos^2 x) dx \\
 \downarrow \quad \downarrow \quad \downarrow \\
 \int x^2 dx \quad \int 3x dx \quad \int \sin^2 x \cdot \cos^2 x dx \\
 \downarrow \\
 \int (1 - \cos^2 x) \cos^2 x dx \\
 \downarrow \\
 (\cos^2 x) dx - \int \cos^4 x dx
 \end{array}$$

(2) Can solution steps be ignored or undo?

In the 8-puzzle, moves can be undone and backtracked.

Such problems are called **recoverable** problems.

2	8	3		1	2	3	
1	6	4	→	8		4	
7		5		7	6	5	

In these moves can be retracted? Such problems are called **irrecoverable** problems.

Irrecoverable problems can be solved using a simple control structure that never backtracks. Recoverable problems can be solved using backtracking. Irrecoverable problems can be solved by recoverable style method via planning.

(3) Is the universe of the problem predictable?

In playing Bridge, we cannot know exactly where all the cards are or what the other player will do on their turns. Uncertain outcome!

For certain outcome problems, planning can be used to generate a sequence of operators that is guaranteed to lead to a solution.

For uncertain outcome problems, a sequence of generated operators can only have a good probability of leading to a solution.

④ Is a good solution to the problem is absolute or relative?  
The travelling salesman problem, we have to try all paths to find the shortest one.

Any path problem can be solved using heuristics that suggest good paths to explore.

For best-path problems, a much more exhaustive search will be performed.

⑤ Is the solution to the problem a state or a path?  
The water jug problem, the path that leads to the goal must be reported. A path-sol" problem can be reformulated as state-solution problem by describing "a state as a partial path to a solution".

⑥ What is the role of knowledge in solving a problem using artificial intelligence?

Knowledge is required even to be able to recognize a solution.

⑦ Does the task of solving a problem require human interaction?

The solitary problem, in which there is no intermediate communication and no demand for an explanation of the reasoning process.

The conversational problem, in which intermediate communication is to provide either additional assistance to the computer or additional information to the user.

(Ques. 3d) why do we need heuristic function? Explain the heuristic function to solve 8 puzzle problem.

- ① A heuristic function, is a function that calculates an approximate cost to a problem.
- ② The heuristic function is a way to inform the search about the direction to a goal.
- ③ Heuristic approach emphasizes speed over accuracy; it is often combined with optimization algorithms to improve results.

\* 8 puzzle by heuristic function: →

Initial State			Local State		
2	8	3		1	2
1	6	4		8	4
7		5		7	6

2	8	3
1	6	4
7		5

2	8	3	2	8	3	2	8	3
1		4	1	6	4	1	6	4
7	6	5	7	5		7	5	

$h=3$

$h=5$

$h=5$

2	8	3	2	8	3	2	8	3	2	8	3
1	6	4	1	8	4	1	4		1	4	
7		5	7	6	5	7	6	5	7	6	5

$h=4$

$h=3$

$h=3$

$h=4$

2	8	3	4	7	1	2	3	4	5	6	7	8	9
1	2	3	4	5	6	7	8	9	1	2	3	4	5
7	6	5	4	3	2	1	8	9	7	6	5	4	3

$h=3$  estimate with  $h=2$  less as this  $h=4$  is more

1	2	3	4	5	6	7	8	9	1	2	3	4	5
8	4	3	2	1	9	7	6	5	8	4	3	2	1
7	6	5	4	3	2	1	9	8	7	6	5	4	3

$h=1$

$h=3$  less as it is less

1	2	3
8		4
7	6	5

ques. 3b) what is best first search algo.? Give its stepwise illustration with respect to suitable example.

- ① The best first search uses the concept of a priority queue and heuristic search.
- ② It is a search algorithm that works on a specific rule.
- ③ The main aim is to reach the goal from the initial state via the shortest path.
- ④ The BFS is used for finding the shortest path from a given starting node to a goal node in a graph.
- ⑤ The algo. works by expanding the nodes of the graph in order of increasing the distance from the starting node until the goal node is reached.

\* Steps : →

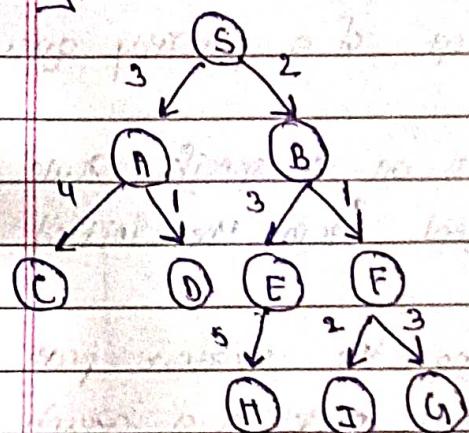
Step 1 : place the starting node into the OPEN list

Step 2 : If the open list is empty, stop and return failure.

- Step 3: Remove the node  $n$ , from the open list which has the lowest value of  $h(n)$  and place it in the closed list.
- Step 4: Expand the node  $n$  and generate the successors of node  $n$ .
- Step 5: Check each successor of node  $n$ , and find whether any node is a goal node or not. If any successor node is goal node the return success and terminate the search.
- Step 6: For each successor node, algo checks for evaluation function( $f(n)$ ) and then check if the node has been in either open or closed list. If the node has not been in both list, then add it to the open list.
- Step 7: Return to Step 2.

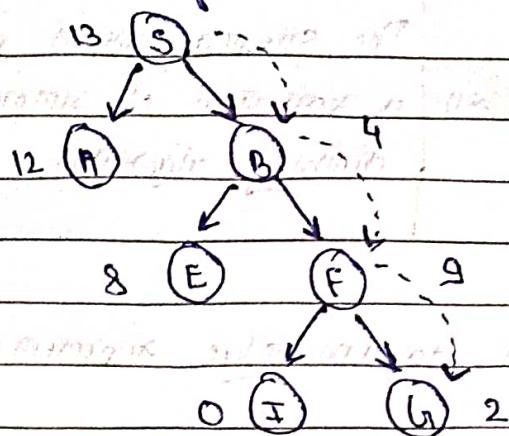
#### \* Example:

Consider the below search problem and we will traverse it using greedy best-first search. At each iteration, each node is expanded using evaluation function  $f(n) = h(n)$ , which is given in below table.



node	$h(n)$
A	12
B	4
C	7
D	3
E	8
F	2
H	4
I	9
S	13
G	0

In this search example, we have two lists which are open and closed lists. Following are the iteration for traversing the above example:



Ques. 4(a) Write the differences between simple and steepest ascent hill climbing algorithm.

$\rightarrow$	simple hill climbing Algo.	steepest ascent hill climbing Algo.
①	An iterative algo. which already has an arbitrary solution to a problem but then attempts to find a better solution by making changes to the arbitrary soln is called as simple hill climbing.	An iterative algo. which already has an arbitrary solution to a problem but then attempts to find a better solution by comparing any the successors to the closest soln.
②	The closest node is chosen in a simple hill climbing algorithm.	The node closest to the solution is identified and chosen in a steepest ascent hill climbing algo.
③	simple hill climbing - breadth first search technique	steepest ascent hill climbing - best first search algorithm.
④	less time consuming and less optimal soln and the soln is not guaranteed	consumes more time as it searched for multiple neighbors.

Simple Hill climbing Algorithm

- ⑤ Simple hill climbing is the simplest way to implement a hill climbing algorithm.

Steepest Ascent hill climbing

The steepest ascent algorithm is a variation of simple hill climbing algorithm.

(Ques. 4b) What are various approaches to knowledge representation? Explain w/o details.

→ There are mainly four approaches to knowledge representation which are given below:

① Simple Relational knowledge : →

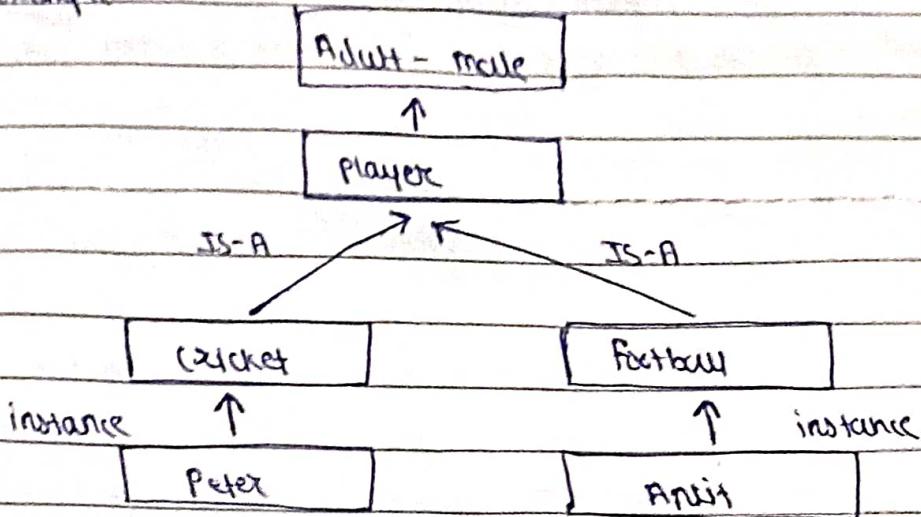
- Is the simplest way of storing facts which use the relational methods, and each about a set of the object is set out systematically in columns.
- This approach has little opportunity for inference.
- Example :

Player	weight	Age
Player 1	65	23
Player 2	58	18
Player 3	75	24

② Inheritable knowledge : →

- In this, all data must be stored into a hierarchy of classes.
- All classes should be arranged in generalized form.
- In this, we apply inheritance property.
- Every individual frame can represent the collection of attributes and its values.
- Objects and values are represented in boxed nodes.

- we use arrows which point from object to their values.
- example:



#### ⑥ Inferential knowledge : →

- Inferential knowledge approach represent knowledge in the form of formal logics.
- This approach can be used to derive more facts.
- It guaranteed correctness.
- Example:

(lets suppose there are two statements):

- a) Marcus is a man
- b) All men are mortal

man (marcus)

$$\forall x = \text{man}(x) \dashrightarrow \text{mortal}(x)$$

#### ⑦ Procedural knowledge : →

- It is user small program and codes which describes how to do specific things, and how to proceed.
- One imp. rule is used which is If-Then rule.
- we can easily represent heuristic or domain-specific knowledge using this approach.
- But it is not necessary that we can represent all case in this approach

Ques 1) Write short notes on:

① Scripts : →

→ ① A script is a structured representation describing a stereotyped sequence of events in a particular context.

② Scripts are used in natural language understanding systems to organize a knowledge base in terms of the situations that the system should understand.

③ A script is a structure that prescribes a set of circumstances that could be expected to follow on from one another.

④ The components of script includes:

a) Entry condition : There are basic conditions which must be fulfilled before events in the script can occur.

b) Results : condition that will be true after events in script occurred.

c) Props : slots representing objects involved in events.

d) Roles : These are the actions that the individual participant performs.

e) Track : Variations on the script.

f) Scenes : The sequence of events that occur.

⑤ Example :

Script for going to the bank to withdraw money.

SCRIPT : withdraw money

TRACK : Bank

PROPS : money

counter

Form

Tokens

Roles : P = customer

E = Employee

C = cashier

Entry conditions : P has no or less money

The bank is open

Result : P has more money.

Scene 1: Entering

P PTRANS P into the Bank

P ATTEND eyes to E

P MOVE P to E

Scene 2: Filling form

P MTRANS signal to E

E ATTRANS form to P

P PROPEL form for writing

P ATTRANS form to P

E ATTRANS form to P

Scene 3: withdrawing money

P ATTEND eyes to counter P and follows P PTRANS to out of bank.

P PTRANS P to queue at counter

P PTRANS token to queue and wait in queue

C ATTRANS money to P

Scene 4: Exiting the bank② Frame: →

- ① Frame is a record like structure which consist of a collection of attributes and its value to describe an entity in the world.
- ② Frame are the AI data structure which divides knowledge into substructure by representing stereotypes situations.
- ③ It consist of collections of slot and slot values. These slots may be of any type and sizes. slot have names and values which are called facets.
- ④ Facets are features of frame which enable us to put constraint on frames.
- ⑤ A frame is also known as slot-filter knowledge representation in AI.

## ⑥ Example:

	Slots	Filters
Name	Sahil	pink
Profession	Student	good
Age	20	young
marital status	Single	adult

Ques. 5(b) What is Semantic Network? Explain its advantages and disadvantages.

→ \* Semantic Network: →

- (1) A semantic Network is a graphical notation for representing knowledge in pattern of interconnected nodes.
- (2) Semantic Network became popular in AI and natural language processing only because it represent knowledge or support reasoning.
- (3) It consist of nodes, links and link labels. Nodes appear in form of circle or even rectangle which represent object such as physical object, concepts or situation.
- (4) Links appear as arrow to express the relationship b/w object, and links labels specify relations.
- (5) semantic nets also referred as associative nets. as the nodes are associated with other nodes.
- (6) Semantic Network are mainly used for:
  - a) Representing data
  - b) Revealing structure
  - c) Supporting conceptual edition
  - d) supporting navigation.

\* Advantages: →

- (1) It is simple and comprehensible.
- (2) Efficient in space requirement.
- (3) Easliy cluster related knowledge.
- (4) It is flexible and easy to visualize
- (5) It is natural representation of knowledge.

\* Disadvantages: →

- (1) Inheritance cause problem.
- (2) links on objects represent only binary options.
- (3) Interactable for large domains.

- ④ Don't represent performances or meta-knowledge effectively.
- ⑤ It's difficult to express some properties using semantic networks, like negation, disjunction etc.