Suggested Question Bank

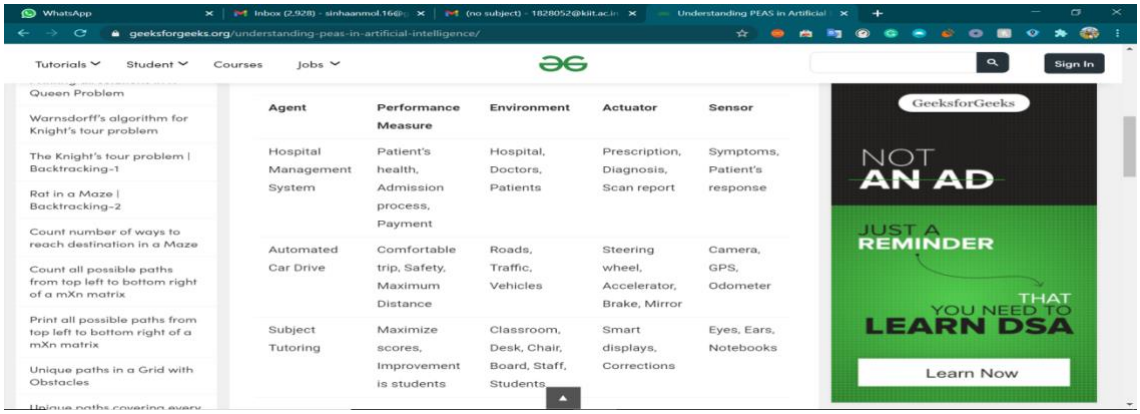
Long Question:

1. What is AI?

Ans: It is the study of how to make computers behave intelligently.(PPT answer)
Artificial intelligence, is intelligence demonstrated by machines, unlike the natural intelligence displayed by humans and animals

2. What is PEAS? Explain different agent types with their PEAS descriptions.

Ans:Task environments are problems to which rational agents are the solutions. The task environment is specified by PEAS.
PEAS stands for :- Performance measure,Environment, Actuators, Sensors.
PEAS specifies the settings for an intelligent agent design.



3. Explain in detail the properties of Task Environments.

Ans:Properties of the task environment

- **Fully observable vs. Partially observable**

A task environment is effectively fully observable, if the agent's sensors are able to detect all the aspects that are relevant to its choice of action.

- **Deterministic vs. stochastic**

If a next state of the environment is completely determined by an agent, and any variations are excluded, then the environment is deterministic. Otherwise, it is stochastic.

- **Episodic vs. sequential**

Episodic environment is divided into atomic episodes, each of which consist of agent perceiving and performing a single action. Next episode is independent from actions taken in the previous episode. In contrast, in sequential environment, each decision can affect all the future decisions.

- **Static vs. Dynamic**

If an environment is changing while an agent is deliberating, then it is dynamic. Static environments does not change over time. **Semidynamic** environments does not change, but an agent's performance score does.

- **Discrete vs. Continuous**

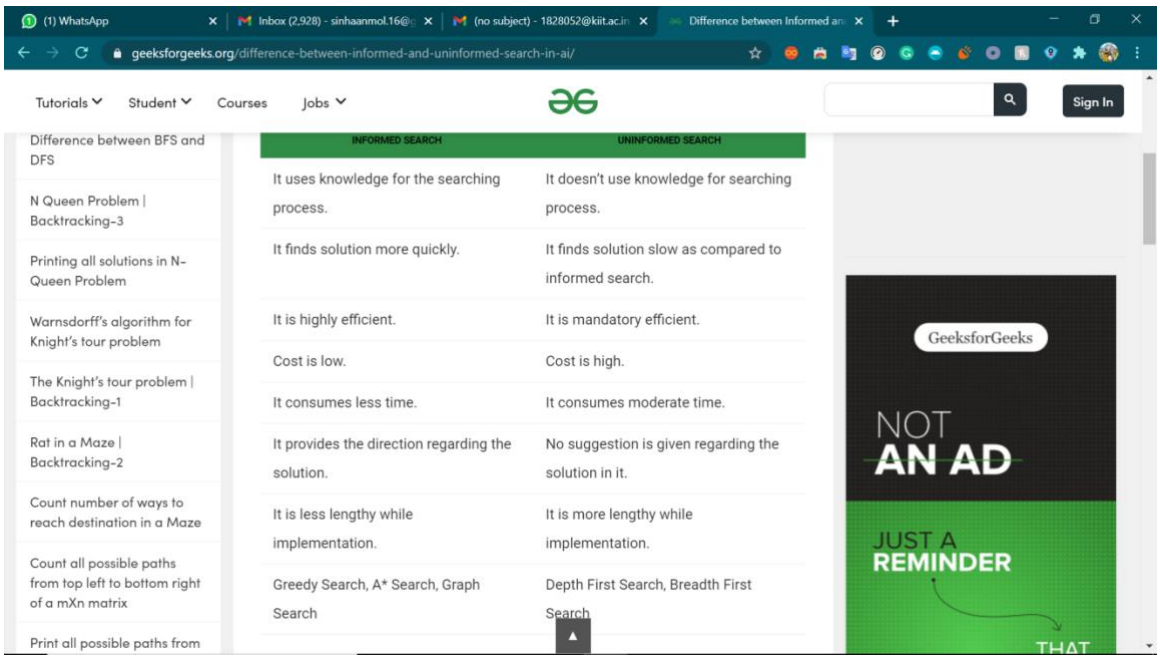
Describes a state of the environment, the way time is being handled, and to the percepts and action of an agent. Chess game is discrete (finite number of states, discrete set of actions). Taxi driving is continuous.

- **Single agent vs. multiagent**

Either an agent is acting in the environment solely, or engage into certain relationships with other agents, distinguishing them from other objects of the environment (by identifying that its own perormance depends on other agent's performance). Multiagent environment can be competitive, cooperative, or partially both.

4. Differentiate Informed & Uninformed search. Give examples.

Ans:



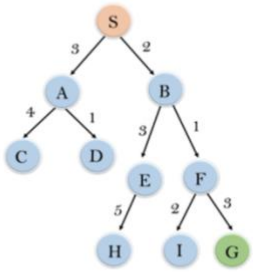
5. What is Greedy Best First Search? Explain with an example the different stages of Greedy Best First search.

Ans:Greedy best-first search algorithm always selects the path which appears best at that moment. It is the combination of depth-first search and breadth-first search algorithms. It

uses the heuristic function and search. Best-first search allows us to take the advantages of both algorithms.

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 the 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 are using two lists which are **OPEN** and **CLOSED** Lists. Following are the iteration for traversing the above example.

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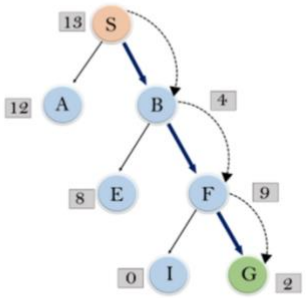


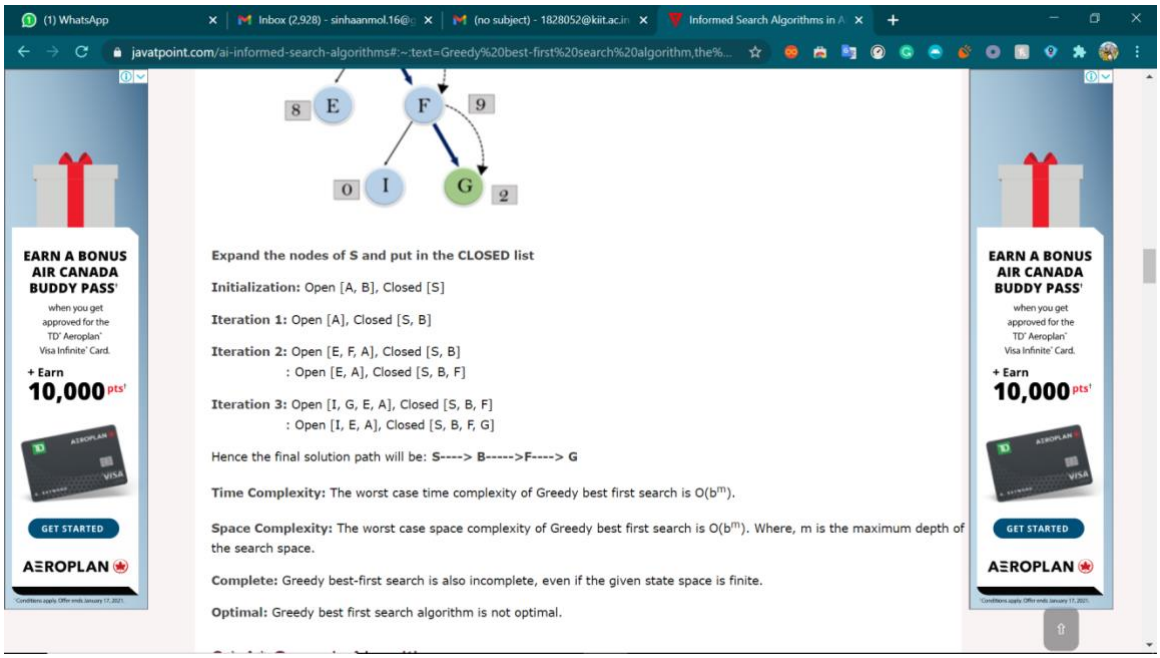
Expand the nodes of S and put in the CLOSED list

Initialization: Open [A, B], Closed [S]

Iteration 1: Open [A], Closed [S, B]

Iteration 2: Open [E, F, A], Closed [S, B]
: Open [E, A], Closed [S, B, F]

Iteration 3: Open [I, G, E, A], Closed [S, B, F]
: Open [I, E, A], Closed [S, B, F, G]



6. Explain the following local search strategy with examples.
Hill climbing.

Ans:

It is often used when a good heuristic function is available for evaluating states but when no other useful knowledge is available. This algorithm is simply a loop that continuously moves in the direction of increasing value i.e uphill. It terminates when it reaches a "peak" where no neighbor has a higher value. The algorithm doesn't maintain a search tree, so the current node data structure only records the state and its objective function value. Hill – climbing doesn't look ahead beyond the immediate neighbors of the current state.

1)Evaluate the initial state (IS). If it is the goal state (GS) , then return it and quit. Else consider IS as the current state (CS) and proceed.

2)Loop until a solution is found or there are no new operator (OP) to be applied to the CS.

(a)Select an OP that has not yet been applied to the CS and apply it to produce a new state (NS).

(b) Evaluate the NS:

If NS is a GS , then return it and quit.If it is not a GS but better than the CS, then consider it as the current state(i,e CS <- NS) and proceed.If NS is not better than CS then continue in the loop by selecting the next appropriate OP for CS.

One of the widely discussed **examples** of **Hill climbing** algorithm is Traveling-salesman Problem in which we need to minimize the distance traveled by the salesman. It is also called greedy local search as it only looks to its good immediate neighbor state and not beyond that.

7. Define constraint satisfaction problem (CSP). How CSP is formulated as a search problem? Explain with an example.

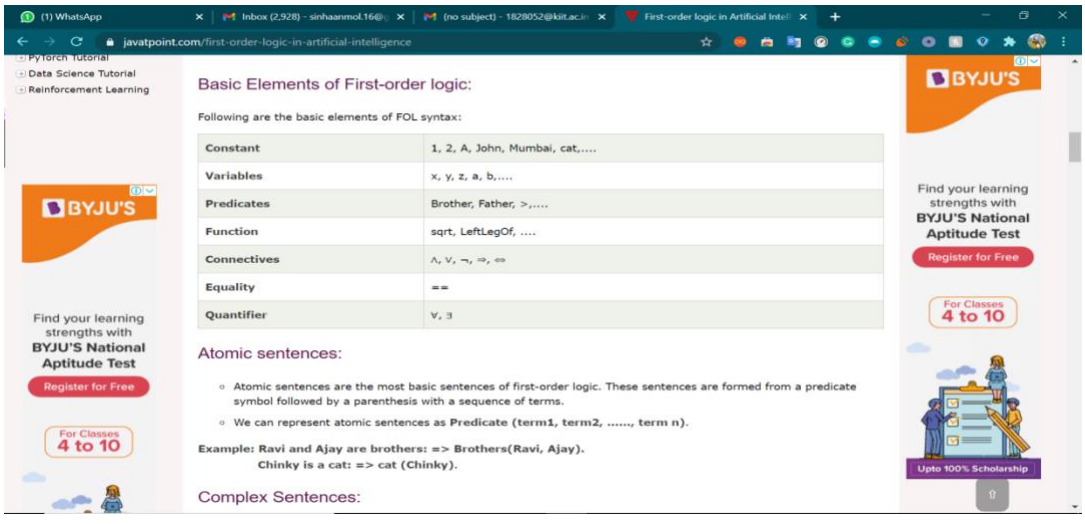
Ans:

8. Illustrate the use of first-order logic to represent knowledge.
   - Ans:First-order logic is another way of knowledge representation in artificial intelligence. It is an extension to propositional logic.
   - FOL is sufficiently expressive to represent the natural language statements in a concise way.
   - First-order logic is also known as **Predicate logic or First-order predicate logic**. First-order logic is a powerful language that develops information about the objects in a more easy way and can also express the relationship between those objects.
   - First-order logic (like natural language) does not only assume that the world contains facts like propositional logic but also assumes the following things in the world:
     1. **Objects:** A, B, people, numbers, colors, wars, theories, squares, pits, wumpus, ...
     2. **Relations: It can be unary relation such as:** red, round, is adjacent, **or n-any relation such as:** the sister of, brother of, has color, comes between
     3. **Function:** Father of, best friend, third inning of, end of, ...
   - As a natural language, first-order logic also has two main parts:

     1. **Syntax**
     2. **Semantics**

9. **(**a) Define the syntactic elements of first-Order logic (b) Illustrate the use of firstorder logic to represent knowledge.

Ans:(a)The syntax of FOL determines which collection of symbols is a logical expression in first-order logic. The basic syntactic elements of first-order logic are symbols. We write statements in short-hand notation in FOL.



(b)Ans of Ques 8

10. Explain with algorithm and example : Minimax algorithm.

- Ans:Mini-max algorithm is a recursive or backtracking algorithm which is used in decision-making and game theory. It provides an optimal move for the player assuming that opponent is also playing optimally.
- Mini-Max algorithm uses recursion to search through the game-tree.
- Min-Max algorithm is mostly used for game playing in AI. Such as Chess, Checkers, tic-tac-toe, go, and various tow-players game. This Algorithm computes the minimax decision for the current state.

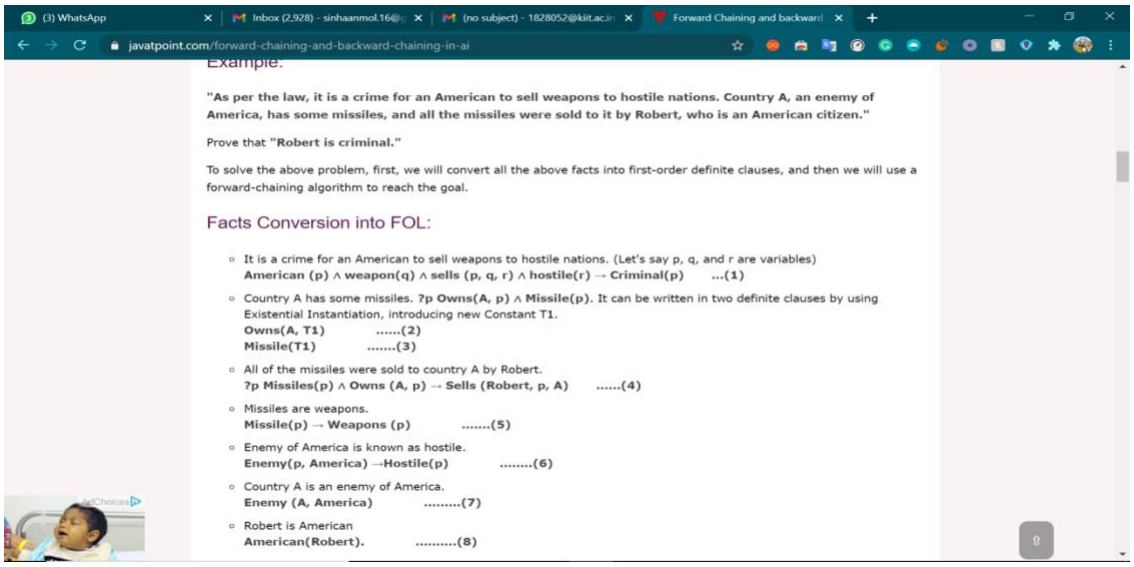
Pseudo-code for MinMax Algorithm:

```
function minimax(node, depth, maximizingPlayer) is
if depth ==0 or node is a terminal node then
return static evaluation of node

if MaximizingPlayer then      // for Maximizer Player
maxEva= -infinity
 for each child of node do
 eva= minimax(child, depth-1, false)
maxEva= max(maxEva,eva)       //gives Maximum of the values
return maxEva

else                    // for Minimizer player
 minEva= +infinity
 for each child of node do
 eva= minimax(child, depth-1, true)
 minEva= min(minEva, eva)       //gives minimum of the values
 return minEva
```

Example of minmax :https://www.javatpoint.com/mini-max-algorithm-in-ai

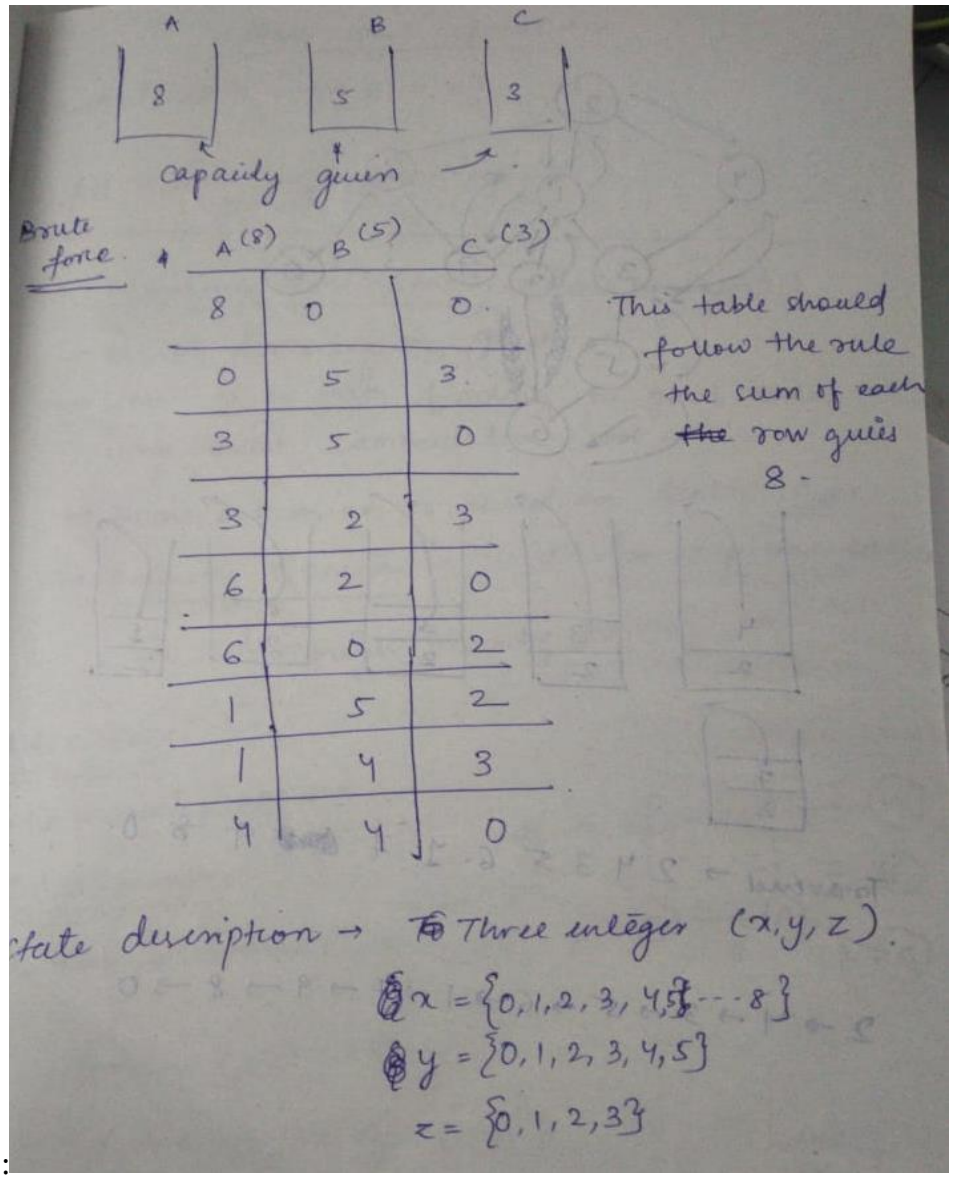
11. Explain forward chaining with example.

Ans:Forward chaining is also known as a forward deduction or forward reasoning method when using an inference engine. Forward chaining is a form of reasoning which start with atomic sentences in the knowledge base and applies inference rules (Modus Ponens) in the forward direction to extract more data until a goal is reached.



12. Suppose, there are 3 jugs of capacities 8, 5 and 3 litres respectively. There is no scale on the jugs, so it's only their capacities that is known. Initially the 8 litre jug is full of water the other two jugs are empty. The water can be poured from one jug to another. The goal is to have exactly 4 litre of water in any of the jugs. The amount of the water in other two jugs at the end is irrelevant.

Ans:



Formulate this problem as a state space search problem and draw the state space graph of this problem.

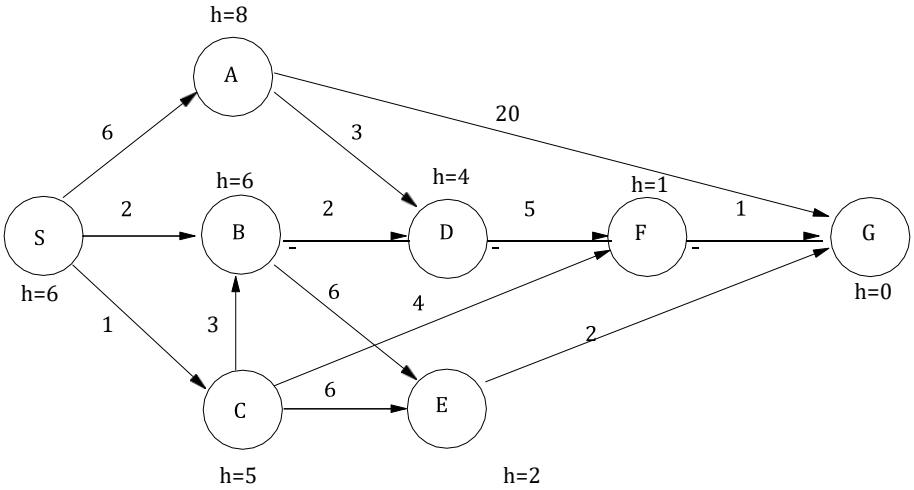
12. Consider the search problem below with start state *S* and goal state G. The transition costs are next to the edges, and the heuristic values are above the states. (i) What is the path if best first search algorithm is used to reach the goal?

(ii) What is the path if depth first search is used? If a node has multiple successors, then expend the successors in increasing alphabetical order (iii) If A* algorithm is used, what is the path?

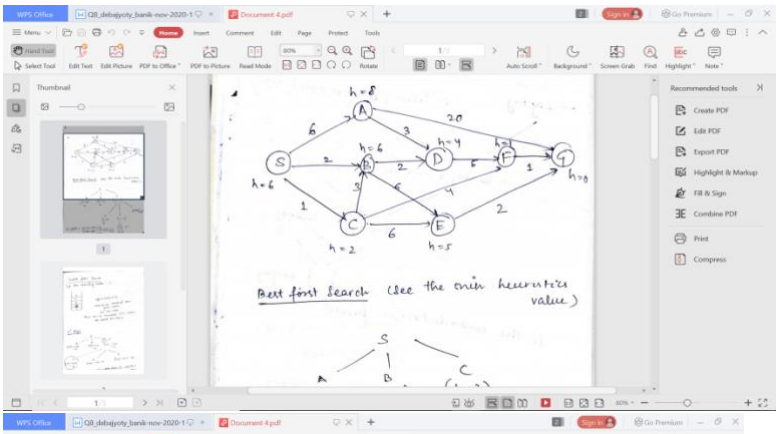
(iv) Is the heuristic function in this problem admissible?

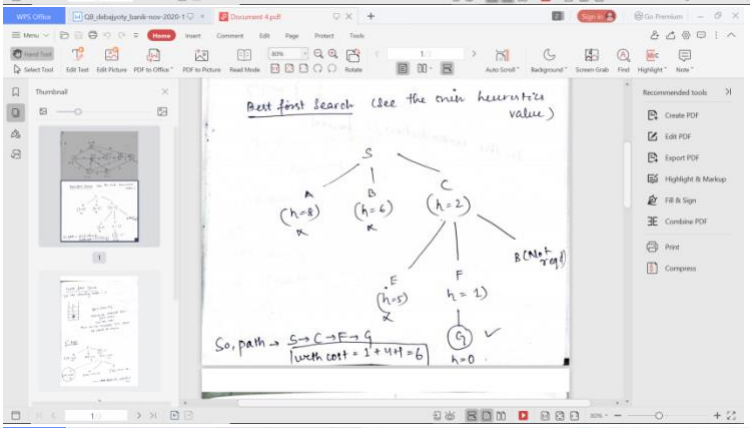
13. Consider the search problem below with start state *S* and goal state G. The transition costs are next to the edges, and the heuristic values are above the states. (v) What is the path if best first search algorithm is used to reach the goal?

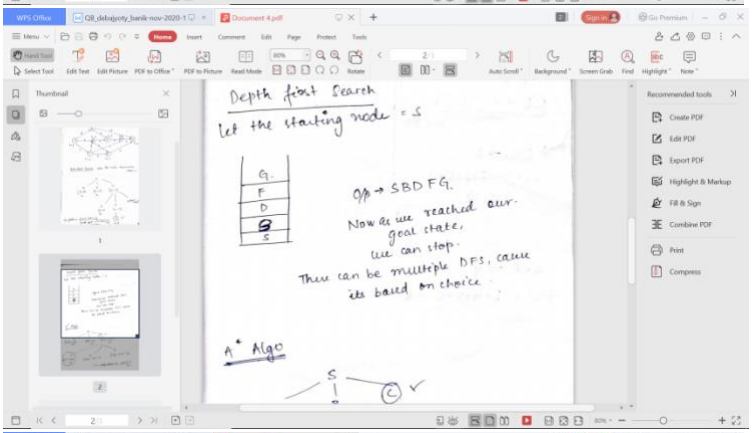
(vi) What is the path if depth first search is used? If a node has multiple successors, then expend the successors in increasing alphabetical order (vii) If A* algorithm is used, what is the path?
(viii) 14.
(ix) Is the heuristic function in this problem admissible?

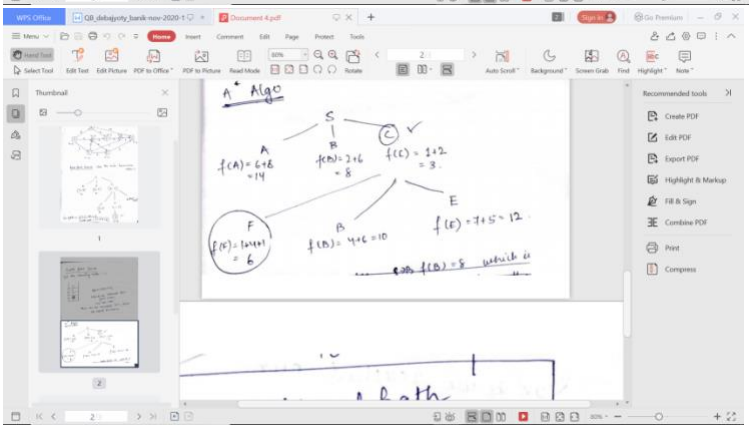


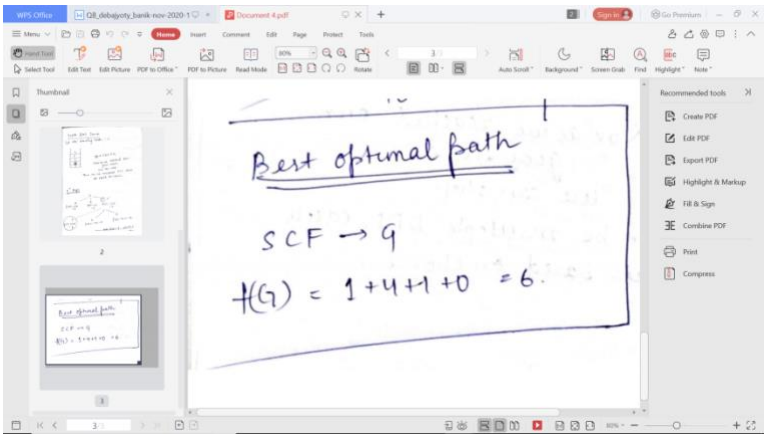
Ans:


Best first Search (See the onin heuristics value)


Best first Search (See the onin heuristics value)
So, path → S→C→F→G
With cost = 1+4+1 = 6

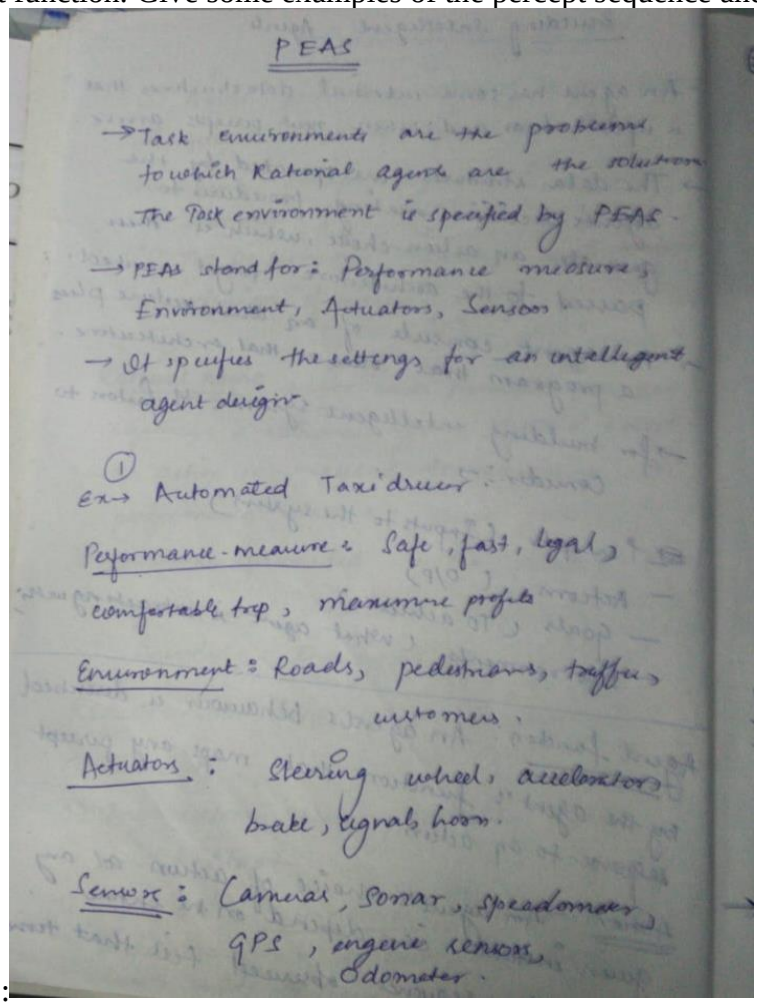

Depth first Search
Let the starting node = S
op → SBDFG.
Now as we reached our goal state, we can stop.
There can be multiple DFS, cause its based on choice.
A* Algo

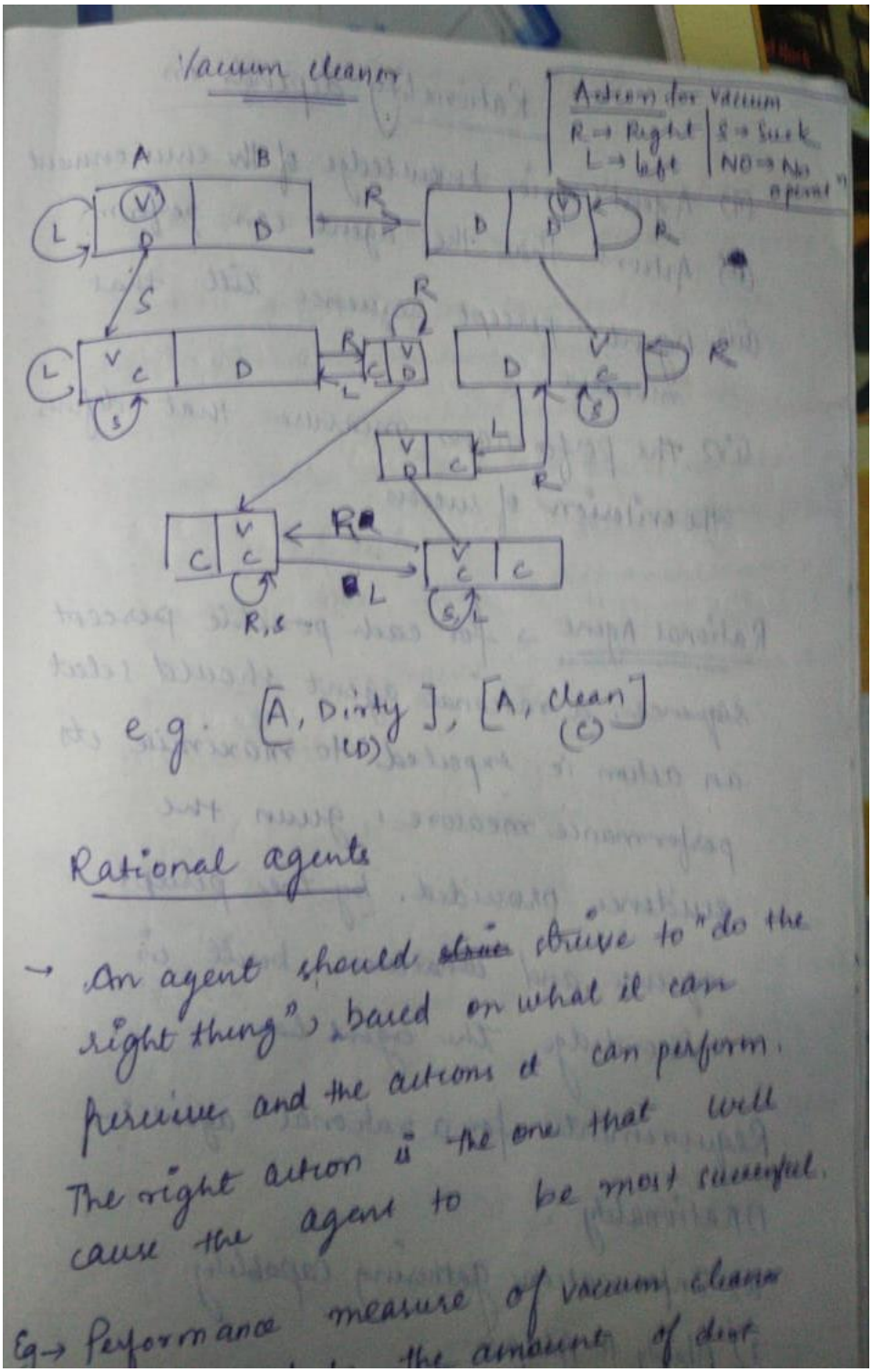

A* Algo
f(A) = 6+8 = 14
f(B) = 2+6 = 8
f(C) = 1+2 = 3
f(E) = 7+5 = 12
f(F) = 1+4+1 = 6
f(B) = 4+6 = 10



14. Explain Task environment, State space and PEAS representation. Give the PEAS representation for Vaccum-Cleaner world along with its State space diagram. Write its Agent function. Give some examples of the percept sequence and action mapping.

Ans:





15. Describe various Consistencies for Contraints Propagation in CSPs. Write the Arc consistency algorithm with an example showing its use.

Ans:

16. List and explain the methodologies that can be adopted to improve the Backtracking algorithm used to solve CSPs. Give appropriate example for each.

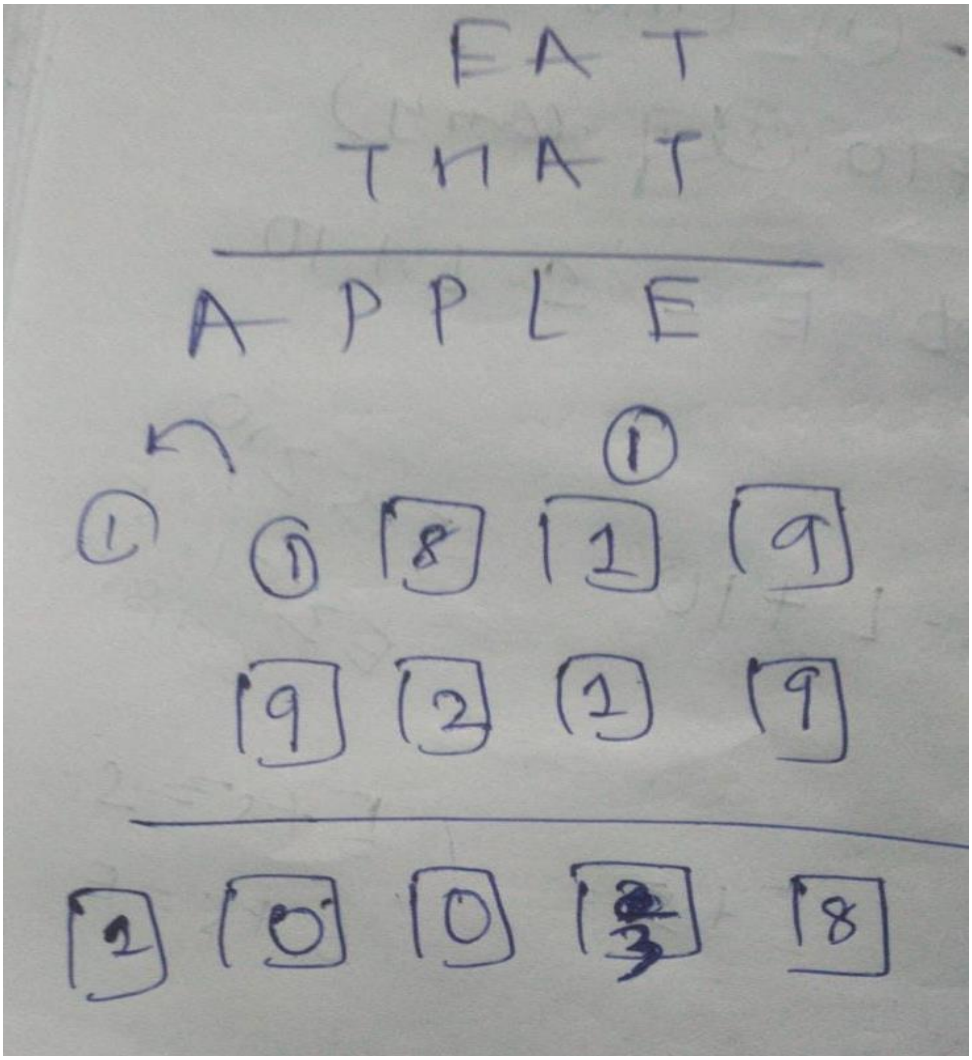
17. Define Constraint Satisfaction Problems along with its components. Solve the following Cryptarithmatic Problem, properly defining its variables, domains and constraints involved- EAT

THAT

APPLE

Draw the constraint graph of the same.

Ans:**A-ppt-5 s-1,2**



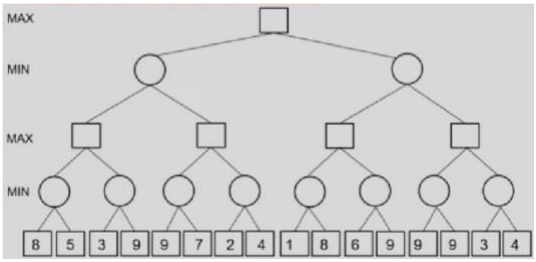
18. Write the algorithm for Backtracking search in CSPs. What are its drawback ? What

is Backjumping and how it is better than backtracking ? Explain by taking the example of 4-Queens problem.
A-ppt-5 s-16.

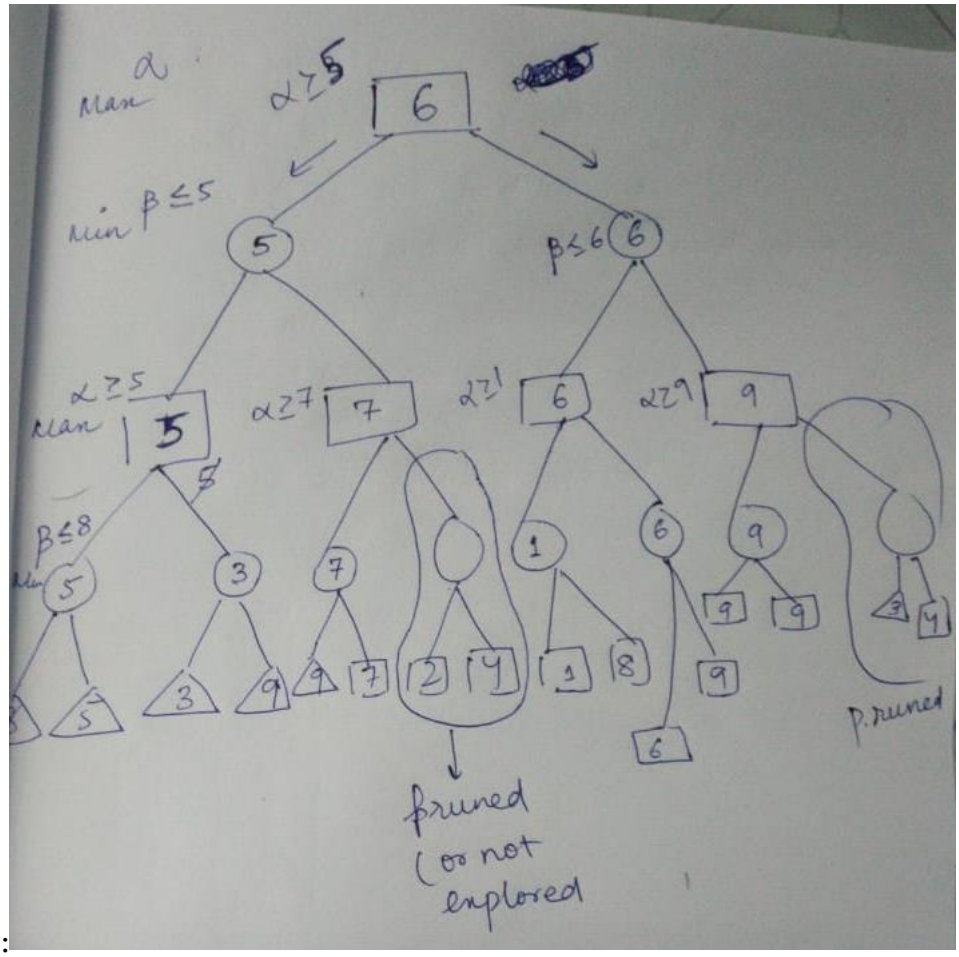
19. How the Local search can be applied to solve CSPs. Write and explain 'MinConflict Algorithm'. Give the 4-Queens problem formulation and solve it using local search.

A-ppt-5 s-32

20. Write the Alpha-Beta Algorithm. Explain Alpha cut and Beta Cut briefly. Solve the following example and show how alpha-beta pruning helped in pruning the search tree.



Ans:



21. Explain the scenario of 'Imperfect Real Time' decisions. What methodologies could be adopted to deal with such situations? Explain by giving some examples of such scenario.

22. Write the Minimax Algorithm and explain 'Evaluation function' and 'Optimal Strategy'. Take an example of Tic-tac-toe game and explain how evaluation function can be used to find the next best move.

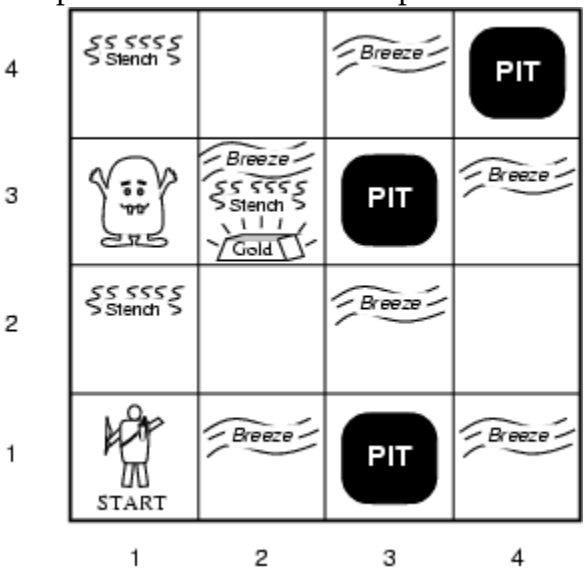
A-ppt-6 s-6,4

23. What is Logical Agent? What are its properties? Give the PEAS representation and characteristics feature for 'Wumpus world' problem. Take an example and explain how the logical agent can solve the problem.

ANS:

Logical agents apply inference to a knowledge base to derive new information and make decisions.

Basic concepts of logic:
syntax: formal structure of sentences
semantics: truth of sentences w.r.t models
entailment: necessary truth of one sentence given another
inference: deriving sentences from other sentences
soundness: derivations produce only entailed sentences
completeness: derivations can produce all entailed sentence



PEAS-
Performance measure
gold +1000, death -1000
-1 per step, -10 for using the arrow

Environment
Squares adjacent to wumpus are smelly
Squares adjacent to pit are breezy
Glitter iff gold is in the same square

Shooting kills wumpus if you are facing it
Shooting uses up the only arrow
Grabbing picks up gold if in same square
Releasing drops the gold in same square
Sensors: Stench, Breeze, Glitter, Bump, Scream
Actuators: Left turn, Right turn, Forward, Grab, Release, Shoot

Wumpus world characterization-
Fully Observable No – only local perception
Deterministic Yes – outcomes exactly specified
Episodic No – sequential at the level of actions
Static Yes – Wumpus and Pits do not move
Discrete Yes
Single-agent? Yes – Wumpus is essentially a natural feature

24. State and explain clearly, the Knowledge Engineering process in First order Logic. Explain the 'Quantifiers' used in FOL giving some examples.

ANS:
Identify the task
Assemble the relevant knowledge
Decide on a vocabulary of predicates, functions, and constants
Encode general knowledge about the domain
Encode a description of the specific problem instance
Pose queries to the inference procedure and get answers
Debug the knowledge base

Slide m8 FOL

25. Explain how the Planning problems can be represented. Explain the 'Block's World' problem and how it can be solved using Total ordered planning.

ANS:
Planning problems can be represented as states, actions and goals.
Representation of states:- planners decompose the world into logical conditions and represent a state as a conjunction of positive literals.
Representation of goals:- A goal is a partially specified state, represented as a conjunction of positive literals.
Representation of actions:- An action is specified in terms of the preconditions that must hold before it can be executed and the effects that ensure when it is executed.

The blocks world consists of a set of cube shaped blocks sitting on a table.
A robot arm can pick up only one block at a time and move it to another position , either on the table or on top of another block.
Suppose the goal is to get block A on B and block B on C .

So to build a three-block tower one solution is:-

Init (On(A,Table) ∩ On(B,Table) ∩ On(C,Table) ∩Block(A) ∩Block(B) ∩Block(C) ∩ clear(A) ∩clear(B) ∩clear(C))
Goal(On(A, B) ∩ On(B,C))
Action(Move(b, x, y))
Then we can formulate the solution as the sequence
[Move (B, Table, C), Move(A, Table, B)]
The planning of the above type are called totally ordered planning.

26. Discuss various types of agents in AI. What are problem solving agents? Discuss about the states, percept sequence and working in case of 8 queen problem.

ANS:
Four basic types of agents in order of increasing sophistication:
Simple reflex agents
Model-based reflex agents
Goal-based agents
Utility-based agents

Whenever the agent is confronted by a problem, its first action is seeking a solution is its knowledge system. This is known as the search for the solution in the knowledge base. Another attempt can be to search for a solution by going into different states. The search of the agent stops in the state when the agent reaches the goal state. Example: BFS, Uniform Cost Search, DFS, Depth Limited Search, Bi-Directional Search

--don't know(GG)

27. Give a comparison between all the uninformed search algorithms and write their advantages and disadvantages. Write the algorithm for solving 8 queen problem using the hill climbing approach.

ANS:
Refer m3- search slides

```
function HILL-CLIMBING( problem) returns a state that is a local maximum
  inputs: problem, a problem
  local variables: current, a node
                   neighbor, a node
  current ← MAKE-NODE(INITIAL-STATE[problem])
  loop do
      neighbor ← a highest-valued successor of current
      if VALUE[neighbor] ≤ VALUE[current] then return STATE[current]
      current ← neighbor
```

28. What is backtracking and what are its benefits and disadvantages over brute force? Explain CSP with an MapColoring problem example?

A-ppt-6 s-15,16,17,18,19,20

29. What are Stochastic games? List some Stochastic games. What is Alpha Beta pruning? Prove that alpha-beta pruning takes time O^(2^m/2) with optimal move ordering,where m is the maximum depth of the game tree.

ANS:

30. Demonstrate the Wumpus world problem and its solution with the help of logical agents.

ANS:

31. What is first order logic? Give examples of its syntax.

Differentiate between Propositional and First order inference. What is forward chaining?

ANS:

first-order logic (like natural language) assumes the world contains

Objects: people, houses, numbers, colors, baseball games, wars, …

Relations: red, round, prime, brother of, bigger than, part of, comes between, …

Functions: father of, best friend, one more than, plus, …

Syntax of FOL:

Connectives □, □, □, □, □

Equality =

Constants : they are fixed value terms, belong to a given domain.

Example:- KingJohn, 2, NUS,...

Quantifiers □ (universal), □ (existential)

Auxiliary symbols : like),(,[],{} are used for punctuation.

Variables : they are terms that can assume different values over a given domain. It is denoted by letters x, y, a, b,...

Functions : function symbols defined over a domain map n elements (n>0) to a single element of the domain. Here n is called the rank or degree of a function.

Examples :- Sqrt, LeftLegOf,...

terms : constant variables and functions are called terms.

Predicates : they denote relations or functional mapping from the elements of a domain to the values true or false. For example :- Brother, >,... . Like functions, predicates can have n (n>= 0) terms as argument. A 0-ary predicate is a proposition. i.e. propositions are constant predicates.

Key differences between PL and FOL

- Propositional Logic converts a complete sentence into a symbol and makes it logical whereas in First-Order Logic relation of a particular sentence will be made that involves relations, constants, functions, and constants.

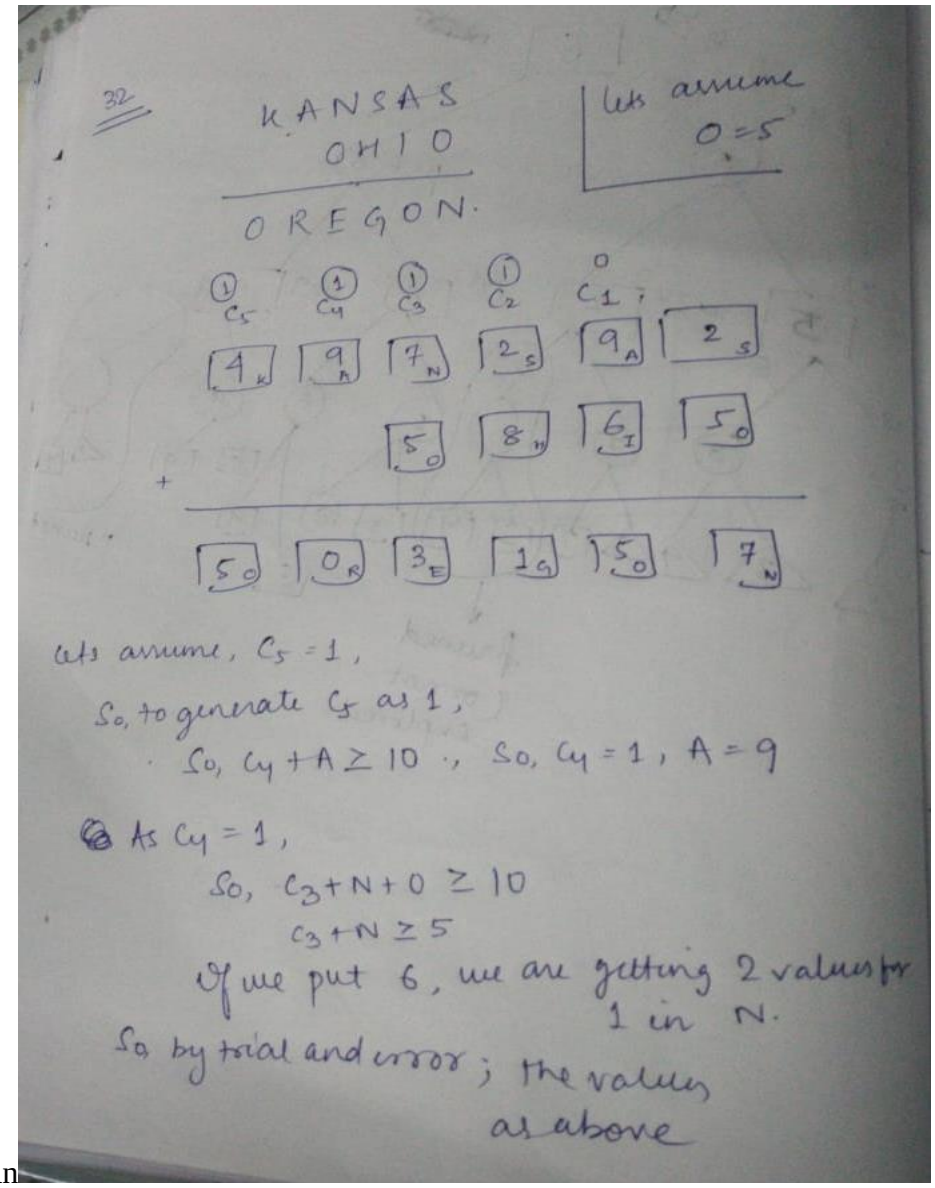
- The limitation of PL is that it does not represent any individual entities whereas FOL can easily represent the individual establishment that means if you are writing a single sentence then it can be easily represented in FOL.

- PL does not signify or express the generalization, specialization or pattern for example 'QUANTIFIERS' cannot be used in PL but in FOL users can easily use quantifiers as it does express the generalization, specialization, and pattern.

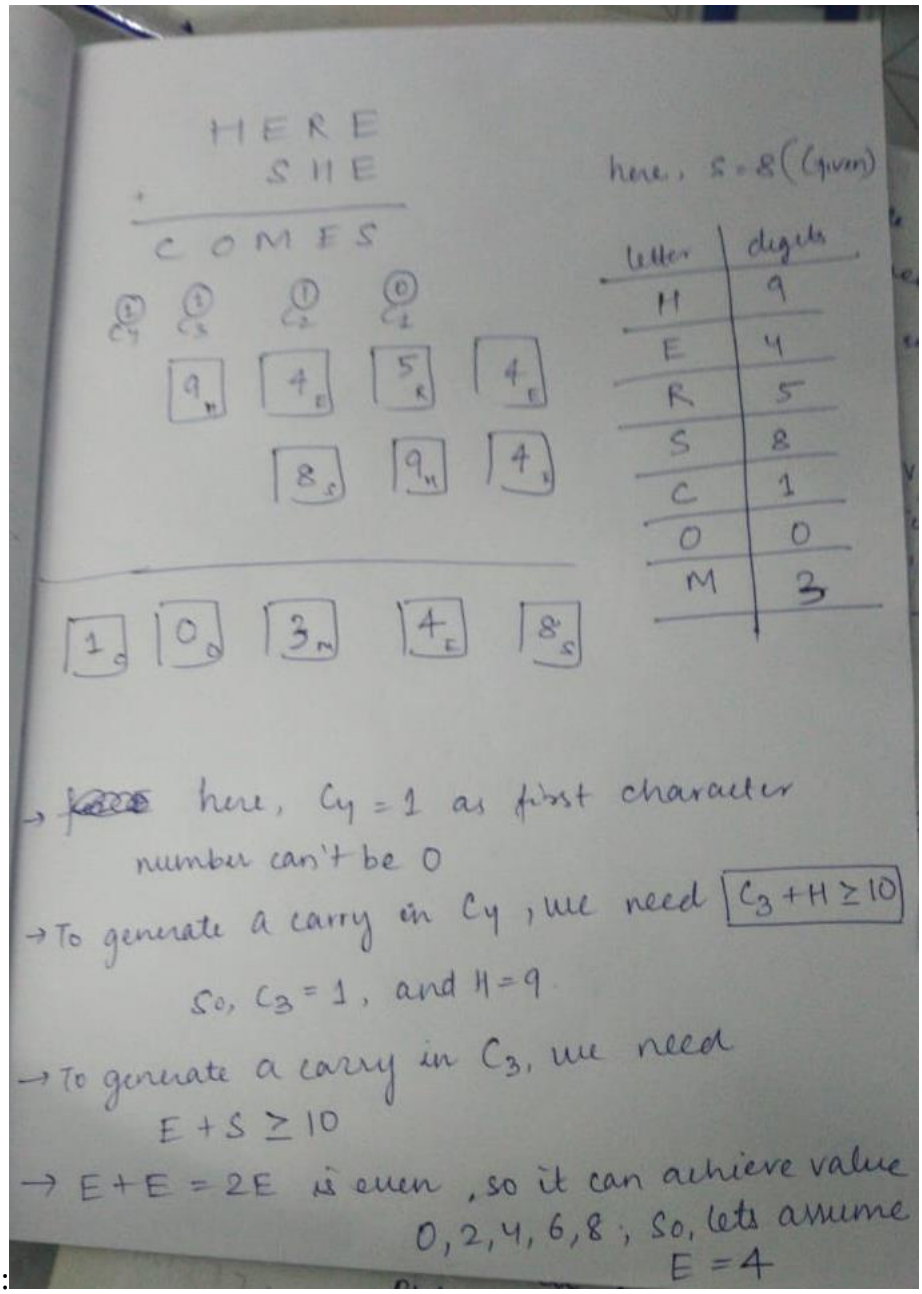
Forward chaining:
It is the process of selecting the rules by matching the LHS.
Here reasoning begins from the start or initial state.
LHS of the rules are matched against the state description.
The RHS of the matched rule is added to the state.
This process is repeated until an useful conclusion is made.
This process is also called "data-driven" inference since input data is used to guide the direction of the inference process.

32. (a) If KANSAS + OHIO = OREGON Then find the value of G + R + O + S + S (apply constrain satisfaction rules)
(b) HERE = COMES - SHE, (Assume S = 8) Find the value of R + H + O (apply constrain satisfaction rules)

An


32
KANSAS
OHIO
OREGON.
Lets assume
O=5
1 1 1 1 0
C5 C4 C3 C2 C1
4K 9A 7N 2S 9A 2S
5O 8H 6I 5O
+
5O 0R 3E 1G 5O 7N
Lets assume, C5 = 1,
So, to generate C5 as 1,
So, C4 + A ≥ 10 ., So, C4 = 1, A = 9
As C4 = 1,
So, C3 + N + O ≥ 10
C3 + N ≥ 5
If we put 6, we are getting 2 values for 1 in N.
So by trial and error; the values as above

s:



33. Consider the following figure

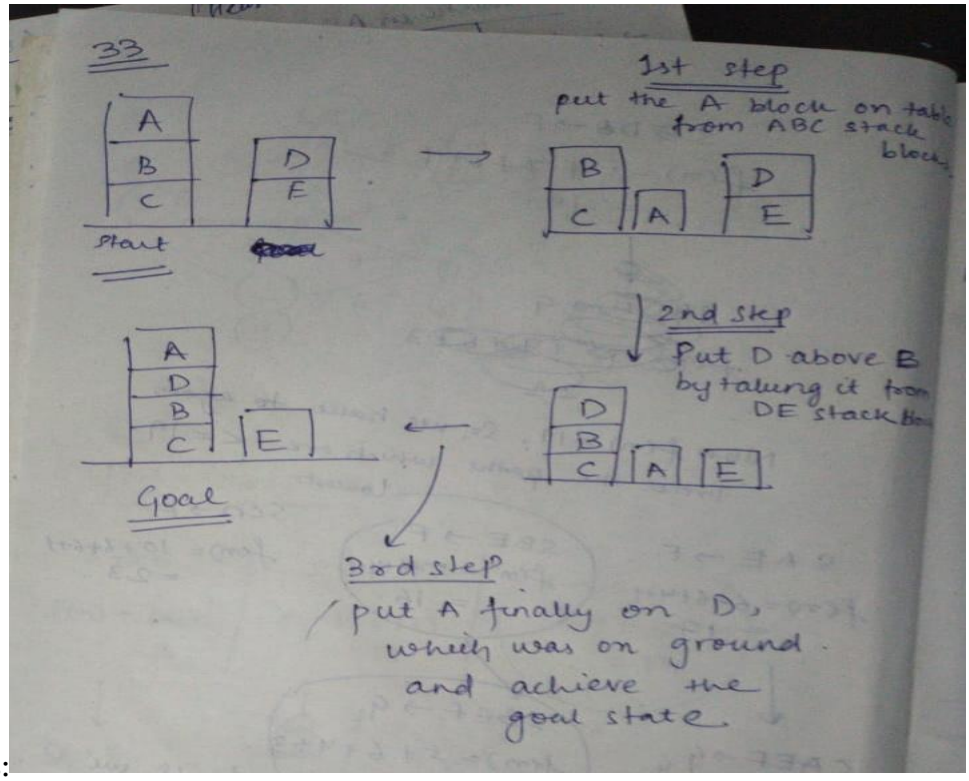
Start State

Goal State

Use the heuristic function h(n)=+1, if the block is on the correct block/table =-1, otherwise

Which type of problem do you face using hill climbing algorithm to reach the goal? Use a suitable heuristic function to avoid this problem to reach the goal. Show all the steps.

Ans:



34. Write the Hill climbing search algorithm. Analyze the performance of the algorithm basing upon appropriate characteristics feature.
    - https://www.javatpoint.com/hill-climbing-algorithm-in-ai
35. What is the importance of using contours for the A* search method?
36. Suppose, there are 3 jugs of capacities 8, 5 and 3 litres respectively. There is no scale on the jugs, so it's only their capacities that are known. Initially the 8 litre jug is full of water the other two jugs are empty. The water can be poured from one jug to another. The goal is to have exactly 4 litre of water in any of the jugs. The amount of the water in other two jugs at the end is irrelevant.

    Formulate this problem as a state space search problem and draw the state space graph of this problem
    - **Same as ques 12.**

37. Explain how to formally define a problem using constraint satisfaction problem? Provide the constraint propagation and backtracking process in relation to map coloring problem.

- Step 1: Create a variable set.
  Step 2: Create a domain set.
  Step 3: Create a **constraint** set **with** variables **and** domains (if possible) after considering the **constraints**.
  Step 4: Find an optimal solution
- https://cs.fit.edu/~dmitra/ArtInt/lectures/constraint.pdf - Graph coloring problem.

38. Formally define crypt-arithmetic problem , map colouring problem and N queen's problem as constraint satisfaction problem. Solve Map Colouring Problem using constraint Satisfaction problem.

- https://www.tutorialandexample.com/cryptarithmetic-problem/
- https://cs.fit.edu/~dmitra/ArtInt/lectures/constraint.pdf
- https://www.cs.toronto.edu/~fbacchus/Presentations/CSP-BasicIntro.pdf (From slide no- 13 - 22)

39. Formally define crypt-arithmetic problem , map colouring problem and N queen's problem as constraint satisfaction problem. -
    - **Same as previous question.**

40. What is the problem with informed search algorithms. Why uninformed search techniques in some condition are better than informed search techniques.

- https://www.javatpoint.com/ai-informed-search-algorithms
- https://intellipaat.com/community/3654/what-is-the-difference-between-informed-and-uninformed-searches

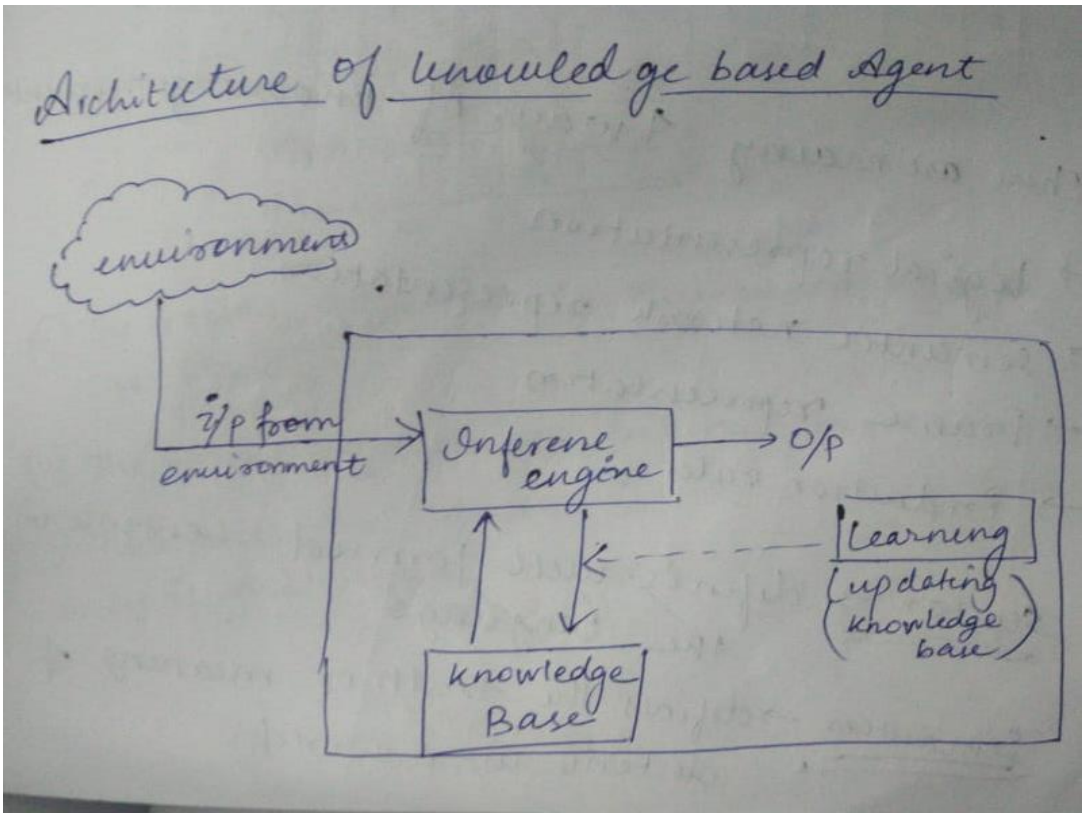
41. What do you understand by informed search techniques. Given A* Algorithm , explain how can you modify the A* algorithm to behave as Greedy Best First algorithm.

- https://www.javatpoint.com/ai-informed-search-algorithms

42. What is the problem with informed search algorithms. Derive the time and space complexity of Iterative Depth First Search Algorithm?

43. What do you understand by soundness and completeness in inference mechanism? Provide the architecture of a knowledge based agent for partially observable environment .

- http://www.cs.cornell.edu/courses/cs2800/2016sp/lectures/lec39-sound-complete.html



44. Provide the architecture of a knowledge based agent for partially observable environment. Elaborate how propositional logic can be used in designing knowledge based agent. You may take example of “The Wumpus World”.
    - **First part is same as previous one** …

Knowledge base for Wumpus World :-

atomic proposition variables for wumpus world.

1. Let $P_{i,j}$ be true if there is a pit in the room $[i,j]$
2. Let $B_{i,j}$ be true if agent is perceives breeze in $[i,j]$
3. Let $W_{i,j}$ be true if there is wumpus in square (i,j)
4. Let $S_{i,j}$ be true if agent perceives stench in (i,j)
5. Let $V_{i,j}$ be true if square (i,j) is visited.
6. Let $G_{i,j}$ be true if there is gold.
7. Let $OK_{i,j}$ be true if room is safe.

Some propositional rules for

$R_1 \Rightarrow \neg S_{11} \rightarrow \neg W_{11} \rightarrow \neg W_{12} \rightarrow \neg W_{21}$

$R_2 \Rightarrow \neg S_{21} \leftrightarrow \neg W_{11} \rightarrow \neg W_{21} \wedge \neg W_{22} \wedge \neg W_{31}$

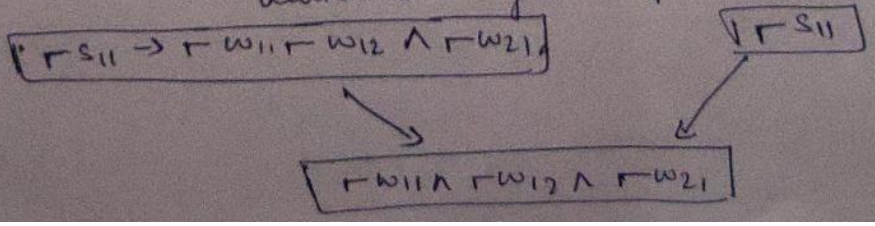
$R_3 \Rightarrow \neg S_{12} \rightarrow \neg W_{11} \wedge \neg W_{12} \wedge \neg W_{22} \wedge \neg W_{13}$

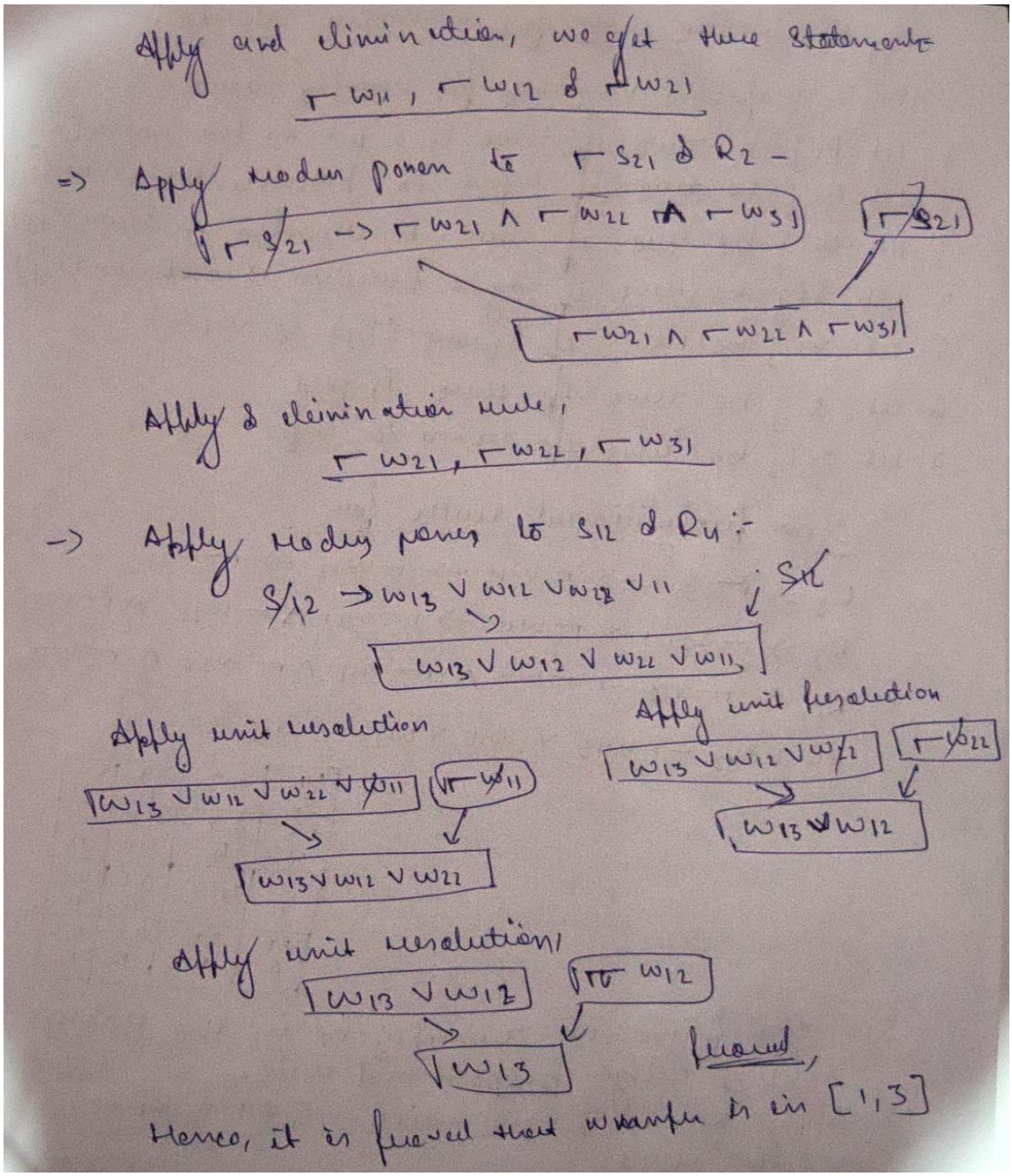
$R_4 \Rightarrow S_{12} \rightarrow W_{13} \vee W_{12} \vee W_{22} \vee W_{11}$

1,4 S	2,4	3,4 B	4,4 PIT
4,3 W	2,3 G	3,3 PIT	4,3 B
1,2 S	2,2	3,2 B	4,2 I
1,1 A	2,1 B	3,1 B	4,4 B

We can prove the wumpus is in the room (1,3) using propositional rule –

1) Apply modus ponens with $\neg S_{11}$ & R_1 –
rule applied,
$\neg S_{11} \rightarrow \neg W_{11} \wedge \neg W_{12} \wedge \neg W_{21}$ & $\neg S_{11}$
which will given o/p





45. How Resolution Algorithm is used for inference mechanism , provide the algorithm and elaborate using an example of your choice.

Resolution in FOL

→ It is a theorem proving technique that proofs by contradiction.

→ It is used, if there are various stmts are given & need to prove conclusion of those stmt.

→ Unification is a key concept in proofs by Resolution.

→ Resolution is a single interference rule which can efficiently operate on conjuctive Normal forms (CNF)

Clause: Disjunction of literals.

CNF → A sentence represented as a conjuction of clauses.

Steps for Resolution

1) Conversion of facts into FOL
2) Convert FOL stmt into CNF
3) Negate the stmt which needs to prove (by contradiction)
4) Draw Resolution Graph (Unification)

Resolution example

(a) If it is sunny & warm day you will enjoy

(b) If it is raining you will get wet

(c) It is warmday

It is raining

It is sunny

Goal → you will enjoy.

1) Convert to FOL

(a) Sunny ∧ Warm → Enjoy.

(b) Raining → ~~wait~~ wet

(c) Warm

(d) Raining

(e) Sunny

Convert to CNF

(a) ¬(Sunny ∧ Warm) ∨ enjoy

→ ¬Sunny ∨ ¬Warm ∨ Enjoy

(b) Raining → wet

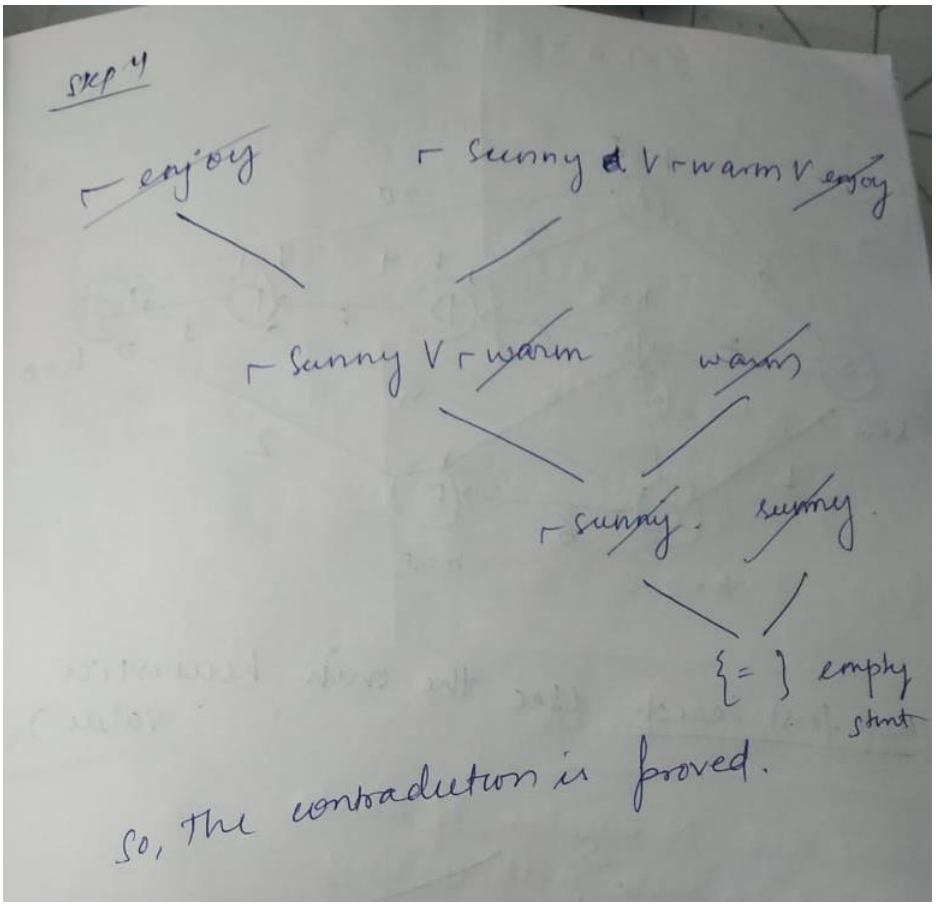
¬Raining → wet

(c) Warm

(d) Raining

(e) Sunny

(f) Warm → ¬ enjoy.



46. Contrast Multiagent Planning with conditional and continuous planning. For a partially observable environment what type of planning do you suggest .

- Conditional planning has to work regardless of the outcome of an action.

It takes place in Fully Observable Environment where the current state of the agent is known environment is fully observable. The outcome of actions cannot be determined so the environment is said to be nondeterministic.

Here we can check what is happening in environment at predermined points of the plan to deal with ambiguous actions.

It needs to take some actions at every state and must be able to handle every outcome for the action it takes. A state node is represented with a square and chance node is represented with a circles.

For a state node we have an option of choosing some actions. For a chance node agent has to handle every outcome.

Conditional Planning can also take place in the Partially Observable Environments where, we cannot keep a track on every state.

In vacuum cleaner e.g. if the dirt is at Right and agent knows about Right, but not about Left. Then, in such cases Dirt might be left behind when the agent, leaves a clean square. Initial state is also called as a state set or a belief state.

Sensors play important role in Conditional planning for partially observable environments. Automatic sensing can be useful; with automatic sensing an agent gets all the available percepts at every step.

47. Given a partially observable environment what type of planning do you suggest . Justify by giving proper technical explanation.

48. Elaborate and explain using proper example the difference between inference using forward and backward chaining.
- https://www.javatpoint.com/difference-between-backward-chaining-and-forward-chaining

Objective Questions

1. In which of the following situations might a blind search be acceptable? a) real-life situation b) complex game c) small search space d) all of the mentioned	CO1	c
What are the main goals of AI? A. To Create Expert Systems B. To Implement Human Intelligence in Machines C. Both A and B D. None of the Above	CO1	C
An Artificial Neural Network Is based on? a) Strong Artificial Intelligence approach b) Weak Artificial Intelligence approach c) Cognitive Artificial Intelligence approach d) Applied Artificial Intelligence approach	CO2	C
Which of the following is	CO2	D

not a type of agents in artificial intelligence? A. Model based B. Utility based C. Simple reflex D. target based		
How many types are available in uninformed search method? a) 3 b) 4 c) 5 d) 6	CO3	C
A search algorithm takes _____ as an input and returns _____ as an output. a) Input, output b) Problem, solution c) Solution, problem d) Parameters, sequence of actions	CO3	B
A* algorithm is based on _____ a) Breadth-First-Search b) Depth-First – Search c) Best-First-Search d) Hill climbing	CO3	C

uniform-cost search expands the node n with the _____ a) Lowest path cost	CO3	A
b) Heuristic cost c) Highest path cost d) Average path cost		
What among the following constitutes to the incremental formulation of CSP? a) Path cost b) Goal cost c) Successor function d) All of the mentioned	CO4	d
Consider a problem of preparing a schedule for a class of student. What type of problem is this? a) Search Problem b) Backtrack Problem c) CSP d) Planning Problem	CO4	c

Adversarial search problems uses _____ a) Competitive Environment b) Cooperative Environment c) Neither Competitive nor Cooperative Environment d) Only Competitive and Cooperative Environment	CO4	a
What is called as transposition table? 1. Hash table of next seen positions 2. Hash table of previously seen positions 3. Next value in the search 4. None of the mentioned	CO4	2
Translate the following sentence into FOL “For ever a, if a is a philosopher, then a is a scholar” A. For all a, philosopher(a) scholar(a) B. For some a, philosopher(a) scholar(a) C. All of the above D. None of the above	CO5	A

What is the condition of literals in variables? a) Existentially quantified b) Universally quantified c) Quantified d) None of the mentioned	CO5	B
First Order Logic is also known as _____ a) First Order Predicate Calculus b) Quantification Theory c) Lower Order Calculus d) All of the mentioned	CO5	D
Planning In partial order plan. A. Relationships between	CO6	A
the actions of the behavior are set prior to the actions B. Relationships between the actions of the behavior are not set until absolutely necessary Choose the correct option. a) A is true b) B is true c) Either A or B can be true depending upon situation d) Neither A nor B is true View		
What is artificial intelligence?	CO1	Artificial intelligence, is intelligence demonstrated by machines, unlike the natural intelligence displayed by humans and animals

What are the parameters on which the performance of an intelligent agent depend on ?	CO2	
What is a heuristic function and what do you mean by admissible heuristic function? Show the proof.	CO3	A heuristic function, also called simply a heuristic, is a function that ranks alternatives in search algorithms at each branching step based on available information to decide which branch to follow. For **example**, it may approximate the exact solution. A **heuristic is admissible if** it never overestimates the true cost to a nearest goal. A **heuristic** is consistent **if**, **when** going from neighboring nodes a to b, the **heuristic** difference/step cost never overestimates the actual step cost.
How can you increase the effectiveness of the alphabeta pruning ?	CO4	
Give some examples of Constraint Satisfaction Problems "CSP"	CO5	Examples of problems that can be modeled as a constraint satisfaction problem include: • Type inference[3][4] • Eight queens puzzle • Map coloring problem • Sudoku, Crosswords, Futoshiki, Kakuro (Cross Sums), Numbrix, Hidato and many other logic puzzles
The initial state and the legal moves for each side	CO4	b

define the _____ for the game. a. Search Tree b. Game Tree c. State Space Search d. Forest		

General algorithm applied on game tree for making decision of win/lose is _____. a. DFS/BFS Search Algorithms b. Heuristic Search Algorithms c. Greedy Search Algorithms d. MIN/MAX Algorithms	CO4	d
Which search is equal to minimax search but eliminates the branches that can't influence the final decision? Depth-first search b. Breadth-first search c. Alpha-beta pruning d. None of the mentioned	CO4	c
Which of the following is identical to the closed list in Graph search? a. Hill climbing search algorithm b. Depth-first search c. Transposition table d. None of the mentioned	CO4	c
Which function is used to calculate the feasibility of	CO5	a

whole game tree? a. Evaluation function b. Transposition c. Alpha-beta pruning d. All of the mentioned		
What is called as transposition table? a. Hash table of next seen positions b. Hash table of previously seen positions c. Next value in the search d. None of the mentioned	CO5	b
Uncertainty arises in the Wumpus world because the agent's sensors give only _____ a) Full & Global information b) Partial & Global Information c) Partial & local Information d) Full & local information	CO5	c
What is a learning agent. Explain its components.	A **learning agent in** AI is the type of **agent** which can **learn** from **its** past experiences or it has **learning** capabilities. It starts to act **with** basic knowledge **and** then able to act **and** adapt automatically through **learning**.	CO1
Explain autonomous agent and omniscient agent with example.	An **autonomous agent** is an intelligent agent operating on an owner's behalf but without any interference of that ownership entity.	CO1

	Non-biological **examples** include intelligent **agents**, **autonomous** robots, and various software **agents**, including artificial life **agents**, and many computer viruses. An **omniscient agent** is an **agent** which knows the actual outcome of its action in advance. a tic-tac-toe AI is **omniscient** as it always knows the outcome in advance.	
What are the factors that a rational agent should depend on at any given time?	Rational agent at any given time depends on four things: • The performance measure that defines the criterion of success. • The agent's prior knowledge of the environment. • The actions that the agent can perform. • The agent's percept sequence to date.	CO1
What are the main factors considered in designing the intelligent systems?	In designing intelligent systems there are four main factors to consider: P Percepts – the inputs to our system A Actions – the outputs of our system G Goals – what the agent is expected to achieve E Environment – what the agent is interacting with	CO1
Differentiate between a node and a state. Explain the components of a node.	A state is a (representation of) a physical configuration. A node is a data structure constituting part of a search tree includes state, parent node, action, path cost g(x), depth	CO2
Define the different ways we can	*Algorithm evaluation* is the process of assessing a property or properties of an algorithm.	CO2

evaluate an algorithm's performance?	(Not complete)	

What is bi-directional search? What are its pros and cons.	Bidirectional search is a graph search where unlike breadth First search and Depth First Search, the search begins simultaneously from Source vertex and Goal vertex and ends when the two searches meet somewhere in between in the graph. One of the main advantages of bidirectional searches is the speed at which we get the desired results. The fundamental issue with bidirectional search is that the user should be aware of goal state to use bidirectional search and thereby decreasing its use cases drastically.	CO2
How a problem can formally be defined? List and explain the important features a problem definition should have.	No search result	CO2
Which is an example of global constraint ? a. k-consistent b. *alldiff* c. x<0 d. x+y >=5	b	CO3
Minimax algorithm uses the property of a. Depth First Search b. Breadth First Search c. A* Algorithm d. Best First Search	a	CO3
In alpha-beta pruning, alpha is a. the root node b. minimum value found so far c. leaf node d. maximum value found so far	d	CO3
Many game playing programs use _____ for opening and ending part of games. a. BFS and DFS b. Heuristic Search c. table look-up d. backtracking	c	CO3

Define consistent assignment and partial assignment with example.	An **assignment** that does not violate any constraints is called a **consistent** or legal **assignment** A **partial assignment** is one that assigns values to only some of the variables.	CO4
List out the varieties of constraints with example	**The types of constraints in artificial intelligence are:** **State constraints: These constraints include physical constraints on the given state or on the states and make sure to forbid the states that are against maintenance goals.** **Effect constraints: These constraints are among the state variables and action variables at given time t, state variables with time t + 1 along with previous state.** **Precondition constraints: These constraints are between the state variable of given time t and specify the actions from a state.** **Actions constraints: They state which actions cannot co-occur.** **Initial state constraints and goal constraints.**	CO4
What is the use of forward checking? Give one example.	**Forward checking** detects the inconsistency earlier than simple backtracking and thus it allows branches of the search tree that will lead to failure to be pruned earlier than **with** simple backtracking. This reduces the search tree and (hopefully) the overall amount of work done. Example: Find in net	CO4
Explain Conflict directed Backjumping and its advantages.	https://en.wikipedia.org/wiki/Backjumping	CO4
Why First order logic is preferred over propositional logic ? Explain briefly.		CO5
Define Knowledge representation. What are the desired properties of a knowledge representation language?		CO5
What is inference? What are the properties of a good inference algorithm?		CO5

Define object, predicate, relations and quantifiers with respect to the FOL.		CO5

What is Move-ordering and how it affects alpha-beta pruning?		CO3
What are Killer moves and what is Killer move heuristic?		CO3
What is Horizon effect in Real time games? How they can be handled?		CO3
What is quiescence search? What is its use?		CO3
How the Monte-carlo simulation be helpful in Stochastic games?		CO6
What are Stochastic games? Give one example. What are Chance nodes?		CO6
Explain Meta-reasoning. Where is it used?	**Meta-reasoning** is **reasoning** about the **reasoning** process itself. Example not found	CO6
What is Planning and what is a Solution to planning? List some classical planning environments.	The **planning in Artificial Intelligence** is about the decision making tasks performed by the robots or computer programs to achieve a specific goal. (Incomplete)	CO6
Question -Any agent with no percepts can never fully satisfy its goals. State T/F.		Ans F
Question -2 An environment that is fully observable for one agent can be partially observable for another agent. State T/F with justification.		Ans T
Question -3 If the environment does not change when the agent is deliberating on what action to do next, the environment is called A. Static environment B. Partial environment C. Dynamic Environment D. None of the above		Ans A
Question -4 The agent which internalises the the present state of the environment based on the previous state, previous action, current percepts and the model of the world is called a A. Simple reflex agent B. Model Based reflex agent C. Goal based agent D. Utility based agent		Ans B

Question -1 The agent which maximises the expected performance given the percept sequence to date and prior knowledge is called a A. Model based reflex agent		Ans C

B. Goal based agent C. Rational agent D. None of the above		
The agent has very capable sensors which can sense the entire geography of the surroundings. A. Fully observable B. Partially observable C. Some times fully observable and some times partially observable D. None of these		Ans A
The agent's sucking action cleans the floor with a probability which is less than one. A. Deterministic B. Stochastic C. Insufficient Data D. None of these		Ans B
The cooking agent should cook the food well in time, the food should neither be burned nor half-cooked, the taste should be good, the ingredients should be in the right proportion. A. Performance B. Environment C. Actuators D. None of these		Ans A
utensils, LPG stove, refrigerator and other kitchenware. **A. Environment** **B. Actuators C. Sensors** **D. None of these**		Ans A

The state of the food being cooked (particularly its temperature and water content) on the stove can change while the cooking agent is deliberating on what to do next. A. Dynamic B. Continuous C. Static D. None of these		Ans A
Consider a uniform search tree T with branching factor b, depth of the solution d, and depth of the tree m. Let B and D be bread-first and depth-first search		

implementations respectively that can be applied on T. What is the difference in the number of nodes expanded by B and D in the worst-case scenario when the goal state is at depth d? Assume that the root node is at depth 0.		
Describe a state space in which iterative deepening search performs much worse than depthfirst search.		
Briefly define and describe the significance of an admissible heuristic		
Prove or give a counter example: Uniform Cost Search is a special case of A* search		
Prove that if a heuristic is consistent, it must be admissible. Construct an admissible heuristic that is not consistent		
Which are the basic requirements tha should fulfill?		
State the fundamental goal of KR.		

List the 4 properties any KR system should possess		
Give an example of relational knowledge.		
Writethe clausal form for the given English breathe"?		
What is a heuristic function in problem solving searching algorithms?	CO1	

What do you understand by state space representation?	CO1	
Provide two uninformed search algorithms for problem solving?	CO1	
Provide two informed search algorithms for problem solving?	CO1	
Knowledge and reasoning also play a crucial role in dealing with _____ environment. a) Completely Observable b) Partially Observable c) Neither Completely nor Partially Observable d) Only Completely and Partially Observable	CO4	(b)
A) Knowledge base (KB) is consists of set of statements. B) Inference is deriving a new sentence from the KB. Choose the correct option. a) A is true, B is true b) A is false, B is false c) A is true, B is false d) A is false, B is true	CO4	(a)

Wumpus World is a classic problem, best example of _____ a) Single player Game b) Two player Game c) Reasoning with Knowledge d) Knowledge based Game	CO4	(c)
Inference algorithm is complete only if _____ a) It can derive any sentence b) It can derive any sentence that is an entailed version c) It is truth preserving d) It can derive any sentence that is an entailed version & It is truth preserving	CO4	(d)
Which search is equal to minimax search but eliminates the branches that can't influence the final decision? a) Depth-first search b) Breadth-first search c) Alpha-beta pruning d) None of the mentioned	CO2	(c)
To which depth does the alpha-beta pruning can be applied? a) 10 states b) 8 States c) 6 States d) Any depth	CO2	(d)
Which search is similar to minimax search? a) Hill-climbing search b) Depth-first search c) Breadth-first search d) All of the mentioned	CO2	(b)
Which value is assigned to alpha and beta in the alpha-beta pruning? a) Alpha = max b) Beta = min c) Beta = max d) Both Alpha = max & Beta = min	CO2	(d)

What is the expansion if PEAS in task environment? a) Peer, Environment, Actuators, Sense b) Perceiving, Environment, Actuators, Sensors c) Performance, Environment, Actuators, Sensors d) None of the mentioned	CO6	(c)
What kind of observing environments are present in artificial intelligence? a) Partial b) Fully c) Learning d) Both Partial & Fully	CO6	(d)
What kind of environment is crossword puzzle? a) Static b) Dynamic c) Semi Dynamic d) None of the mentioned	CO6	(a)
Where does the performance measure is included? a) Rational agent b) Task environment c) Actuators d) Sensor	CO6	(b)
What is an agent? Provide two application of agents.	CO1	
What is utility based agents?	CO1	
Enlist the four basic components of agent architecture?	CO1	
Why Agents are the “nuts and bolt” of A.I ?	CO1	
Which algorithm will work backward from the goal to solve a problem? a) Forward chaining b) Backward chaining c) Depth First Search d) None of the mentioned	CO3	(b)
What will backward chaining algorithm will return? a) Additional statements b) Logical statement c) Substitutes matching the query d) All of the mentioned	CO3	(c)

Which problem can frequently occur in backward chaining algorithm? a) Repeated states b) Incompleteness c) Complexity d) Both Repeated states & Incompleteness	CO3	(d)
What is used in backward chaining algorithm? a) Conjuncts b) Substitution c) Composition of substitution d) None of the mentioned	CO3	(c)
Which closely resembles propositional definite clause? a) Resolution b) Inference c) Conjunction d) First-order definite clauses	CO6	(d)
Which condition is used to cease the growth of forward chaining? a) Atomic sentences b) Complex sentences c) No further inference d) All of the mentioned	CO6	(c)
Which will be the instance of the class datalog knowledge bases? a) Variables b) No function symbols c) First-order definite clauses d) None of the mentioned.	CO6	(b)
Which will solve the conjuncts of the rule so that the total cost is minimized? a) Constraint variable b) Conjunct ordering c) Data complexity d) All of the mentioned	CO6	(b)