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5/5

Q1 What is AI? Considering the COVID is pandemic situation how AI helped to survive and renovated our way of life with different applications?

→ Artifical Intelligence (AI) enables machines to think learn and make decisions like humans. It includes technologies like machine learning, NLP & robotics

Applications:

1) Healthcare: AI helped in early diagnosis, vaccine development and chatbot-based health assitance

2) Contact Tracing - AI powered apps tracked COVID-19 exposure ensuring public safety

3) Remote work & Education: AI enhanced virtual meeting online learning & productivity tools

4) Supply chain & Delivery: AI optimized logistics & enabled autonomous deliveries

5) Mental Health Support: AI driven apps provided emotional & fitness assistance

Q2 What are AI Agents terminology, explain with examples

→ 1) Agent: An entity that interacts with the environment & makes decision based on inputs

ex: A self-driving car perceives traffic signal & adjust speed accordingly.

2) Performance measures: Defines how successful an agent is in achieving its goals

ex: A self-driving cars performance measures could be minimizing accidents, fuel efficiency & travel time.

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3) Behaviour / Action of Agent: The action an agent make take based on its percepts
ex: A robotic vaccum cleaner moves around obstacles after detecting them.
4) Percept: The data an agent receives at a specific moment from sensors
ex: A spam filter receives an email & detects keywords Sensor info and attachments.
5) Percept Sequence: The entire history of percepts recived by an agent
ex: A chessplaying AI remembers all previous moves in the game before making the next moves
6) Agent Function: A mapping from the percept sequence to an action
ex: A smart thermostat analyzes past temperature changes & adjusts heating accordingly

Q3 How AI technique is used to solve 8-puzzle problem?
→ It consists of a 3x3 grid with 8 numbered tiles & one empty space where the objective is to move the tiles around to match a predefined goal configuration.

Initial State

1	2	3
4		6
7	5	8

This is the random starting configuration of the 8 puzzle with the tiles placed in a non-goal configuration

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2) Goal state: The goal is to arrange the tiles in a specific order with the blank space at the bottom right
Goal State

1 2 3
4 5 6
7 8

* Solving the 8 Puzzle problem
• AI search algorithm such as breadth first search (BFS) depth-first Search (DFS) and A^* are commonly used:

1) Breadth-First Search (BFS)
• BFS is an uniformed search algorithm that explore all possible state level by level starting from the initial state.
• BFS guarantees that the solution found is the shortest in terms of number of moves but it can be very slow.
Advantages:
• Guaranteed to find the optimal solution
Disadvantages:
• BFS has a high memory requirement as it must store all the states at each level of exploration

2) Depth First Search (DFS)
• DFS is another uniformed search algorithm that explores one branch of the state space tree as deep as possible before backtracking
Advantages:
• DFS is more memory-efficient than BFS
Disadvantage:
• DFS can get stuck in deep non-optimal paths & may not find the shortest solution

Steps using A^*

- Compute Manhattan distance for each possible move
- Choose the best move (lowest f(n))
- Repeat until reaching the goal state

Q4 What is PEAS descriptor? Give PEAS descriptor for following

1) Taxi driver
   - P: Minimize travel time fuel efficiency, passenger safety obey traffic rules
   - E: Roads, traffic, passengers, weather, obstacles
   - A: Steering, accelerator, brakes, ~~turns~~ signals, horn
   - S: Camera, GPS, speedometer, radar, microphone.

2) Medical Diagnosis System
   - P: Accuracy of diagnosis, treatment success rate, response time
   - E: Patient records, symptoms, medical tests, hospital database
   - A: Display screen, printed prescriptions, notification.
   - S: Patient input, lab reports, electronic health records

3) A Music Composer

P: Quality of music, adherence to genre, audience engagement

E: Digital workspace, music production software real time composition setting

A: Audio output, digital instrument selection, file saving/export

S: User inputs; style preferences, tempo, feedback from listeners music theory contraints

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4) An aircraft Autolander
P: Smooth landing, accuracy in reaching runway, passenger safety, fuel efficiency
E: Airspace runway, weather, wind, speed, visibility
A: Flight control, landing gears brakes
S: GPS airspeed indicators, gyroscope, radar, weather sensors

5) An ~~essasy~~ essay Evaluator
P: Accuracy of grading consistency fairness grammer
E: Digital text, input, student essay predefined grading criteria
A: Feedback generation score assignment highlighting error suggesting improvement
S: Optical character recognition : NLP grammer & spell check

6) A robotic sentry gun for the keck lab
P: Target accuracy threat detection efficiency response speed
E: Keck lab premises, intruders, lighting condition obstacles
A: Gun aiming system, firing mechanism camera panning alert system.
S: Motion detectors, infrared sensors, ~~camera~~ LIDAR radar

Categorize a shopping bot for an offline bookstore according to each of six dimension (fully/partially observable, deterministic/stochastic episodic/sequential, static/dynamic, discrete/continous single/multi agent)
→ 1) Partially Observable: The bot may not have complete visibility
2) Stochastic: The environment in unpredictable
3) Sequential: Each decision bot makes affect future states.
4) Dynamic: The bookstore environment changes over time

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5) Discrete: Bot choose discrete choice (selecting books)
6) Multi agent: The bot interacts with multiple entities

Q6 Differentiate Model based & Utility based agent

Model Based Agent	Utility Based Agent
1) Maintains an internal model of the environment to make decision	Use a utility function to measure performance & make option choice
2) Relies on stored knowledge & Updates the model	Choose actions based on maximizing expected utility
3) Can adapt to changing environment by updating the internal model	More flexible & goal oriented adapting changes dynamically
4) Moderate complexity due to model maintainance	Higher complexity due to the need to compute utilities for different action
5) Ex Self driving car that predicts pedestrian movement	A self driving car that evaluate route & selects the best one

Q7 Explain the architecture of a knowledge based agent & learning Agents
→ 1. Knowledge Based Agent Architecture
• A knowledge-based agent is an intelligent that makes decisions using knowledge (KB) and reasoning mechanism

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Architecture Component :

1) Knowledge base : Stores fact, rules & heuristic about the world
2) Inference Engine : Use logical reasoning (FOL) to derive new knowledge from the KB
3) Perception Module : Collects data from sensors & update the KB
4) Action selection Module : Chooses appropriate actions based on reasoning outcomes
5) Communication Module : Allows interaction with other agents

Working Process

- The agents perceives the environment & updates its KB
- The interference engine applies logical rules to infer new knowledge
- The ~~a~~ agent decides on action and executes it
- The KB is continuously updated to improve decision making

2) Learning Agent Architecture

- A learning agent improves its performance overtime by learning from past experiences & interaction with the environment

Architecture components

1) Learning Element : Analyzes feedback from the environment and improves knowledge
2) performance Element : Make decisions & executes action
3) Critic : Evaluates the agent's action & provide feedback
4) Problem Generator : Suggest explatory action to improve learning

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Working Process:
- The performance element select an action
- The critic evaluates the action & provides feedback
- The learning element updates the agent knowledge to improve future decision
- The problem generator suggests new strategies to explore better solution

9 Convert the following to predicate

a. Anita travels by car if available otherwise travel by bus
→ → Car Available ⇒ Travel by Car (Anita)
¬ Car Available → Travel by Bus (Anita)

b. Bus goes via Andheri and Goregaon
→ GoesVia (Bus, Andheri) ∧ ~~Goes~~ Goes Via (Bus, Goregaon)

c. Car has puncture so is not available
Puncture (car)
Puncture (car) → ¬ Car Available

Will Anita travel via Goregaon use forward reasoning

From (c)
Puncture (car) is true
As Puncture (car) → ¬ Car Available
From (a)
¬ Car Available, we use ¬ car Available → Travels By Bus (Auto)
From (b)

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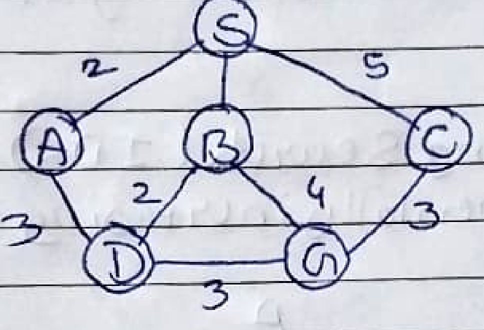
Goes via (Bus, Goregaon)
Since Anita travels by bus she will follow this route
Thus Anita will travel via Goregaon

Q10 Find the route from S to G using BFS



Current Node
1. Start at S
Queue = [S]
2. Dequeue S and explore its neighbouring nodes
Queue = [A, B, C]
3. Dequeue A and explore neighbour
Queue = [B, C, D]
4. Dequeue B and explore neighbour
Queue = [C, D, G]
5 Dequeue C and explore neighbour
Queue = [D, G]
6. Dequeue D
Queue = [G]
7. Dequeue G

∴ G is our destination node BFS will stop here
Route from S to G : S -> B -> G

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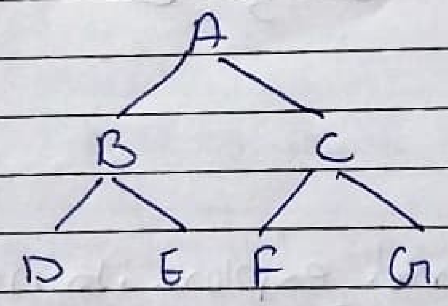
11. What do you mean by depth limited search? Explain Iterative deepening search with example

-> Depth limited search (DLS) is an uniformed search algorithm that modifies DFS by introducing a depth limited L preventing exploration beyond the defined level. This prevents infinite loop in graphs but risk missing beyond L

Iterative Deepening Search (IDS) combines DLS with BFS by incrementally increasing the depth bond

Example



Goal = G

Initially the depth limit is 0 for iteration 1

Node visited = A

Goal not found

Iteration 2 Limit = 1

Nodes visited = A -> B -> C

Goal not found

Iteration 3, Limit = 2

Node visited = A -> B, -> D -> E -> C -> F -> G

Goal G is found

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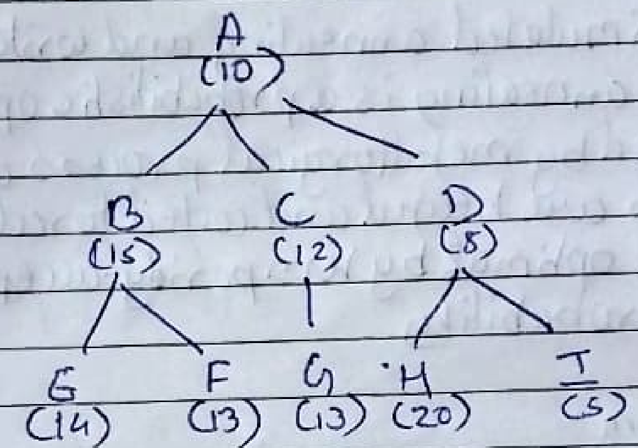
12. Explain hill climbing and its drawbacks in details with example. Also state limitation of steepest-ascent hill climbing

-> Hill climbing is a local search optimization algorithm which moves forwards towards a better neighbouring solution until it reaches a peak

Example



Goal = G

Steps

1. Start at root node A (10)
2. Compare its children B, C, D
3. Move to child with highest value ie B(15)
4. ~~Rope~~ Repeat for B's children E and F
5. Terminate at E(14)

The algorithm stops at E(14) not reaching the Goal G

Drawback

1. Local maxima - The algorithm greedily selects the best immediate child and can thus get stuck on local maxima
2. Plateau - If sibling have equal values the algorithm can't decide the next step and gets stucks
3. Ridges - Narrow uphill paths require backtracking which hill climbing algorithm does not support

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Limitation of steepest ascent hill climbing
1. Computationally expensive: Evaluates all neighbours before selecting the best
2. Can get stuck - It can still get stuck in local maxima plateaus or ridges
3. No global optimality - It only focuses on immediate improvement

13 Explain simulated annealing and write its algorithm
→ Simulated annealing is a probabilistic optimization algorithm inspired by metallurgical process of annealing where materials are heated and cooled to reduce defects. It escape the local optima by temporarily accepting worse solution with a probability

Algorithm
1. Initialize
· Set an initial solution and define an initial temperature T
2. Repeat until stopping condition
· Generate a new neighbour solution
compute changes in cost
· If new solution is better then accept it
· Decrease temperature T
3 Return best solution
Example: Travelling salesman problem

14 Explain A* algorithm with an example

-> A* is a best first Search algorithm used in path finding and graph traversal. It uses the following formulas

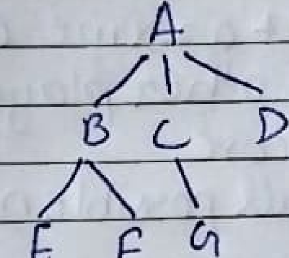
$f(n) = g(n) + h(n)$

$g(n)$ -> Cost to reach n from start

$h(n)$ -> heuristic estimate of cost to reach from goal to n

$f(n)$ -> total estimated cost

goal : G



Node	$g(A,n)$	$h(n,G)$
A	0	6
B	1	4
C	2	2
D	4	7
E	3	5
F	5	3
G	6	0

Steps

1. Start at root node A $f(A) = g(A) + h(A) = 0 + 6 = 6$

$f(B) = 1+4 = 5$
$f(C) = 2+2 = 4$ } 2. Expand neighbour B, C, D
$f(D) = 4+7 = 11$

3. Choose lowest value that is $f(C)$

4. Expand neighbours of C

$f(C) = 2 + 4 + 0 = 6$

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5. Goal reached at G with total cost 6

Advantages ->
- Efficient for finding the shortest path in weighted graph
- balances exploration by considering both g(n) and h(n)

15 Explain MinMax algorithm and draw game tree for tic tac toe game
-> The min max algorithm is a decision making algorithm used in 2 players games. It assume One plax (max) tries to maximize the score other player (MIN) tries to ~~mimi~~ minimize the score
- Game tree represent all possible moves

Algorithm:
1 Generate game tree
2 Assign score
3. Max picks highest values from children MIN picks lowest values
4. Repeat until root node is evaluated

Game tree for tic tac toe game:

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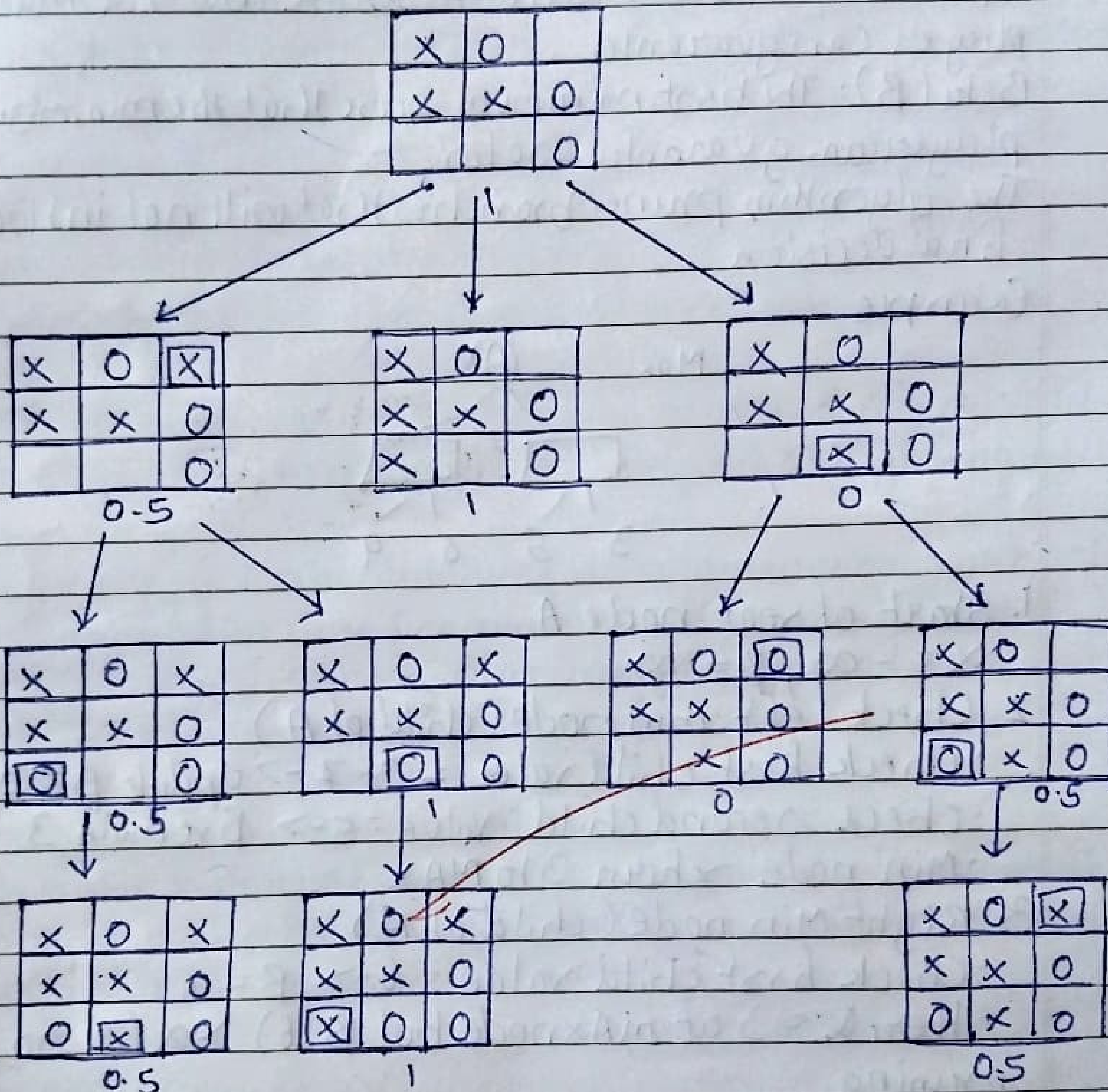
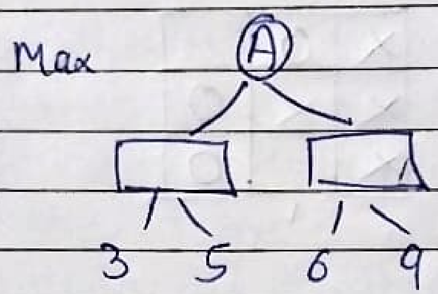


16 Explain alphabeta pruning algorithm for adversarial search with example

-> Alpha beta pruning is an optimization technique used in minimax algorithm to reduce the number of nodes evaluated in adversarial search problems like game-playing AI (eg - chess, tic-tac-toe)

Alpha beta pruning includes :

Alpha(α): The best maximum score that the maximising player can guarantee
Beta(β): The best minimum score that the minimizing player can guarantee so far
The algorithm prunes branches that will not influence final decision
Example



1. Start at root node A
   $\alpha = -\infty$, $\beta = \infty$
2. Check left min node (child of A)
   - Check first child value = 3 -> Update $\beta = 3$
   - Check second child: value = 5 -> β remain 3
   - Min node return 3 to MAX
3. Right Min node (child of A)
   - Check first child: value = 6 -> $\beta = 6$
   - Here $\alpha = 3$ at MAX node but $\beta(6) > \alpha(3)$ so no pruning
   - Explore 2nd child (9) -> Here pruning will occur
   $\therefore$ MIN node already has a value ≤ 6 it will never choose 9 and so we prune the node with value 9
4. Max value = 6

17 Explain WUMPUS world environment giving its PEAS description. Explain how percept sequence is generated
-> The Wumpus world environment is a simple grid-based environment used in AI to study intelligent agent behaviour in uncertain environment. It is a turn based environment where an agent must navigate a cave to find gold while avoiding hazards like pits and a monster called wumpus

PEAS
P: The agent is reward for grabbing gold and exiting safely. Penalty is imposed for falling into pits and getting eaten by wumpus
E: 4x4 grid world containing the agent wumpus, pit, gold
A: The agent can move forward left, Right, shoot, Climb
S: Agent perceives stench (near wumpus), breeze (near a pit) glitter (near gold), bump and scream

Percept sequence generation
It is the history of all perception received by the agent. At each time step the agent perceives information based on its current location and surrounding

Example percept sequence
1. Agent start at (1, 1)
· No breeze, not stench, no glitter -> safe square
2. Agent moves to (2, 1)
· Breeze detected -> A pit is nearby but not in current square)
3. Agent moves to (1, 2)
stench detected -> whumpus is a in adjent cell
4. Agent moves to (2, 2)
Glitter detected -> gold is here
5. Agent moves back to (1, 1) and climb out

18 Solve the following Crypto arithmetic problems

1. SEND + MORE = MONEY

→ Step 1:

M must be 1. The sum of 2 four digit number cannot be more than than 10000

```
  SEND
+ 1ORE
------
 1ONEY
```

Step 2

Now S must be 8 because there is 1 carry over from column EON. O must be 0 (if S = 8) and there is a 1 carried or S = 9 and there is no 1 ~~core~~ carried or (if ~~8~~ S = 9 and there is a 1 carried) But 1 is already taken is O mus be 0

```
  SEND
+ 10RE
------
 10NEY
```

Step 3

~~M~~ There cannot be a carry from column EON because any digit to <10 unless there is a carry from the column NRE and E = 9 But this cannot be the case because then N would be 0 and 0 is already taken so E<9 and there is not carry from this column therefore S = 9 because 9+1=10

Step 4

Case 1

No carry N+R = 10 + (N - 1) = N + 9

R = 9

But 9 is already taken 'so will not work

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Case 2

carry : $N + R + 1 = 9$

$R = 9 - 1 = 8$ This must be ~~tal~~ the solution of R

Steps 5

Let's consider $E = 5$ or 6

$E = 5$

Then $D = 7$ and $Y = 3$ so this part will work but look at the column N 8 E. There is a carry from the column D 5 Y

$N + 8 + 1 = 16$ But then $N = 7$ and 7 is taken by D Therefore

$E = 5$

$$
\begin{array}{r}
9\,5\,N\,D \\
+\ 1\,0\,8\,5 \\
\hline
1\,0\,N\,5\,Y
\end{array}
$$

Now,

$N + 8 + 1 = 15,\ N = 6$

$$
\begin{array}{r}
9\,5\,6\,D \\
+\ 1\,0\,8\,5 \\
\hline
1\,0\,6\,5\,Y
\end{array}
$$

Step 6

The digits left are 7, 4, 3 and 2 we known there is carry from column D 5 Y so only pair that work is $D = 7$ and $Y = 2$

$$
\begin{array}{r}
9\,5\,6\,7 \\
+\ 1\,0\,8\,5 \\
\hline
1\,0\,6\,5\,2
\end{array}
$$

19 Consider the following axioms

All people who are graduating are happy

All happy people are smiling

Someone is graduating

Date
Page

1) Represent these ~~axioms~~ axioms in first order predicate logic
2) Convert each formula to clause form
3) Prove that "Is someone smiling?" using resolution technique
Draw the resolution tree

1) In clause form = $\{G(a)\}$
we define the following predicate
$G(x)$ = x is graduating
$H(x)$ = x is happy
$S(x)$ · x is smiling

Translating axioms into predicate logic
1. All people who are graduating are happy
$\forall x (G(x) \rightarrow H(x))$

2 All happy people are smiling
$\forall x (H(x) \rightarrow S(x))$

3 Someone is graduating
$\exists x \ G(x)$

2) Convert implication to clausal form
$\forall x (G(x) \rightarrow H(x))$
· Using implication removal:
$\forall x (\neg G(x) \vee H(x))$
· In clause form
$\{\neg G(x), H(x)\}$

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2. $\forall x (H(x) \rightarrow S(x))$
using implication removal
$\forall x (\neg H(x) \vee S(x))$
· In clause form
$\{\neg H(x), S(x)\}$

3. $\exists x\, G(x)$
· In clause form: $\{G(a)\}$

3) Prove "is someone still smiling" using resolution

1) Collect clause
1). $\{\neg G(x), H(x)\}$
2) $\{\neg H(x), S(x)\}$
3) $\{G(a)\}$

2) Apply resolution
Resolve (1) $\{\neg G(x), H(x)\}$ with (3)
$\{G(a)\}$
Substituting $x = a$
$\{\neg G(a), H(a)\}$
∵ we have $G(a)$ resolving gives
$\{H(a)\}$
∵ Resolve (2) $\{\neg H(x), S(x)\}$ with $\{H(a)\}$
Substituting $x = a$
$\{\neg H(a), S(a)\}$
Since we have $H(a)$ resolving gives $\{S(a)\}$
Since we have derived $S(a)$ we conclude that someone (a) is ~~sim~~ smiling

20 Explain Modus ponen with suitable example

-> Modus ponen is a fundamental rules of inference in propositional logic ~~rules of~~ that allows us to deduce a conclusion from a conditional statement and its antecedent

It follow the form

$P \to Q$ (if P then Q)

P (P is true)

Q (Q must be true)

Example

1. If it rains, the ground will be wet $P \to Q$
2. It is raining $\to P$

Ground is wet $\to Q$

21 Explain forward chaining and backward chaining algorithm with the help of example

-> Forward chaining: It start with given facts and applies inference rules to derive new fact until the goal is reached. It is a data driven approach because it begins with known data and works forward to reach a conclusion

Example Diagnosing a disease

Rules:

1. If a person has a fever and cough they might have Flu
2. If a person has a sore throat and fever they might have cold

Facts:

- The patient has a fever
- The patient has a cough

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Inferunce
1. Fever + cough -> Flu (rule 1 applies)
2. conclusion the patient might have Flu

Backward chaining: It starts with goal and work backward by checking what facts are needed to support it. It is a goal driven approach

Example : Diagnosing a disease

Goal : Determine if patient has Flu

Rules
1. (Fever ^ Cough) -> Flu
2. (Sore Throat ^ Fever) -> Cold

Process using backward chaining
1. We want to prove Flu
2. Looking at rule 1 : (Fever ^ cough) -> flu
we need to check if patient has fever and cough
3. We check our known facts :
- Patient has fever
- Patient has cough
4. Since both condition are met we confirm Flu is true