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AIDS Assignment

Q1) What is AI? Considering the COVID-19 pandemic situation, how AI helped to survive & renovated our way of life with different application?

→ Artificial Intelligence (AI) refers to the ability of machines & system to simulate human intelligence, including tasks like learning, reasoning, problem-solving & decision making. It leverages techniques like machine learning & NLP to analyse data, identify patterns & improve performance over time.

Role of AI during the Pandemic:

- Healthcare - AI was used to quickly analyze medical imaging eg. CT scans & predicting severity.
- Remote work & Education - The pandemic drove widespread adoption of AI in virtual learning & remote work tools.
- Retail - Retail stores are using computerized models to map out their stores & track inventory. This is in a response to need given the rush buy specific items at various stages of pandemic

Q2) What are AI agents terminology, explain with examples.

→ AI agents are autonomous system that perceive the environment, make decisions.

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AI Agent Terminology:

1) Agent - An AI system that interacts with the environment & takes action.
Example - A self-driving car that perceives traffic signals & adjusts speed accordingly.

2) Environment - The surrounding in which the AI agent operated.
Ex - For a chess-playing AI, the chessboard & opponent are part of its environment.

3) Percepts - The information received by agent via sensors
Ex - A robot vaccum detecting obstacles using cameras & infrared ray.

4) Actions - The move an agent makes in response to percept.
Ex. A chatbot responding to user's past ~~preferences~~ query.

5) Percept Sequence - The entire history of percepts recieved by an agent Ex - A recommendation system tracking user's past preferences.

6) Performance Measure - Determine success of an agent.
Ex - A self driving car's performance measure will be reaching the destination safely & in a timely manner

Q3) How AI techniques is used to solve 8-puzzle problem?

→ Initial State: 1 2 3 Goal State: 1 2 3
4 0 6 4 5 6
1 5 8 7 8 0

Misplaced tiles : $h(n)=2$

Steps to solve 8 puzzle problem by A*:

1) Initialize a priority queue.
2) Insert the initial state with $f(n) = g(n) + h(n)$
3) While queue not empty:
   Remove state with lowest $f(n)$
   If state = goal, return solution
   Generate valid moves (up, down, left, right)
   Compute $g(n)$ & $h(n)$ for new states
   Insert new states into queue
4) Repeat until goal is reached

Example Execution

Step 1	Step 2	Step 3: (Goal)
1 2 3	1 2 3	1 2 3
4 0 6	4 5 6	4 5 6
7 5 8	7 0 8	7 8 0
(h=2)	(h=1)	(h=0)

Q4) What is PEAS description? Give PEAS description for following.

⇒ PEAS stands for Performance measure, Environment, Actuators & sensors.

P⇒ Criteria to evaluate the agents success.

E⇒ Surrounding where agent operates.

A→ Component that allows agent to take actions

S⇒ component that help agent percept the environment

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1) Taxi Driver
P → Reaching destination, fuel efficiency
E → Roads, traffic
A → Steering, wheel, accelerator, brakes
S → Camera, GPS, speedometer
2) Medical Diagnosis System
P → Accuracy of diagnosis, patient satisfaction
E → Medical records, test result symptoms
A → Prescription generation, Report generation
S → Patient data input, lab test results.
3) Music Composer
P → Quality of composition, User satisfaction
E → Musical genres, musical theory constraints
A → Music synthesizer, Instrument, generating notes
S → Composition structure, user feedback
4) Aircraft Autolander
P → Smooth & safe landing
E → Weather, runway condition, air traffic
A → Flaps, landing gear, throttle.
S → Altitude sensor, GPS, wind direction sensors.
5) Essay Evaluator
P → Accurate grading, feedback quality.
E → Grammar rules, submitted essays.
A → displaying grades & feedback
S → Text inputs, spelling & grammar checkers
6) Robotic Sentry Gun for Rock Lab
P → correctly indentifying threats, accuracy.
E → authorized personnel
A → Camera movement, alarm system
S → motion sensor, facial recognition

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Q5) Categorize a shopping bot for an offline bookstore according to each of the six dimensions.

=> 1) Partially observable
- but may not have full visibility of store's inventory

2) Stochastic - outcomes uncertain due to customer behaviour, stock availability.

3) Sequential - Bot will suggest books based on previous customer queries.

4) Dynamic - Bookstore environment changes like books getting sold, new stock

5) Discrete - Bots process finite number of actions.

6) Multiagent - Bot interacts with customers & store employee, each have their own goals.

Q6) Differentiate between Model-Base & Utility Based Agents.

=>

Model-Based agents	Utility-based agents
1) Uses an internal model of environments to make decisions.	1) Choose actions based on utility function that measure performance.
2) Decision based on past & present percepts	2) Selects action based on maximum utility.
3) Can be good based but doesn't necessary optimize for best outcomes	3) Optimizes for higher possible utility ensuring better performance
4) Ex- Robot vacuum using a map to Navigate	4) Ex- Self-Driving car choosing safest & fastest route.

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7) Explain the architecture of a knowledge based agent & learning agent.

⇒ <u>Knowledge-based agent</u>

A knowledge-based agent uses stored knowledge to make decisions. It consists of

- Knowledge base ⇒ Stores facts, rules & logic
- Inference Engine ⇒ uses reasoning to derive conclusions.
- Perception (sensors) ⇒ gathers new information from environment
- Action Mechanism ⇒ performs appropriate actions based on reasoning

Ex: AI in medical diagnosis uses past cases & symptoms to diagnose diseases.

<u>Learning agent</u>

A learning agent improves its performance over time. It consists of

- Learning Element ⇒ update knowledge based on experience
- Performance Element ⇒ Decides actions based on current knowledge
- Critic ⇒ provides feedback by evaluating actions.
- Problem Generator ⇒ suggests new actions to improve learning

Ex: A self-driving car learns from traffic patterns & adjusts driving behaviour.

8) Convert the following to predicates:

⇒ a). Anita travels by car if available otherwise travels by bus.

Car Available ⇒ Travels by car (Anita)

~~Car Available ⇒ Travels by bus (Anita)~~

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Car Available ⇒ Travels by Bus (Anita)

b) Bus goes via Andheri & Goregaon.

Goes Via (Bus, Andheri) ∧ Goes Via (Bus, Goregaon)

c) Car has punctures 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 (Anita)

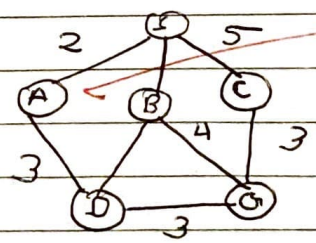
From (b)

Goes Via (Bus, Goregaon)

Since Anita travels by bus, she follows this route

Thus, Anita will travel via goregaon.

Q9) Find route from S to G using BFS



⇒ To find route from S to G using BFS, we systematically explore all node level by level starting from source node (S) until we reach destination node (G)

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1) Start at S

Queue : [S]

2) From S, we go to it neighbours: A, B, C

Queue : [A, B, C]

3) Dequeue A & explore its neighbours

Queue : [B, C, D]

4) Dequeue B & queue neighbours

Queue [C, D, G]

5) Dequeue C & queue neighbours

Queue : [D, G]

6) Dequeue D

Queue -[G]

7) Dequeue G

As G is our destination, BFS stops here.

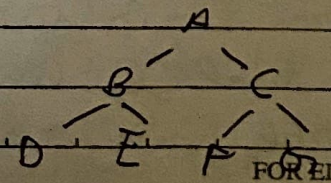
Route from S to G: S→B→G.

Q11) What do you mean by depth limited search? Explain Iterative Deepening Search with Example

→ Depth Limited Search (DLS) is an uninformed search algorithm that modifies DFS by introducing a depth limit L, preventing exploration beyond the predefined limit. This prevents infinite loops in infinite graphs but risks missing goals beyond L.

Iterative Deepening Search (IDS) combines DLS with BFS by incrementally increasing the Depth limit.

Example:



Goal = G

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Interation 1: Depth limit = 0

Node visited = A

Result = Goal Not Found

Iteration 2: L = 1

Node visited: A→B→C

Goal Not Found

Iteration 3: L = 2

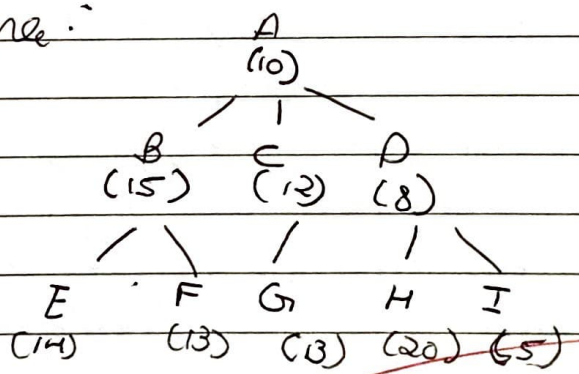
Node visited: A→B→D→E→C→F→G

Goal is found at L = 2.

Q12) Explain Hill climbing & its Drawbacks in detail with example. Also state limitations of steepest-ascent.

⇒ Hill climbing is a ~~goal~~ local search optimization algorithm, which moves toward better neighbouring solutions until it reaches a peak.

Example:



Steps:

Start at a root node A(10)

Compare its children B, C & D

Move to child with highest value i.e B(15)

Repeats for B's children E & F.

Terminates at A(14)

The algorithm stops at E(14) not reaching the goal.

Drawbacks :

1) Local maxima - The algorithm greedily selects the best immediate child & can thus get stuck on local maxima
2) Plateau - If siblings have equal algorithm, the algorith cant decide the next step.
3) Rigid : Narrower uphill paths require backtracking hill climbing does not support.

Limitation of Steepest-Ascent Hill Climbing :

1) Computationally Expensive - Evaluates all neighbors before selecting the best.
2) Can get stuck - It can get stuck in local maxima plateaus or ridges.

Q13) Explain Simulated and & write its algorithm.

⇒ Simulated Annealing (SA) is a probabilistic Optimization algorithm inspired by metallurgical process of annealing where materials are heated & cooled to reduce ~~defe~~ defects. It escapes the local optimal by temporarily accepting worse solution with a probability.

Algorithm :

1) Initialize - Set a initial solution & define an initial temp T.
2) Repeat until stopping conditions
   - Generate a new neighbour solution
   - Compute change in Loss T ($\Delta E = E_{new} - E_{current}$)
   - If new solution is better i.e $\Delta E > 0$, accept it.
   - If worse, accept it while probability $P = e^{-\Delta E / T}$
   - Decrease temperature T (cooling schedule)

3 Return best solution.

Example:

Travelling salesman Problem

Swap two cities in a route accept a longer route easily (high T) but rejects it later (low T).

Q14) Explain A* algorithm with one example.

⇒ A* is a best first search algorithm used in pathfind & graph traversal. It used the following formula:

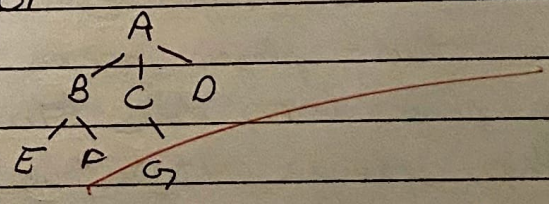
$$f(n) = g(n) + h(n)$$

$g(n)$ = Cost to search node n from start

$h(n)$ = heuristic estimate of cost to search from goal to n

$f(n)$ = total estimated cost.

Example: 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

$f(A) = g(A) + h(A) = 0 + 6$
$= 6$

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2 Expand neighbours : B, C, D

$f(B) = 1+4 = 5$

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

$f(D) = 4+7 = 11$

3 Choose lowest value that is C ($f(C) = 4$)

4 Expand neighbours of C: G

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

5 Goal reached at G with total cost 6

Advantages →

- Efficient for finding shortest paths in weighted graphs
- Balances exploration by considering both $g(n)$ & $h(n)$.

Q15) Explain Min-Max Algorithm & draw game tree for Tic Tac Toe game.

⇒ The Min Max Algorithm is a decision making algorithm used in two-player games. It assumes:

- One player (MAX) tries to maximize the score.
- Other player (MIN) tries to minimize the score.
- Game tree represents all possible moves.

Algorithm

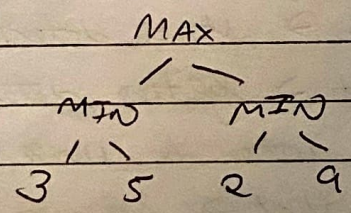
1) Generate game tree
   → All possible moves from current state.
2) Assign scores
   Terminal state (win/loss/draw), get +1, -1, 0
3) Max picks higher value from children
   MIN picks lowest value.
4) Repeat until root node is evaluated.

Q16) Explain Alpha beta pruning algorithm for adversarial search with example.

⇒ Alpha-beta pruning is a optimization technique for Min-Max algorithm used in Adversial Search. It reduces the number of nodes evaluated in a game tree by eliminating branches that won't influence the final decision.

- Alpha (α): Best value for max so far.
- Beta (β): Best value for min so far.
- Pruning condition: if α ≥ β, stop exploring that branch

Example:



- Without pruning: All nodes are evaluated
- With pruning: Once Min finds 2, 9 is ignored, saving computation.

Q17) Explain Wumpus world environment giving its PEAS discription. Explain how percept sequence is generated

⇒ A grid-based game where an agent navigates a cave to find gold while avoiding pits & a Wumpus.

PEAS Description:

- P (Performance Measure): Gold found (+), falls into a pit / Wumpus (-), steps taken (-).

• E (Environment): A 4x4 grid, containing gold, pits, Wumpus & agent.
• A (Actuators): Move (left, right, up, down), grab gold, shoot arrow, climb out.
• S (Sensors):
  • Breeze: Near a pit
  • Stench: Near Wumpus.
  • Glitter: Gold present
  • Bump: Hits a wall

Percept Sequence Generation:
The agent senses the environment based on its position:
  • If near a pit → Breeze detected.
  • If near a Wumpus → Stench detected.
  • If gold is present → Glitter detected.
  • If agent moves into a wall → Bump sensed.
  • If Wumpus is shot → Scream heard.

Q18) Solve the following crypto-arithmetic problem
SEND + MORE = MONEY

⇒ Step 1: Identify M
• Since the sum produce a five-digit result the addends have at most 4 digits, M=1

Step 2: Consider Carrying
The S+M sum must create the first digit M=1, meaning S=9

Step 3: Assigning Other Values
Through logical & deduction Techniques
• S=9, E=5, N=6, D=7, M=1, O=0, R=8, Y=2.

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Q(a) Consider the following axioms:
All people who are graduating are happy!
All happy people are smiling.
Someone is graduating.
Explain the following:
1) Represent these axioms in first order predicate logic
2) Convert each formula to clause form
3) Prove that "Is someone smiling?" using resolution technique.

⇒ Step 1: Represent in FOLPL
Let:

$G(x)$: x is graduating

$H(x)$: x is happy

$S(x)$: x is smiling

Step 2: Convert to Clause Form

1) $G(x) \rightarrow H(x) = \neg G(x) \vee H(x)$
2) $H(x) \rightarrow S(x) = \neg H(x) \vee S(x)$
3) $\exists x\, G(x)$ remain as $G(A)$

Thus, the clause set is:

1) $\neg G(x) \vee H(x)$
2) $\neg H(x) \vee S(x)$
3) $G(A)$

Step 3: Prove "Is someone smiling?" using Resolution

1) $G(A)$
2) $\neg G(A) \vee H(A)$
   - Resolution with (1): $H(A)$
3) $\neg H(A) \vee S(A)$
   - Resolution with (2): $S(A)$

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Since we derived S(A), our assumption ¬S(x) is false
Thus, someone is smiling.

Q20) Explain Modus Ponens with suitable example.
⇒ Modus Ponens is a fundamental rule of inference in logic that states:
If P→Q (If P then Q) is true, & P is true, then Q must be true.
Logical Form:
1) P → Q
2) P (P is true)
∴ Q (Therefore, Q is true)
Example:
1) If it rains, the ground will be wet. (R→W)
2) It is raining.
∴ The ground is wet.

Q21) Explain Forward & backward chaining with the help of example.
⇒ Forward chaining:
Starts from known facts & applies rules to reach a conclusion
Ex: Given Rules:
1) If it rains, the ground wet. (R→W)
2) If the ground is wet, it is slippery. (W→S)
3) It is raining (R)

Process:

- From R, infer W
- From W, infer S

Conclusion: The ground is slippery.

Backward Chaing:

Starts from a goal & works backward to find supporting facts.

Ex: Process:

- To prove S, check W → S → Need to prove W.
- To prove W, check R → W → Need to prove R.
- If R is true, then W is true → S is true.

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