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AIDS Assignment - 1

Q.1] What is AI? Considering the Covid-19 pandemic situation, how AI helped to survive and renovated our way of life with different applications?

→ AI (Artificial intelligence) refers to the simulation of human intelligence in machines, enabling them to learn, reason and solve problems. AI encompasses machine learning, natural language processing, robotics and expert systems.

AI's role in the COVID-19 pandemic:

1] Healthcare → AI powered tools helped in diagnosing COVID-19 using chest X-rays, predicting outbreaks and accelerating vaccine development

2] Chatbots → AI drive chatbots provided real-time information and assisted in symptom checking.

3] Supply Chain Management → AI optimized supply chains by predicting shortages of medical equipment.

4] Drug discovery → AI assisted in analyzing protein structure to identify potential treatments

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Q.2) What are AI agents terminology, explain with example?
→ An AI agents perceives it's environment using sensors and acts upon it using actuators.

Key terminologies:

1) Agent → An entity that senses and acts. Ex:- a self driving car.

2) Sensors → Devices used to perceive the environment (ex:- cameras).

3) Actuators → Components responsible for actions (eg:- robot arms in automation).

4) Rationality → An agent acts rationally to achieve it's goal.

5) Performance measure → Criteria to evaluate agent performance.

Ex:- A robot vacuum cleaner uses sensor to detect obstacles and moves using actuators based on programmed logic.

Q.3) How AI technique is used to solve 8 puzzle problem?
→ The 8-puzzle consists of a 3x3 grid with numbered tiles and an empty space and the goal is to arrange the tiles in order.

AI techniques used:-

1) Breadth-First search (BFS) → Explore All possible moves at each step.

2) Depth-First search (DFS) → Explores a single path deeply before backtracking.

3) A* Algorithm → uses heuristics to find the shortest path.

4) Best-First search → select moves that bring it closest to the goal state.

AI ensures the problem is solved optimally using search & heuristic based approach.

Q.4) what is PEAS descriptor? Give PEAS for the following

→ PEAS is used to describe and analyze the task environment of an AI agent.

System	Measure	Environment	Actuators	Sensors
Taxi driver	safety time, customer satisfaction	Roads, traffic passengers	steering, breaking, acceleration	GPS, speedometer, camera
medical diagnosis	Accuracy of diagnosis speed	Patient data, symptoms	Display recommendations	Patient records, medical tests
music composer	Quality of composition, popularity	Music industry, users	Sound generation, editing tools	musical notes, user preferences.

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Environment	Actuators	Sensors	Performance measure	
System	Performance measure	Environment	Actuators	Sensors
Aircraft Autolander	Smooth landing, safety	Airport, weather	Display feedback	Text analysis grammar
Essay Evaluator	Grammar accuracy relevance	Essays writing styles	Aiming, filing mechanism	Motion sensors, infrared cameras

Q.5) Categorize a shopping bot for an offline bookstore according to each of the six dimensions.

→

Dimension	Categorization
Observability	Partially observable (it doesn't know all book stocks instantly)
Determinism	Stochastic (stock availability changes unpredictably)
Episodic vs sequential	Sequential (it learns from past user interactions
Static vs Dynamic	Dynamic (book availability and price changes)

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Discrete vs Continuous	Discrete (fixed set of book categories & user queries)
Single vs Multi-Agent	Multiagent (interacts with customers and inventory databases

Q.6) Differentiate model based and utility based ?

Feature	Model based	Utility based
Definition	Uses an internal representation of the environment to make decisions	Chooses actions based on a utility based functions that maximizes the best possible outcome
Decision making	Relies on stored knowledge about how the environment behaves	Selects actions based on numerical values assigned to outcomes
Complexity	moderate, as it requires a well-defined model of the environment	High, as it involves calculating and comparing multiple possible outcomes.
Adaptability	Less adaptive, as it depends on pre defined rules.	More adaptive, as it evaluates outcomes dynamically.
Example	A chess-playing AI tracking opponent moves based on past strategies	A self driving car choosing the safest and fastest route.

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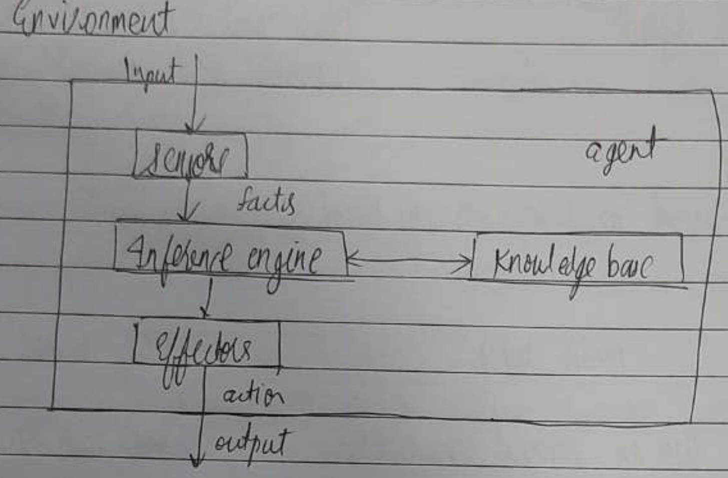
Q.7) Explain the architecture of a knowledge based agent & learning Agent

• Knowledge based Agent



A Knowledge based agent includes a knowledge base and an inference engine system. A Knowledge base is a set of representations of facts of the world.

The agent operates as follows:-

1) It TELLS the knowledge base what it perceives.
2) It ASKs the knowledge base what action it should perform.
3) It performs the chosen action.

• Learning Agent

By actively exploring and experimenting with their environment, the most powerful agents are able to learn.

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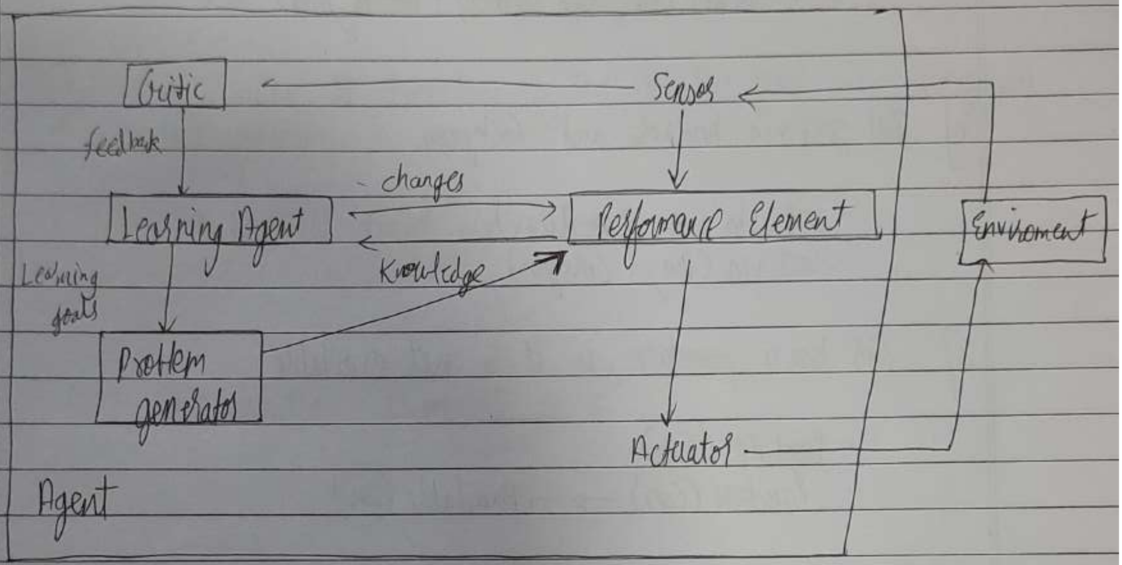
A agents can be further divided into 4 conceptual components



Q.8 Convert the following to predicates

Lets define predicates

- Travels(x,y) → x travels by y
- Available(y) → y is available
- Goes_via(y,z) → Vehicle y goes via location z.
- Puncture(y) → y has a puncture
- Not (Available(y)) → y is not available

a] Anita travels by Car if available, otherwise by bus

- Available (Car) → Travels (Anita, Car)
- ~~B~~ ¬ Available (Car) → Travels (Anita, Bus)

b] Bus goes via Andheri and Goregaon

- Goes_via (Bus, Andheri)
- Goes_via (Bus, Goregaon)

c] Car has a puncture, so it is not available

- Puncture (Car)
- Puncture (Car) → ¬ Available (Car)

- Forward Reasoning to Determine Anita's Travel Route

1] Given Puncture (Car), we apply the rule Puncture (Car) → ¬ Available (Car), so:-

- ¬ Available (Car) (Car is not available)

2] From ¬ Available (Car) → Travels (Anita, Bus), we infer:

- Travels (Anita, Bus) (Anita travels by Bus)

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3] Given Goes_via (Bus, Goregaon), we know

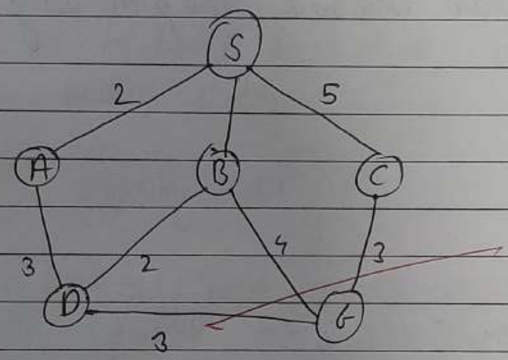
~~The buses pass~~
- The bus passes through goregaon

4] Since Anita is travelling by Bus and Bus goes via Goregaon we will conclude:

- Anita will travel via Goregaon

~~Q9~~]

Q10] Find the route from S to G



BFS explores the graph level by level, starting from the source nodes

Step 1:

1] Start at S: Add S to the queue
- Queue: [S]

- Expand S: Visit it's neighbors A, B, C
  - Queue: [A, B, C]
  - Parent Mapping
    $S \to A$, $S \to B$, $S \to C$

- Expand A: Visit D
  - Queue [B, C, D]
  - Parent mapping: $A \to D$

- Expand B: Visit G (goal found)
  - Queue: [C, D, G]
  - Parent mapping: $B \to G$

Since we found G, we trace back the path using the parent mapping.

~~Step 2:~~

Step 2:

The shortest path from S to G is
$S \to B \to G$

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

→

• Depth limited search (DLS)

It is a variant of depth first search that restricts the depth of recursion to fixed limit L. In avoids infinite loop search spaces.

Algorithms :-

1] Start from the initial node and explore deeper untill depth L is reached
2] If goal is found, return the solution
3] If the depth limit is reached without finding the goal, backtrack.
4] If no solution is found at all, increase the depth limit or choose another strategy

• Iterative Deepening Search (IDS)

Iterative Deepening Search combines the advantages of both BFS and DFS. It repeatedly runs Depth Limited Search with increasing depth limits untill the goal is found.

Algorithm:

1] Set depth limit L=0
2] Run depth-Limited Search (DLS) up to depth L.
3] If the goal is not found, increase L and repeat DLS
4] Continue untill the goal is found or all nodes are explored.

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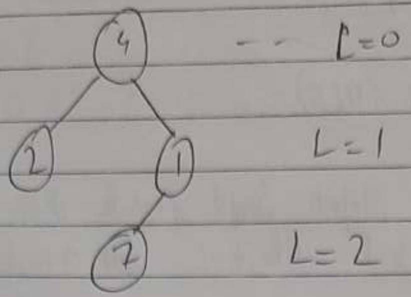
Example :- Consider tree we need to find 7 at depth 2



For L=0, 4 → goal not found search further by increasing depth
For L=1 2, 1 → goal not found search further by increasing depth.
For L=2 7 → goal found.

12) Explain Hill climbing and it's drawbacks in detail with example. Also state limitations.

→ Hill climbing is a local search algorithm that continuously moves toward higher-valued states in search space to find the optimal solution. It is widely used in optimization problem.

Algorithm :-

1) Start from an initial state

2) Evaluate all neighbouring states.

3) Move to the neighbour with highest value

4) Repeat untill no better neighour is found

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- Drawbacks of Hill climbing:

i) Local Maxima → It can get stuck at a peak that is not global maximum

ii) Plateau Problem → If all neighbours have the same value, the algorithm may stop

- Limitations of Steepest-Ascent Hill climbing

i) Evaluates all neighbors, which maybe computationally expensive
ii) Can get stuck in local maxima instead of finding the global optimum
iii) Not useful for complex, non-smooth search spaces.

Q.B) Explain simulated annealing and write it's algorithm.

→ Simulated Annealing is an optimization technique inspired by the cooling process of metals. Unlike Hill climbing it can escape local maxima by allowing some "bad" moves with a probability that decreases over time

Algorithm:-

1) Start with an initial state S and high temperature T.

2) Generate a random neighbour S'.

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3) If S' is better than S, move to S'.

4) If S' is worse, accept it with probability $e^{(-\Delta E/T)}$, where ΔE is difference in values.

5) Reduce T gradually

6) Repeat until $T \to 0$ or a solution is found

Example:- In Travelling Salesman Problem (TSP) to optimize the shortest route while avoiding local ~~mini~~ optima.

Q.14) Explain A* algorithm with an example.

→ A* is a search algorithm used in pathfinding and graph traversal. It finds the shortest path from the start node to the goal node using both:

- $g(n) \rightarrow$ the actual cost from the start node to node n.
- $h(n) \rightarrow$ the estimated cost from node n to goal.
- $f(n) = g(n) + h(n) \rightarrow$ The total estimated cost of the cheapest path through n

Algorithm:-

1) Place the start node in an open list
2) Move the node with the lowest $f(n)$ from the open list to the closed list.

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3) Expand the node's neighbors, update their $g(n)$ & $h(n)$ values

4) Repeat until the goal node is reached.

· Advantages →

i) Guarantees the shortest path if $h(n)$ is admissible
ii) more efficient than Dijkstra's algorithm in many cases

Q.15) Explain Minmax. Explain minimax Algorithm & draw game tree for TIC TAC TOE.

→ Minimax is an adversarial search algorithm used in zero sum games like Tic-Tac-Toe, chess and checkers. It assumes two players.

· maximizer (tries to maximize score)
· minimizer (tries to minimize score)

· Algorithms steps:-

1) Generate the game tree up a depth where a terminal state is reached.

2) Assign scores:
· +1 for a win, -1 for a loss, 0 for a draw

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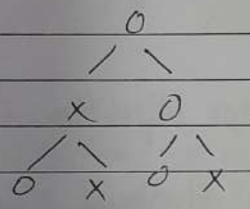
3) Propagate the score back up the tree:

- Maximizer chooses the max value
- minimizer chooses the min value

4) The root node selects the best move for the player.

Example:- Tic-Tac-Toe Game tree

(O's Turn)



- The algorithm evaluates each outcome and select the best move for the current player.

Q.16) Explain Alpha beta pruning algorithm for adversarial search with example.

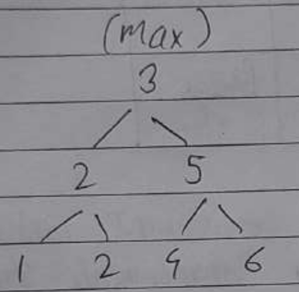
→ Alpha beta pruning improves Minimax by pruning unnecessary branches, reducing computation time without affecting the final result.

- Alpha (α) : Best choice for the maximizer
- Beta (β) : Best choice for the minimizer

Algorithm Steps:-

1) Traverse the game like minimax
2) If a branch's worst case is worse than an already explored branch, prune it.
3) Continue evaluating only necessary branches.

Example: Pruning in Tic Tac Toe



- If left subtree evaluates to 2, and we know the right subtree has a move ≥ 3, we prune the left subtree.

Advantages:-

- Reduces computation from $O(b^d)$ to $O(b^{d/2})$
- Faster decision making in real time games like chess.

Q.17) Explain WUMPUS world environment giving it's PEAS description. Explain how percept sequence is generated.

→

Stench		Breeze	Pit
Wumpus	Breeze Stench Gold	Pit	Breeze
Stench		Breeze	
start (Agent)	Breeze	Pit	Breeze

The WUMPUS world is a grid based environment used to study AI agent behavior in uncertain environments. The agent navigates a cave, avoiding dangers and trying out to find gold.

Environment Details :

- The grid consists of rooms connected by doors (4x4)
- The Wumpus is in one of the rooms
- There are pits which the agent must avoid.
- The agent can sense danger using percepts

i) Stench → Wumpus nearby
ii) Breeze → Pit is nearby
iii) Glitter → Gold is present

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PEAS Description for wumpus world

- Performance Measure
  - +1000 if agent comes out with the gold
  - -1000 if wumpus eats the agent
  - +1 for each action

- Environment
  - A 4x4 grid world with pits, wumpus, gold and walls.

- Actuators
  - move forward, turn left, turn right, ~~grab~~ grab (gold), shoot (arrow), climb (exit)

- Sensors
  - Perceives stench (wumpus), breeze (pit), glitter (gold), bump (wall) and scream (wumpus killed)

Percept sequence

At each step, the agent receives a 5-symbol percept sequence based on the current room.
For example:-

- If agent is in a room next to a pit and gold, the percept is:- [Breeze, None, Glitter, None, None]

- The agent ~~is~~ updates it's knowledge base & decides on the next move.

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Q. 18) Solve the following Crypto-arithmetic problems

```
  SEND
  MORE
 MONEY
```

→

	C_4	C_3	C_2	C_1	
		S 9	E 5	N 6	D 7
		M 1	O 0	R 8	E 5
	M 1	O 0	N 6	E	Y 2

As M is leftmost digit, $M = 1$ because it will get carry value

- $S + M = 0$ — we know $m = 1$
  $S + 1 = 0$ — And we want $S+1 \geq 10$, as we want carry to be generated
  $\therefore S = 9$, $O = 0$

- $E + O = N$
  $E + 0 = N$ .. ($O \to 0$ (zero))
  $E = N$ .. { If $C_2 = 0$, $E = N$ it is violating condition there should be a carry }

Let assume $E = 5$
$\therefore E + O + C_2 = N$
$\boxed{N = 6}$

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- $N + R = E$

$6 + R = 5 \quad (N = 6, E = 5)$

If we take $R = 9$, then it will satisfy but already we have $S = 9$ so it's not possible

Now we want a carry i.e $C_1 = 1$

$6 + R + 1 = 15$

$\boxed{\therefore R = 8}$

- $D + E = Y$

$D + 5 = Y$ -- This equation will generate a carry C_1

$\therefore D \geq 5$ we left with only 7

If $D = 7$

$7 + 5 = 12$

So $D = 7$ & $Y = 2$ with carry

Then it matches

Q.19) Consider the following axioms

All people who are ~~happy~~ graduating are happy
All happy people are smiling
Someone is graduating

Also explain the following

→

Given axioms

1) All people who are graduating are happy → $\forall x$ (Graduating(x) → Happy(x))

2) All happy people are smiling → $\forall x$ Happy(x) → Smilling(x)

3) Someone is graduating → $\exists x$ Graduating(x)

Explain:-

Step 1:- Convert to Clause Form

1) Graduating(x) → Happy(x) → ¬ Graduating (x) ∨ Happy(x)

2) Happy (x) → Smiling(x) → ¬ Happy(x) ∨ Smiling(x)

3) $\exists x$ Graduating(x) → Introduce constants 'a' → Graduating (a).

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Step 2: Prove "Is someone smiling?"

1] Graduating (a) -- Given

2] $\neg$ Graduating (x) $\vee$ Happy (x)

- Substitute $x = a$: $\neg$ Graduating (a) $\vee$ Happy (a)
- Since Graduating (a) is true, resolve to Happy (a)

3] $\neg$ Happy (x) $\vee$ Smiling (x)

- Substituting $x = a$: $\neg$ Happy (a) $\vee$ Smiling (a)
- Since Happy (a) is true, resolve to Smiling (a)

Thus, someone is smiling (Smiling (a)).

Resolution tree for proof

Graduating (a)

|— (Graduating (a) $\vee$ Happy (a)) → Resolve → Happy (a)

|— ($\neg$Happy (a) $\vee$ Smiling (a)) → Resolve → Smiling (a)

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Q.20) Explain Modus Ponen with suitable example.

→ Modus Ponen is a fundamental rule of inference in logic that states:

If "P → Q" (If P then Q) is true and P is true, then Q must be true.

It follows this logical form

1) $P \rightarrow Q$ (If P then Q)
2) P (P is true)
   $\therefore Q$ (Therefore, Q is true)

• Example:
  • If it rains, the ground will be wet ($P \rightarrow Q$)
  • It is raining. (P is true)
  • Therefore, the ground is wet. (Q is true)

• Symbolic Representation:

1) Rain → Wet Ground
2) Rain
   ∴ Wet Ground

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

→

· Forward chaining

Starts from known facts and applies inference rules to ~~reat~~ reach a conclusion.
It is also called as data driven approach.

Algorithm

1) Start with given facts in a knowledge base

2) Apply rules to infer new facts.

3) Repeat untill the goal/conclusion is ~~reahed~~ reached.

Example:-

Rules:-
1) If a person has a fever and cough, then may have the flu.

2) If a person has a sore throat, they may have a cold

Facts:

1) John has a fever and cough
2) Apply rule1 → John may have the flu.

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Conclusion → The system infers John has the flu.

· Backward chaining → Starts from the goal & works backward to check if facts support it.
It is also called goal-driven approach

Algorithm:

1) Start with the goal.
2) Check if there are rules to support it.
3) See if known facts confirm these rules.
4) Repeat until a match is found or disproved.

Example:-

Goal: Does John have the flu?

- Flu :→ Fever and cough (Rule)
- Does John have fever and cough? (Check facts)
- Yes, John has a fever and cough

Conclusion → John has the flu.

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