DS - Assignment #1

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1. What is AI? Considering the COVID 19 Pandemic situation, how AI helped to survive and renovate our way of lifes with different applications?

Ans Artificial Intelligence is the simulation of human intelligence in machine that can think, learn and make decisions. AI includes ML, NLP, robotics

AI role in covid:

Health care: AI was used for drug discovery & early diagnosis

Contact Tracing: Apps like aarogya setu helped in track

Chatbots: Provided medical advice.

Work & Education: AI-enabled remote work & virtual learning

E-commerce: optimized chain and delivery service for no contact.

2. What are AI agent's terminology? With Example

Ans AI agent percive its environment using sensors & actuators

Key terms:-

(1) Agent: entity that percives & act

(2) Percept: Input received from environment.

(3) Actuators: Components taking action.

(4) Rationality: choose best action.

(5) Sensors: Senses the environment

(6) Environment: surrounding system to take input

Example - self driving car

Environment: Road, vehicles

Percepts: Road signs, traffic, obstacle.

Sensors: camera, radar.

Actuators: steering, brake, acceleration

3. How is AI technique used to solve 8 puzzle problem?

Ans The 8 puzzle problem consist of a 3×3 grid with 8 numbered tiles and one empty space, aiming to arrange tile in order using moves.
AI uses technique to solve it:
① Breadth first search (BFS): Explore all possible moves level-wise.
② DFS: moves deeply before backtracking.
③ A*: Uses heuristic (h(n)) & cost (g(n)) to find shortest path.
④ Heuristics like Manhattan Distance: Measure misplaced tiles total distance

4. What is PEAS discription

PEAS (Performance, Environment, Actuators, Sensors)

Agent	Performance	Environment	Actuators	Sensors
Taxi Driver	Safety, time, fuel efficiency	Roads, passenger, traffic	Steering, brake, throttle	Camera, GPS, Speedometer
Medical Diagnosis system	Accuracy, speed	Patient record, symptoms	Display, alert	Patient history, medication sensor
Aircraft autolander	Smooth landing, safety	Weather, runway condition	Flaps, wheels, brake	Altimeter, radar, GPS

6. Categorize a shopping bot for an offline bookstore according to the six dimensions
① Fully / partially observable: Partially observable (not seen all books)
② Deterministic / stochastic: Stochastic (unpredictable price)
③ Episodic / sequential: Sequential (previous interaction needed)
④ Static / Dynamic: Dynamic (customer preferences change)
⑤ Discrete / continuous: Discrete (books are countable)
⑥ Single / Multiagent: Multiagent (interacts with customers)

7. Differentiate Model Based and Utility Based.

Model Based	Utility Based
① Uses an internal model of world to make decision	① Uses a utility function to select best action
② Works well with incomplete information	② Focuses on maximizing performance
③ Example: Self driving car	③ Example: Stock trading bot.

7. Explain the architecture of a knowledge based agent and a learning agent
→ Knowledge Based Agent: Stores facts and rules in a knowledge base and applies inference rules to make decisions.
→ Learning Agent: Learns from past experiences using feedback mechanisms.
Architectural components:
Percept ⇒ Receive input
Inference Engine: Applies logic
Learning module: Improves over time

4 Actuators - Takes action.
Example: Chess playing AI

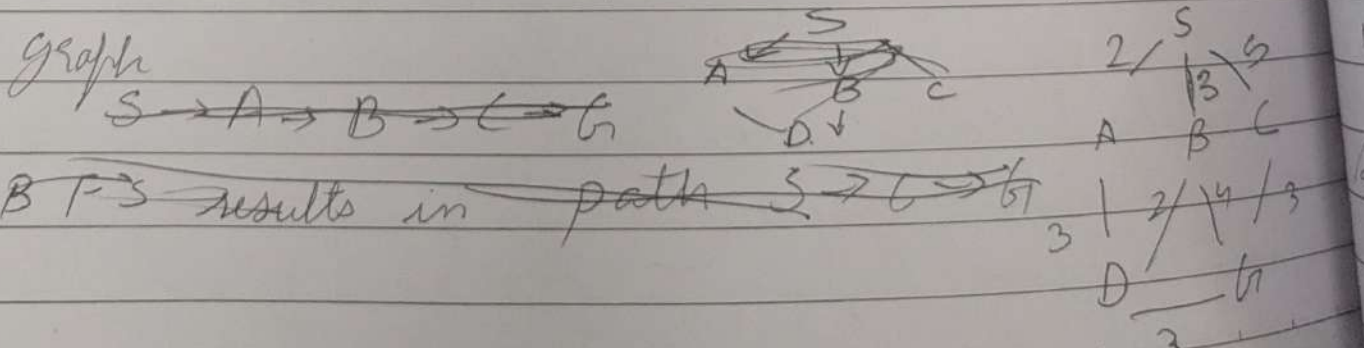
8) Convert the following to predicates
Ans ① Anita travels by car if available, otherwise by Bus
∀x (carAvailable(x) → Travels(Anita, Car))
~carAvailable(x) ⇒ Travel(Anita, Bus)

② Bus goes via Andheri & Goregaon
Goes Bus(Bus, Andheri) ∧ Goes Via(Bus, Goregaon)

③ Car has puncture, so is not available
Puncture(Car) ⇒ ~ CarAvailable(car).

Will anita travel via Gorgaon?
Using forward reasoning it can is not available Anita will take bus, & since bus goes

9) Find the route from S → G1 using BFS
Ans BFS
① Explore all neighbour before moving to next level.
② Ensure the shortest path in an unweighted graph

Graph


S → A → B → C → G1
BFS results in path S → C → G1

From S there A, B & C
S → A In the queue (A, 2) (B, 3) (C, 5)
Then for B next Egn 'D' from A (D, 5) from B (D, 5)
& for G from D (G, 8) & from B (G, 7) &
from C (G, 8)
∴ Path S → B → G is selected

What is Depth Limited Search? Explain IDS?
Depth limited search is a DFS with depth constraint to prevent infinite recursion.
IDS is where we apply DLS with increasing depth limit.
It finds shortest path like BFS but with better memory efficiency

Explain Hill Climbing and its Drawback.
Hill Climbing: Moves toward higher value state.
Drawback:
→ Local maxima: can get stuck
→ Plateau problem: no gradient to follow.
→ Ridges: Narrow path makes it hard to climb.

Explain Simulated Annealing & write its algorithm
Simulated Annealing: Inspired by the cooling process of metals, sometimes accepts worse solutions to escape local maxi

Algorithm:
1. Start with an initial solution.
2. Select a random neighbor.
3. If better, move, else accept with probability $p = e^{-\Delta E/T}$
4. Reduce T over time.
5. Repeat until convergence.

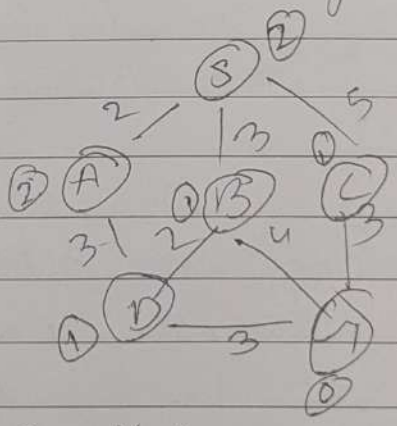
B) Explain A* Algorithm with example.

Ans A* Algorithm is a graph traversal and pathfinding algorithm that finds the shortest path using:

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

- $f(n)$ ↑ Total estimate
- $g(n)$ ↑ cost from start to node n
- $h(n)$ ↑ heuristic from n to goal — Decides using distance formula such as Manhattan

for example.



Now, for S $f(n) = 2$

for A $f(n) = 2 + 2 = 4$

for B $f(n) = 3 + 1 = 4$

for C $f(n) = 5 + 1 = 6$

for D_A $f(n) = 5 + 1 = 6$ $D_B = 5 + 1 = 6$

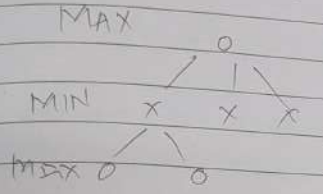
for G_D $f(n) = 8$ $G_B = 7$ $G_C = 8$

∴ Path S → B → G

9) Explain Minimax Algorithm and Draw a Game Tree for Tic-Tac-Toe

The Minimax algorithm is used in turn based game like Tic-Tac-Toe, Chess, etc. It finds best next move by assuming:

- One player (MAX) tries to maximize score.
- Opponent (MIN) tries to minimize the score.

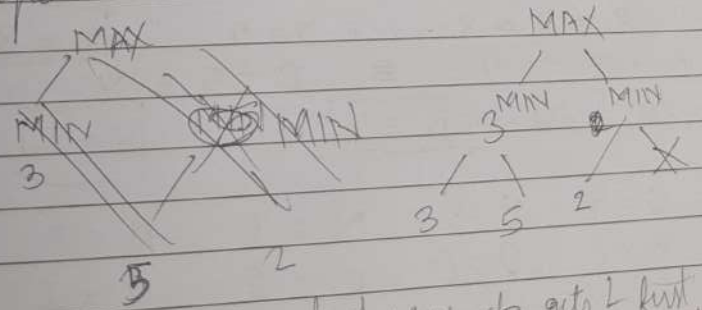


10) Explain Alpha-Beta Pruning in Adversial Search with Example.

Alpha-Beta Pruning improves Minmax by eliminating unnecessary branches, reduces computation steps!

- Traverse the tree like Minimax.
- Maintain alpha (best for Max) and beta (best for Min)
- Prune branches when alpha ≥ beta (no need to explore)

Example



The second Branch of MIN gets 2 first, so whatever the sub part may it will ≤ 2 so we don't search

17) Explain WUMPUS world Environment and PEAS Description

Ans WUMPUS world is a grid based environment where agent must find gold while avoiding WUMPUS and dangerous monsters

PEAS

Performance	Collect Gold, avoid WUMPUS and pits, exit with gold
Environment	Grid Based world, walls, pits, WUMPUS, gold, short arrow
Actuators	Move, grab gold, shoot arrow
Sensors	Stench, Breeze, Glitter

Percept - If stench wumpus is nearby
feels a breeze, a pit is nearby

18) Solve Cryptarithmetic Problem SEND+MORE=MONEY

~~S+N~~

M = 1 cause its leftmost

$S + M + C_2 = O + 10 \cdot C_3$

$\therefore S + 1 + C_2 = O + 10 \quad \therefore S + C_2 = O + 9$

Lets assume $S = 9 \quad \therefore C_2 = 0 \quad \boxed{O = 0}$

$\therefore E + O + C_1 = N \equiv E + C_1 = N$

Lets take $\boxed{E = 5} \quad \therefore \boxed{N = 6}$ or ~~X~~ not possible

$N + R + C_0 = E + 10 C_1 \equiv 6 + R + C_0 = 15$

$\therefore R = 9$ or 8 but $S = 9 \quad \therefore \boxed{R = 8}$

$D + E = Y \equiv D + 5 = Y$

Lets take $\boxed{D = 7} \quad \therefore \boxed{Y = 2}$

$\therefore S = 9, E = 5, N = 6, D = 7$

$M = 1, O = 0, R = 8, Y = 2$

Convert Axioms to 1st Order Predicate logic and use resolution

1. All people who are graduating are happy

$$\forall x \, (\text{Graduating}(x) \rightarrow \text{Happy}(x))$$

2. All happy people are smiling

$$\forall x \, (\text{happy}(x) \rightarrow \text{Smiling}(x))$$

3. Someone is graduating

$$\exists x \, (\text{Graduating}(x))$$

Convert to Claus

1. $\sim \text{Graduating}(x) \vee \text{Happy}(x)$
2. $\sim \text{Happy}(x) \vee \text{Smiling}(x)$
3. $\text{Graduating}(y) \quad y \in x$

Resolution Proof:

From (1) & (3) $\text{Happy}(y)$

$\text{Happy}(y) : \text{Smily}(y)$

Conclusion Someone is Smily

20 Explain Modus Ponens with Example

Modus Ponen is a logical inference rule:

If $p \rightarrow q$ (If p is true then q must be true)

If p Example

1 Premise: If its rain, the ground gets wet

Rains(x) → Wetground(x)

2 Fact: It is raining

Rains(Today)

3 conclusion: The ground is wet.

WetGround(today)

21 Explain forward chaining and Backward Chaining with Exampl

Ans Forward Chaining:

→ Starts from known facts and applies rules to derive conclusion.

→ Example:

Rules: Birds(x) → Canfly(x)

Penguin(x) → ~Canfly(x)

Conclusion: Canfly(Sparrow)

Backward Chaining.

→ Start from goal (query) and works backward to find supporting facts.

Query:

Canfly(Penguin)?

check rule: Penguin(x) → ~Canfly(x)

Fact: Penguin(Tux)

Conclusion: ~Canfly(Tux)