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04/05

AI & DS - I (Assignment)

Assignment I

Q.(1) What is AI? Considering the COVID-19 pandemic situation how AI helped to survive and renovate our way of life with different applications?

Ans AI or artificial intelligence can be defined as the ability of computer systems i.e hardware and software to do tasks normally required human beings to use intelligence.

AI played a crucial role in helping society navigate the COVID-19 pandemic by improving healthcare, enabling, remote work & learning optimising supply chain for example:

(i) Healthcare & Medical Research:

→ Drug discovery and Vaccine development:
AI helped accelerate the search of COVID-19 treatments & vaccines by analysing vast datasets. eg - Deepminds Alpha Fold predicted protein structures for virus.

(ii) Contact Tracing & Disease Surveillance:

→ AI powered mobile apps (eg - Arogya Setu) helped track COVID-19 exposure through bluetooth & location data.

(iii) Remote Work & Education:

→ AI powered chatbots & virtual assistants. made remote work smoother (eg - GMeet, Zoom).

→ E-learning platforms used AI to personalize education. Provide automatic grading & create interactive lessons.

(Q.2) What are AI agents terminology, explain with examples.

Ans The AI agents terminology includes:-

(i) Performance measure of Agent: It determines the success of the agent.

(ii) Percept: Agents perceptual inputs at a specified instance.

(iii) Behavior / Action of agent: It is the action performed by an agent after any specified sequence of percepts.

(iv) Percept Sequence: History of everything agent has percieved till date.

(v) Agent Function: Map from percept sequence to an action.
(Agent function, $a = F(P)$)
Where P is current percept, a is the action carried out & F is the agent function.
F maps percept to action.
Where P is the set of all percepts and A is set of all actions. Action may be dependent of all percepts observed, not only the current percept.
$a_R = F(P_0, P_1, P_2 \ldots P_R)$
Where $P_0, P_1, P_2, \ldots P_R$ is the sequence of percepts recorded till date, a_R is the resulting action carried out and F now maps percepts sequences to an action

For example the vaccum cleaner example

Percept Sequence	Action
[A, Clean]	Right
[A, Dirty]	Suck
[B, Clean]	left
[B, Dirty]	Suck
[A, Dirty], [A, Clean]	Right
[A, Clean], [B, Dirty]	Suck
[B, Dirty], [B, Clean]	left
[B, Clean], [A, Clean]	No-operation
[B, Clean], [A, Dirty]	Suck
[A, Clean], [B, Clean]	No-operation

③ How is AI technique used to solve 8-puzzle Problems?

→ The 8-puzzle problem is a state space search problem in AI where a 3x3 grid contains 8 tiles numbered 1 to 8 empty space. Objective is to rearrange the tiles to reach a predefined goal state.

AI techniques :- ① Uninformed search methods.

- BFS :- Expand the shallow west node first
- DFS :- Explores as deep as possible before backtracking.
- IDS :- Combins DFS & BFS to increase depth limit gradually.

② Informed Search methods-

- BFS :- Expand the shallow west node first that appears closest to the goal.
- Search- $f(n) = g(n) + h(n)$: Based on heuristic & cost to node.

initial state -			Goal State		
1	2	3	1	2	3
5	6		4	5	6
4	7	8	7	8	0

① Compute heuristic of each possible move.
② Expand the state with the lowest f(n) & repeat.

④ What is PEAS description? Give PEAS description for following?

→ Performance Measure - How success of an agent in Evaluated Environment - Surrounding in which agent operates.
Actuators - Component that allows agent to take actions.
Sensors - Component that allows agents to precieve the environment.

① Taxi-Driver agent.
Performance measure Environment Actuators Sensors.
- Safe driving - Traffic Signal - Stering - Camera - travel time - roads - wheels - GPS - traffic rules - weather - accelator - fuel gauge - brakes.

② Medical Diagnostic Agents:-
Perf measurer Environment Actuators Sensors.
- health of patient - patient data - display Screen - heart rate - accuracy of diagnosis - Symptoms Alarm Systems monitor - recommended tests reports robotic arms - lab results.

③ Music Components Agent:-
perf measure Environment Actuator Sensors.
originaly - music db - Speaker - microphones - listener. enggage - user performs - digital music. - quality - interface.

④ Aircraft Outstander.

Perf measure Environment Actuator Sensors.
Smooth landing - runway. landing gear - accuracy
in - wind conditions - flap - GPS touchdown -
air traffics - air brakes - Cameras.

⑤ Essay Evaluator.

→ Perf measure Environment Actuators Sensors.
- grading - dataset - display - optical -
Grammar - rubric Criteria screen Character -
paradigm Check. - text to recognition Speech System.

⑥ Robotic Sentry gun.
Perf measure Environments actuators Sensors -
Neutralize threats - lab area - gun mech - Camera -
target tracking - potentia anism - thermal -
false alarms intruders - alarm sities Sensors -
tracking system.

⑤ Categorize a shopping bot for a shopping bot for an offline bookstore according to the following system.

→ Observability : Partially observate Relies on limited Seasors input.
- Determine or orochastic:- customer pref is unpredictable.

- Episodevs Seaquential- Sequential Deletions affect future actions
- Static vs dynamic - Dynamic customer behaviour is always evolving.
- Discrete vs Cortinuous - Finite no. of choices such as book.

⑥ Differentiate btwn model based & Utility based agent.

→

Model based agent	Utility based agent
- Agent that maintains the internal model at the end to understand its current state & predict future state.	- Agent that selects actions based on utility function aiming to minimize long term satisfaction or benefit.
- Model updates its information about the environment.	- Measures how desirable different states are.
- least Complex	- More Complex.
- Doesn't used for long term words.	- Focuses on long term rewards.
- eg:- Self Driving cars	- eg:- Shopping recommendation system.

⑦ Explain the architecture of Knowledge based agent & learning agent

→ Knowledge based agents:-

- Stores Knowledge & reasons based on logical inference.
- Knowledge base - stores facts, rules & heuristic fuction about the environment.
- Interference engines:- Uses logical reasoning techniques like forward & backward chaining.
- Perception:- Gathers data from the environment.
- actions:- Executes actions based on inferred Knowledge.
- Knowledge update mechanism - Updates itself as new facts are learned.

Learning based agents :-

- Agents that improves its post overtime by & learning from experience, data & Feedbacks.
- Learning Elements - Responsible for improving agents Pref by analyzing past experience using ML techniques
- Critic - Provides feedbacks on agents actions by evaluating Success or failure.
- Problem Generation - Suggests new experiences for learning & explanation.

(8) Convert the following into predicates.

→ Anita travels by car if available otherwise travels by bus.

travels(x, y) → person x travels by y.

Available(y) → y (a vehicle) is available.

Goesvia(y, z) → Vehicle goes via z.

Puncture(y) → y(a vehicle)

a:- Available(car) → Travels(Anita, bus)

b:- Bus goes via Andheri & Goregaon.
Goes via(bus, Andheri).
Goes via(bus, Goregaon).

C:- Car has a puncture so it's not available.
Puncture(car)
Available(car).

(9) What do you mean by depth limit search? Explain iterative Deepening Search with example.

→ Depth limit Search (DLS):-
DLS is a DFS variant with a fixed depth L.
Preventing infinite loop & saving memory.
Advantages:-
(1) Avoids infinite recursion
(2) Memory Efficient.

Disadvantages:-
(1) May miss less Deeper Solutions.
(2) Need for good L (choice (limit).

Iterative Deepening Search (IDS):-
IDS runs DLS repeatedly, increasing L unit until the goal is found.

Advantages:-
(1) Complete the Whole Search.
(2) Gives most optimized answer.
(3) Memory efficient.

Disadvantages:-
(1) Redundant computation.
(2) Higher time Cost

Example - Searches level by level until the goal appears.

(16) Explain Hill Climbing & its drawback in detail with example. Also state limitations of steepest-ascent hill climbing.

→ It is an optimization algorithm that moves toward higher values (better solutions) until a peak (local-optimum) is reached.

Algorithm:-
① Start with an initial state.
② Move to the best neighbouring state.
③ Repeat until no strictly better neighbour exists.

Example:- (8 queens problem):-
- Adjust queens position to minimize conflicts.
- Stops when no improvements are possibles.

Drawbacks:-
- Local maxima:- Stuck at suboptimal peaks.
- plateau - no directions for improvements.
- Ridges - needs special move to progress variations & & solutions&.
- Steepest-Ascent - Evaluates all neighbors but still get stuck.

(12) Explain Simulated Annealing & write its examples.

→ SA improves Hill Climbing by allowing occassionally bad moves to escape local maxima, inspired by metal on calling.

Algorithm :-

① Start with an initial solution & Temperature T.

② Pick a random neighbor & compute ΔE.

③ Accept S is better; otherwise with probability
$P = e^{-\Delta E/(T)}$

④ Reduce T until Stopping Condition.

Advantages :-

① Handles large problems.

② Escapes local maxima.

③ Near-Optimal Solutions.

Disadvantages :-

① Tricky Cooling Schedule.

② No Guarantee of best solution.

(13) Explain A* algorithm with an example.

→ A* is the best-first search algorithm for pathfinding combining

① Uniform cost Search (Cheapest path)

② Greedy best-first Search (heuristic based speed).

Key formula :- $A(n) = g(n) + h(n)$

- $g(n)$: Cost from start to n
- $h(n)$: Cost from n to goal : (estimated)

Steps :-

① Starts with initial node, compute $h(n)$

② Expand the node with lowest $f(n)$

③ If goal is reached, return the path, store, update & Continue.

Advantages :-

① Optimal paths ② Efficient in AI application.

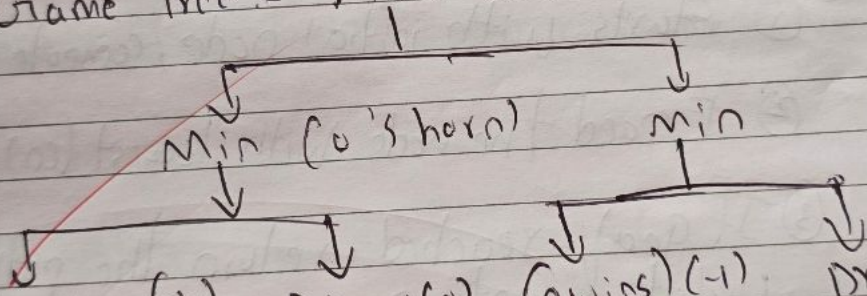
Disadvantages :-

① High memory usage
② Depends on Heuristic.

(13) Explain Minimax algorithm & draw game tree for Tic Tac toe Game

→ Minimax is a game strategy for 2 player games like Tic-Tac-Toe

How it works?
- Maximizer (X) aims to increase the score (+1 for win)
- Minimizer (O) aims for lowest score (-1 for loss)
- Explore all possible moves, assigns score & picking the best one.
- Game Tree :- Max (X's turn)



Each level alternates btw (X) & (O) i.e., Max & min.

Advantages:-
① Always finds the best moves.

Disadvantages:-
① Slow for deep trees (Alpha Beta pruning helps)

(15) Explain alpha beta proning for adversarial search with example.

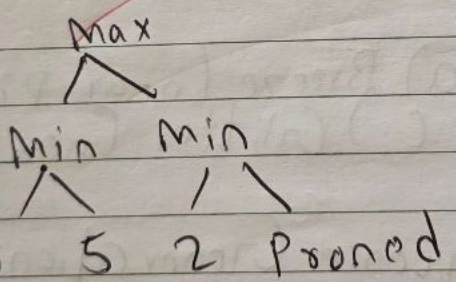
→ Alpha Beta proning optimizes the minimax algorithm by skipping unnecessary branches, making it faster without affecting the result.

Explanation:-

① Alpha (α) :- Best max value found so far.

② Beta (β) :- Best min value found so far.

③ If a move worse than α or β is found then the further exploration is stopped (proned).



Here, if min finds move worse than 5, it stops exploring that branch.

Advantages:-

① Speeds up minimax by ignoring bad checking.
② Same results as minimax but faster.

(16) Explain WUMPUS world environment giving its PEAS description. Explain how percept sequence is generated?

-> Wumpus world is a grid based game environment where an agent navigates a case to find gold while avoiding pits & the wumpus computer.

PEAS description:-

P (Performance measure):- +1000 (Gold) -1000 (Wumpus) -100 (Pit), -1 (move)

E (Environment) - Grid world with Wumpus, Gold, Pits & Agents.

A (Actuators) - move, Grab (Gold), Shoot (Arrow), Climb

S (Sensors) - a) Breeze (near pit) b) Stench (near Wumpus) c) Glitter (near Gold).

Percept Sequence Generation:-

(1) The agent recieves sensory input at each step based on its current decision.

(2) Example - If agent move next to pit, it permits Breeze.

(3) Using Percept History, bit infers safe path & avoid danger.

(17) Solve the following cryptoarithmetic problems:-
1. SEND + MORE = MONEY

→ Each letter represents a unique digit (0-9)
Step 1:- Equation Setup
(1000 S) + (100 E) + (10 N) + D) + (1000 M + 100 O + 10 R + E)
= (10000 M + 10000 + 1000 N + 10 E + Y).

Step 2:- Constraints
• M = 1. (Since MONEY is a 5 digit number).
• S ≠ 0 (It's the first digit in SEND.)
• All letters have unique values.

Step 3: Assigning Digits.

letter	Digits
S	9
E	5
N	6
D	7
M	1
O	0
R	8
Y	2

(18) Consider the following axions
All people who are graduating are happy.
All happy people are smiling.
Someone is graduating.
Explain the following:-
1) Represent these axions in first order predicate
2) Convert each formula to clause form
3) Prove that " is someone smiling" using resolution technique. Draw the resolution tree.

→ ① FUPL:-
let → $G(n)$ → n is graduating, $H(n)$ → n is happy, $S(n)$ → n is smiling
Axioms :- 1) $\forall n\ (G(n) \rightarrow H(n))$
2) $\forall n\ (H(n) \rightarrow S(n))$
3) $\exists n\ G(n)$

② Convert to clause form
1) $\neg G(n) \vee H(n)$.
2) $\neg H(n) \vee S(n)$.
3) $G(A)$ let A be a person graduating.

③ Prove " is someone smiling?"
① $G(A)$ given
② $\neg G(A) \vee H(A)$ → axiom 1
③ $\neg H(A) \vee S(A)$ → axiom 2

Since we derived $S(A)$, the proof confirms that someone is waiting

Resolution Excel :- $G(n)$ $\quad \neg G(A) \vee H(A)$

$H(A)$

$\neg H(A) \vee S(A)$

$S(A)$

(19) Explain Modus Ponen with suitable example.

→ Modus Ponen is a fundamental rule of inference in logic. It states.

If $P \rightarrow Q$ (if P, then Q) is true.

& P is true, then Q must be true.

Symbolically:-

$P \rightarrow Q$, $P \vdash Q$.

example:-

1) If it rains, ground will be wet
2) It is raining. (P)
3) There, the ground is wet (Q).

This rule is widely used in mathematical proofs & AI reasoning systems.

(20) (16) Explain Forward & Backward chaining with an example.

→ These are inference techniques used in rule-based agents & AI-reasoning.

1) Forward Chaining (Data-Driven):-

Starts with known facts & applies rules to infer new facts until the goal is reached.

- Works from cause:- effort (bottom up approach)

Ex:- ① If it is Raining then the ground is wet ($R \rightarrow W$)

② If grand is wet then traffic is slow ($W \rightarrow T$)

2) Backward chaining (Goal-Driven).

Starts with the goal & goes backwards to find supporting facts.

- Works from effect to cause (top-down approach)

Ex:- $W \rightarrow T$: is the ground wet.

$R \rightarrow W$: is it raining.