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05/05

AI & DS-1

Assignment-I

Q1. 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 that 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 and learning, optimizing supply chain, for example:

i) Healthcare & Medical Research:

→ Drug discovery and vaccine development: AI helped accelerate the search for COVID-19 treatments and vaccines by analyzing vast datasets. eg: DeepMind's Alpha Fold predicted protein structures for virus.

→ Predictive Modeling: AI models helped governments forecast infection rates, hospital resource needs.

ii) Contact Tracing & Disease surveillance

→ AI powered mobile apps (eg. Aarogya setu) helped track COVID-19 exposure through bluetooth and location data.

iii) Remote Work and Education.

→ AI powered chatbots and virtual assistant made remote work smoother (eg: Google me
→ E-learning platforms used AI to personalize education, provide automatic grading and creat interactive lessons, eg: Coursera, Duolingo.

Q2-] What are AI Agents terminology, explain wi examples

Ans: The AI Agents terminology includes:-

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

ii) Behaviour/action of Agent: It is the action perform by an agent after any specified sequence of percepts.

iii) Percept: Agents perpetual inputs at a specified instance.

iv) Percept sequence: History of everything agent has perceived 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 and F is the agent function.

f maps percept to action

$$F : P \rightarrow A$$

Where P is the set of all percepts and A is set of all actions. Action may be dependent of all the percepts observed, not only the current percept.

$$a_k = F(p_0 p_1 p_2 \ldots p_k)$$

where $p_0, p_1, p_2, \ldots p_k$ is the sequence of percepts recorded till date, a_k is the resulting action carried out and F now maps percept sequences to action.

$$F : P^* \rightarrow A$$

For example the vacuum cleaner problem:

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

Percept sequence	Action
[B, Clean], [A, Clean]	No operation
[B, Clean], [A, Dirty]	SUCK
[A, Clean], [B Clean]	No-operation

Performance measure of vacuum cleaner agent: All rooms are cleaned.

Behaviour/action of agent: left, Right, suck and no-operation (Do nothing)

Percept: location and status, for example [A, Dirty]

Agent functioning: Mapping of percept sequence to an action.

Q3. How AI technique is used to solve 8 puzzle problem?

Ans: The 8 puzzle problem is a state space search problem in AI where a 3x3 grid contains 8 tiles numbered from 1 to 8 and 1 empty space. Objective is to arrange the tiles to reach a predefined goal state.

AI techniques: i) Uninformed search methods

- BFS: expand shallowest node first.

-DFS- Explores as deep as possible before backtracking.
-IDS - Combines DFS and BFS to increase depth limit gradually.

Informed search methods
-BFS- Best first search based on heuristic function. that appeares closest to the goal.
-A* search- $f(n) = g(n) + h(n)$ Based on heuristic and lost to node

Initial state: 1 2 3
5 6 0
4 7 8

Final state: 1 2 3
4 5 6
7 8 0

i) compute heuristic of each possible move.
ii) expand the state with lowest f(n) and repeat.

Q4] What is PEAS description? Give PEAS description for following?
Performance measure: How success of agent in evaluated; Environment: surrounding in which agent operates.
Actuators: Component that allows agent to take action.
Sensors: Component that allows agent to perceive

environment.

i) Taxi driver agent:

Performance measure	Environment	Actuators	sensors
- safe driving - Travel time - Traffic rules	-Traffic signal -roads -weather	-Steering wheel -accelerator -brakes	-Camera -GPS -Fuel gauge

ii) Medical diagnostic agent

Performance measure	Environment	Actuator	Sensors
- Health of patient - accuracy of diagnosis - recommended treatment	-patient data -symptoms - test reports	display screen alarm system -robotic arms	- heart rate monitor -lab results -lab results

iii) Music component Agent :-

Performance measure	Environment	Actuator	sensor
- originality - listener, engagement - quality	- music database - user performance.	-speaker -digital music	-microphones. -user feedback.

Aircraft Autolander

Performance measure	Environment	Actuator	Sensor
-smooth landing -accuracy in touchdown.	- runway - wind conditions - Air traffic	-'landing gear - Flap - air brakes	- GPS - Camera

v) Essay evaluator

Performance measure	Environment	Actuator	Sensor
- grading -grammar -paradigm check	- plagiarism database - rubrics criteria.	- Display screen - Text to speech system.	- Optical character recognition (OTP)

vi) Robotic Sentry gun

Performance measure	Environment	Actuator	Sensor
- neutralize threats - target tracking - false alarms.	- lab area - potential intruders.	- gun mec-hanism - alarm setter - trashing system	- Camera - Thermal sensors.

Q5.] Categorise a shopping bot for an offline book sto
according to the following system.

→ observability : Partially observable, relies on li
sensor input

- Deterministic or stochastics : Stochastic customer
preference is unpredictable.

- Episodic vs Sequential : sequential decisions
affect future actions.

- Static vs dynamic : Dynamic customer behavior i
always evolving.

- Discrete vs continuous : Finite number of choices

Q6.] Differentiate between model based and utility base

Ans: Model based agent	Utility based agent
1.) Agent that maintains the internal model of the environment to understand current state and predict future states.	1.) Agent that selects actions based on the utility functions aiming to maximize long term satisfaction or benefits.
2.) Model updates its information about the environment.	2.) Measures how desirable different states are
3.) Less complex	3.) More complex.

	Model based	Utility based
4.)	Doesn't concern long term rewards	4.) focuses on long term rewards
5)	eg: self driving cars.	5) eg: shopping recommendation system.

Q7] Explain the architecture of knowledge based agent & learning agent.

Ans: Knowledge based agent: Store Knowledge and reasons based on logical inference.
Knowledge base: Stores facts, rules and heuristics function about the environment
Inference engine: Uses logical reasoning techniques like forward and backward chaining.
perception: Gathers data from environment
actions: executes actions based on inferred knowledge.
Knowledge update mechanism: updates itself as new facts are learned.

learning based Agent: Agent that improves its performance overtime by learning from experience, data and feedback.
learning element: Responsible for improving agents performance by analysing past experience using machine learning techniques.

- critic :- provides feedback on agents actions by evaluating success or failure.
- problem generation: supports new experience for learning and explanation.

Q9] Convert the following to predicates.

Ans: Anita travels by car if available otherwise travels by bus.
travels(n,y) → person n travel by y.
Available(y) → y (a vehicle) is available.
goes via (y,z) → vehicle goes via z.
puncture(y) → y (a vehicle)

a) 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)
~ available(car)

Q10] What do you mean by depth limited search? Explain iterative deepening search with example.

Ans: Depth limit search (DLS) :-
DLS is a DFS variant with a fixed depth L preventing

infinite loop and saving memory

Advantages

1) Avoids infinite recursion
2) Memory efficient

Disadvantages:

1) May miss less Deeper solutions
2) Need for good Lchoice (Limit)

Iterative Deepening Search(IDS) :-

IDS runs DLS repeatedly increasing L until the goal is found.

Advantages :-

1) Completes 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.

Q12.] Explain hill climbing and its drawback in detail with example, Also state limitations of steepest ascent hill climbing.

Ans: 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.

Examples: (8-queens problem):-
- Adjust queens position to minimize conflicts.
- Stop when no improvements are possible.

Drawbacks:
- Local maxima: stuck at suboptimal peaks.
- plateau :- no directions for improvement
- Ridges:- needs special move in progress.
variations and solutions.
- steepest-Ascent: Evaluates all neighbours but still gets stuck.

Q[2] Explain simulated Annealing and write its examples.

Ans:- simulated annealing improves hill climbing by allowing occasionally bad moves to escape local maxima, inspired by metal annealing.
Algorithm:-
1. start with an initial solution & temperature.
2. Pick a random neighbour. S; compute ΔE.
3 Accept S is better; otherwise with probability.

$P = e^{\wedge}(-\Delta E / T)$

4. Reduce T until stopping condition.

Advantage

1) Escapes local maxima
2) Handles large problems
3) Near-optimal solutions

Disadvantages

1) Tricky cooling schedule
2) No guarantee of best solution.

2(a) Explain A* algorithm with an example

Ans: A* is a best first search algorithm for pathfinding combining:-

1) Uniform cost search (Cheapest path)
2) Greedy best-first search (heuristic based spend)

Key formula

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

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

Steps:

1. Start with initial node, compute $f(n)$
2. Expand node with lowest $f(n)$
3. If goal is reached, return the path; else update and continue.

Advantages:-

1) optimal paths
2) Efficient in AI applications

Disadvantages:

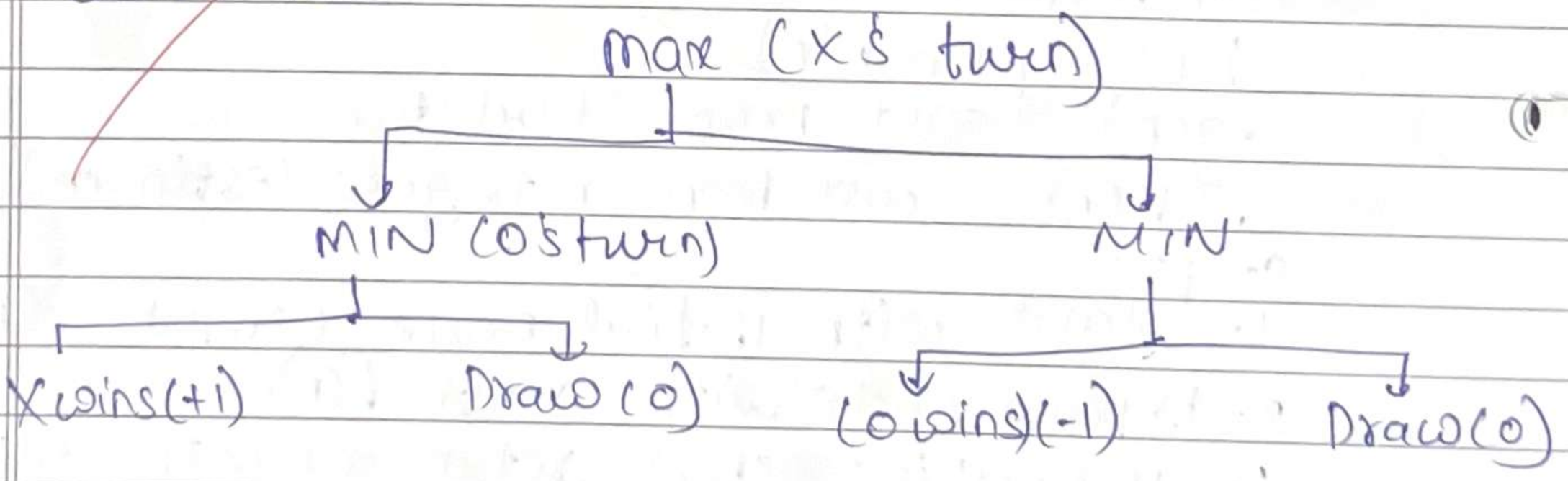
1) High memory usage
2) Depends on heuristic.

Q15] Explain min-max algorithm and draw game tree for tic-tac-toe game

Ans: Minmax is a game strategy for 2 player games like Tic-Tac-Toe.

How it works?

- Maximise (X) aims to increase the score (+1 for win)
- Minimizer (O) aims for lowest score (-1 for loss)
- Explore all possible moves, assign score and picking the best one.
- Game tree:



Each level alternates between (X) and (O). i.e. max and min.

Advantages

1) Always find the best moves

Disadvantages:

i) Slow for deep tree (Alpha-beta pruning helps)

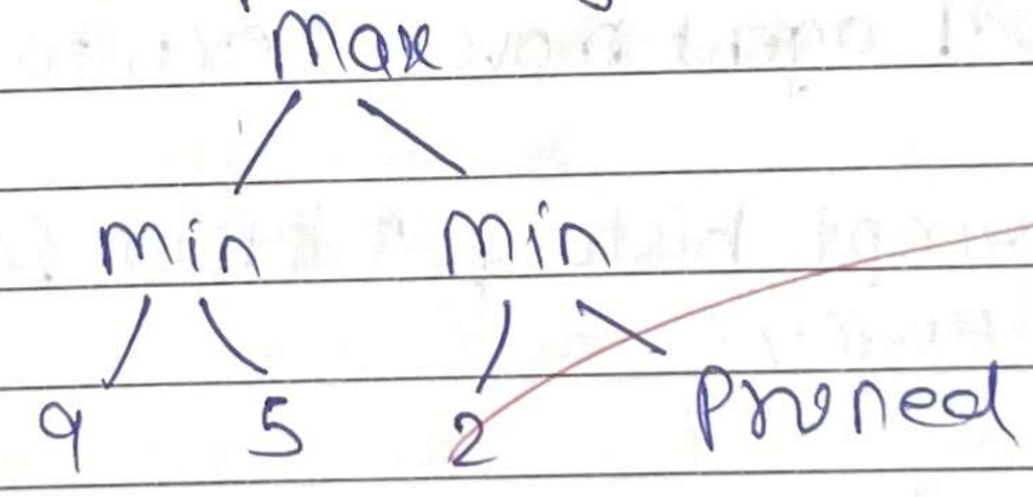
Q16. Explain alpha-beta for adversarial search with example

Ans: Alpha beta pruning optimizes the minimax algorithm by skipping unnecessary branches, making it faster without affecting the result.

Explainations:-

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 further exploration is stopped and proned.

Example: Simplified game tree :-



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

Advantages:-

1) Speeds up minmax : by ignoring bad choices
2) Same result as minmax but faster.

Q17. Explain Wumpus world environment giving its PEAS description. Explain how percept sequence is generated?

Ans: Wumpus World is a grid based game environment where an agent navigates a case to find gold while avoiding Wumpus and pits.

PEAS description:

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

E(Environment): Grid world with wumpus, gold, pits and 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:

The agent receives sensory input at each steps based on its current location

example: If agent moves next to pit, it perceives breeze.

Using percept history it infers safe path and avoids danger.

Q18] solve the following crypto arithmetic problems

1. SEND + MORE = MONEY

Ans: Each letter represents a unique digit (0-9)

Step1: Equation setup

(1000S) + (100E) + (10N + D) + (1000M + 100O + 10R + E)

= (10000M + 1000D + 100M + 10E + Y)

Step2:- Constraints

- M = 1. (since MONEY is 5 digit number)
- S ≠ 0 : (Its the first digit in SEND)

- All letters have unique values

Step3: Assigning digits

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

Consider the following actions.
All people who are graduating are happy.
All happy people are smiling
someone is graduating
Explain the following
i) Represent these axioms 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) FOPL
let: G(n) → n is graduating, H(n) ⟶ n is happy, S(n) → n is smiling

Axioms :- 1.) (G(n) ⟶ H(n))
2.) (H(n) → S(n))
3.) G(n)

2) convert to clause form

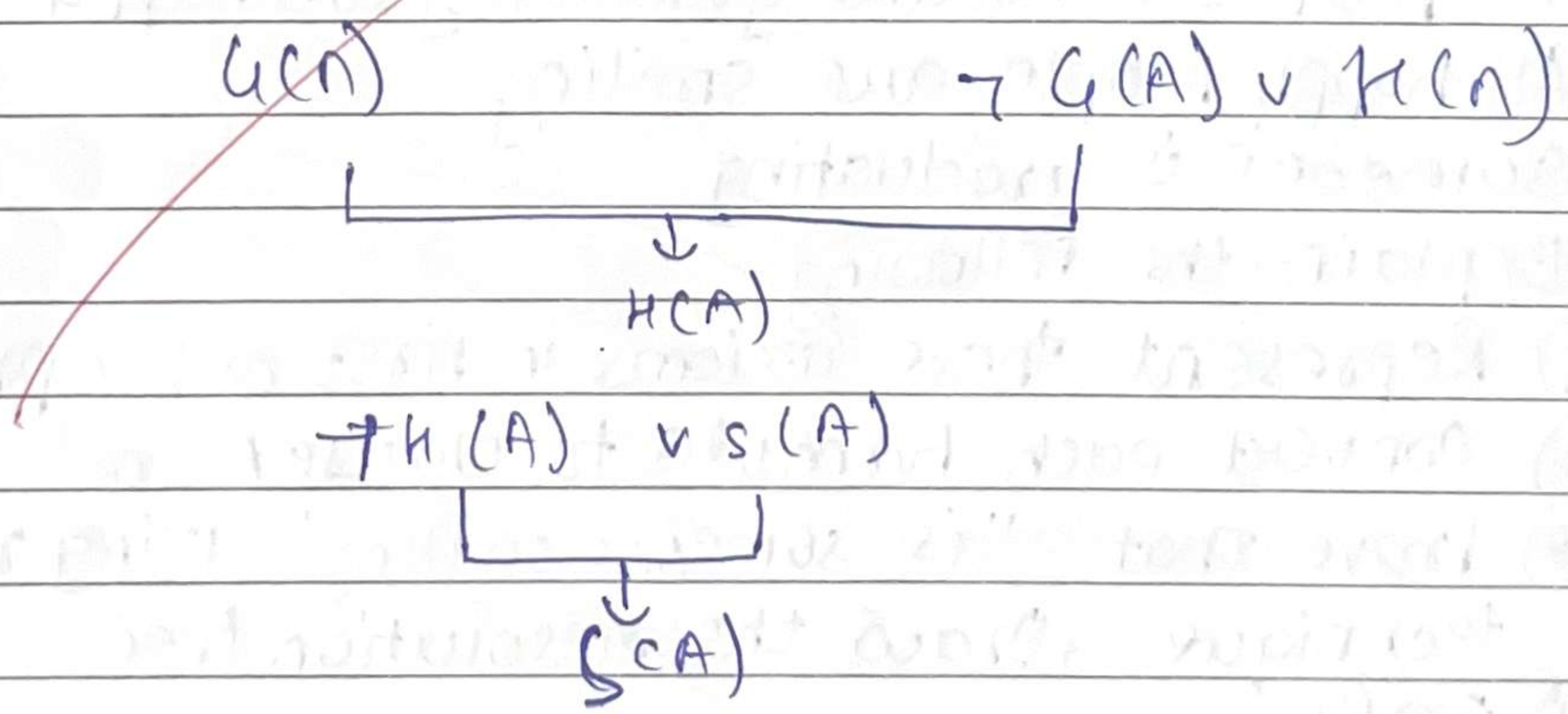
1. $G(n) \vee H(n)$
2. $\neg H(n) \vee S(n)$
3. $\neg G(A)$ let A be a person graduating

3) Prove " is someone smiling?

1. $G(A)$ given
2. $\neg G(A) \vee H(A) \rightarrow$ axiom 1
3. $\neg H(A) \vee S(A) \rightarrow$ axiom 2

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

Resolution free:-



Q20) Explain modus ponen with suitable example:

Ans: 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

~~Symbol~~

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

example

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

This role is widely used in mathematical proofs and AI reasoning systems.

Q21. Explain forward and backward chaining with an example.

Ans: These are inference techniques used in role based systems and AI - reasoning

1. forward chaining (Data-Driven) :-
   Starts with known facts & rules to infer new facts until the goal is reached.
   . Works from cause → effect (bottom-up approa-ch)
   Ex:-
   1. If it is raining then ground is wet ($R \rightarrow W$)
   2. If ground 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

$R \longrightarrow \omega$: is it raining ✓