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D15C
27

AIDS-I Assignment 1

05/05

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

⇒ Artificial Intelligence (AI) is the feild of computer science that enables machines to structure, simulate human ~~responses~~ intelligence including learning, reasoning and decision-making. AI encompasses technologies such as ML, NLP, CV automate tasks.

Role of AI in COVID-19.

1) Early Detection and Diagnostic:- AI models detected outbreak early, and AI assisted CT scans helped in quick diagnosis.

2) Drug and Vaccine Development:- AI accelerated drug discovery and vaccine research.

3) Contact Tracing and Safety:- AI powered apps tracked virus spreading, thermal cameras detected fever.

4) Healthcare and Robotics:- AI chatbots assisted with self-diagnostics, robots disinfected hospitals and delivered medicines.

5) Remote Work and Education:- AI improved video conferencing, virtual assistants and adaptive learning platforms.

Q.2] What is AI agent terminology, explain with example.

⇒ An AI agent perceives its environment through sensors and acts using actuators to achieve goals. The key terminologies include:-

Agent - An entity that percepts and acts.

Percept - Input received by the agent

Percept sequence - The history of all past percepts.

Actuators - Components that allow agent to act.

Teacher's Sign.:

Sensors – Devices collecting data
Environment – The surroundings where the agent operates

Eg:- Self Driving Car

Sensors	Percepts	Actuators	Environ
Camera, LiDAR, GPS	Detects speed limits traffic and obstacle	Accelerate, brake, steer	Road, weather

3) How AI technique is used to solve 8-puzzle problem
⇒ The 8-puzzle problem consists of a 3×3 grid with numbered tiles and 1 empty tile. The goal is to reach a target arrangement by sliding tiles.
Various informed and uninformed techniques are used such as BFS, DFS, IDDFS, A* etc.
For informed search, heuristics such as displaced tiles or manhattan distance can be used.

Consider the following:-

Initial state :- $\begin{bmatrix} 1 & 2 & 3 \\ 4 & 6 & 8 \\ 7 & 5 & \_ \end{bmatrix}$ Goal state:- $\begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & - \end{bmatrix}$

The legal moves AI can make are shift blank to left, right, up, down.
Suppose the heuristic decided is 1 cost per move, the algorithm would look for least cost to goal state.
State changes:-

$$\begin{bmatrix} 1 & 2 & 3 \\ 4 & 6 & \_ \\ 7 & 5 & 8 \end{bmatrix} \rightarrow \begin{bmatrix} 1 & 2 & 3 \\ 4 & - & 6 \\ 7 & 5 & 8 \end{bmatrix} \rightarrow \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & - & 8 \end{bmatrix} \rightarrow \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & - \end{bmatrix}.$$

Goal state reached.

Q.4] What is PEAS description? Give it for the following (i) Taxi Driver (ii) Medical Diagnosis System (iii) An aircraft autolander (iv) A music composer (v) An essay evaluator (vi) A realistic sentry for back lab.

⇒ A PEAS description is a framework used to define the components of an intelligent agent. It helps describe how an AI system interact with its environment and performance tasks

	Performance	Environment	Actuators	Sensors.
Taxi Driver	Safety, fuel efficiency, speed, comfort, traffic	Roads, traffic, pedestrians, passengers weather	steering, accelometer, brakes, indicators	GPS, ~~Cameras~~ speed sensors, proximity sensor
Medical diagnosis system.	Accuracy, Effective ness.	Patient records, medical symptoms, hospital database	Display diagnosis, suggesting treatments	Patient inputs, lab, test results.
Aircraft autoloader	Safe lander, smooth tochdown, weather adaptation.	Runway, weather conditions, wind speed altitude	Controlling thrust, flaps, landing gear, breaking systems.	Radar, altimeter, GPS, wind sensor, speedometer
music composer	Creativity, harmony, originality, satisfaction	Musical notes, user preferences, genre	Generating melodies modifying pitch/tempo	Music database, user feedback, style real time input based
Essay evaluator	Accuracy of grading fairness, grammar, spelling correctness	Essay, grammatic rules, plagarism database, rubrics.	Assigning grades, providing feedback, suggesting feedback	Text input, word count, syntax and grammar checkers.
	Intruder detection accuracy, response time minimal false alarms	laboratory area, authorized personnel intruders	Rotating turret, firing warning shots, sound alarms.	Motion sensors, thermal cameras.

Teacher's Sign.:

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

⇒ (i) Observability :- Partially observable

(ii) Deterministic / Stochastic :- Stochastic

(iii) Episodic / Sequential :- Sequential

(iv) Static / Dynamic :- Dynamic

(v) Discrete / Continuous :- Discrete

(vi) Single / Multi agent :- Multi-agent

~~(vii)~~

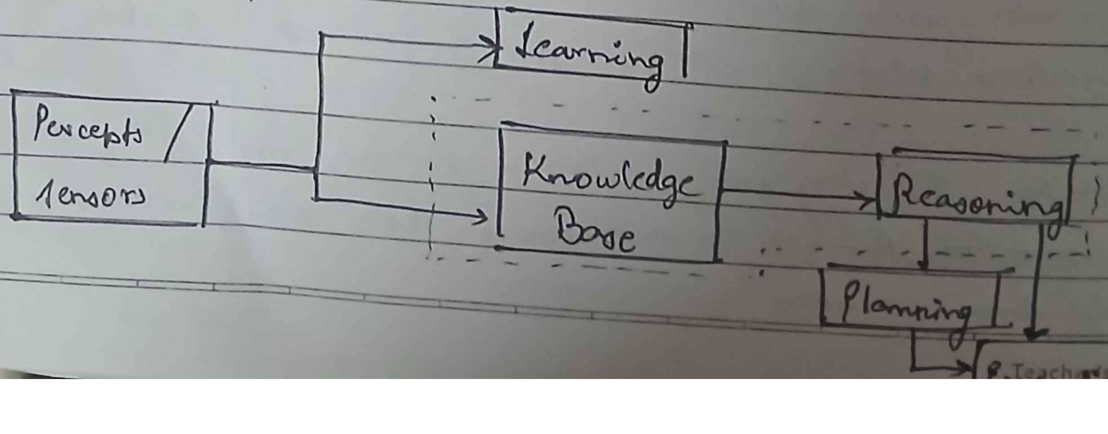
Q.6] Differentiate Model based and utility based Agent.

⇒

Model based agent	Utility based Agent
(i) Uses an internal model of the world	(i) Chooses actions based on a utility function that maxim.. performance.
(ii) Uses stored knowledge (model) to simulate the future state.	(ii) Compares different actions and select the one with the .. utility value.
(iii) Works towards achieving a predefined goal.	(iii) Not just goal-driven, but optimizes for the best possib.. outcome.
(iv) Limited handling of uncertainty	(iv) Handles uncertainty by assigning utilities.

Q.7]. Explain the architecture of a knowledge based agent an.. learning agent.

⇒



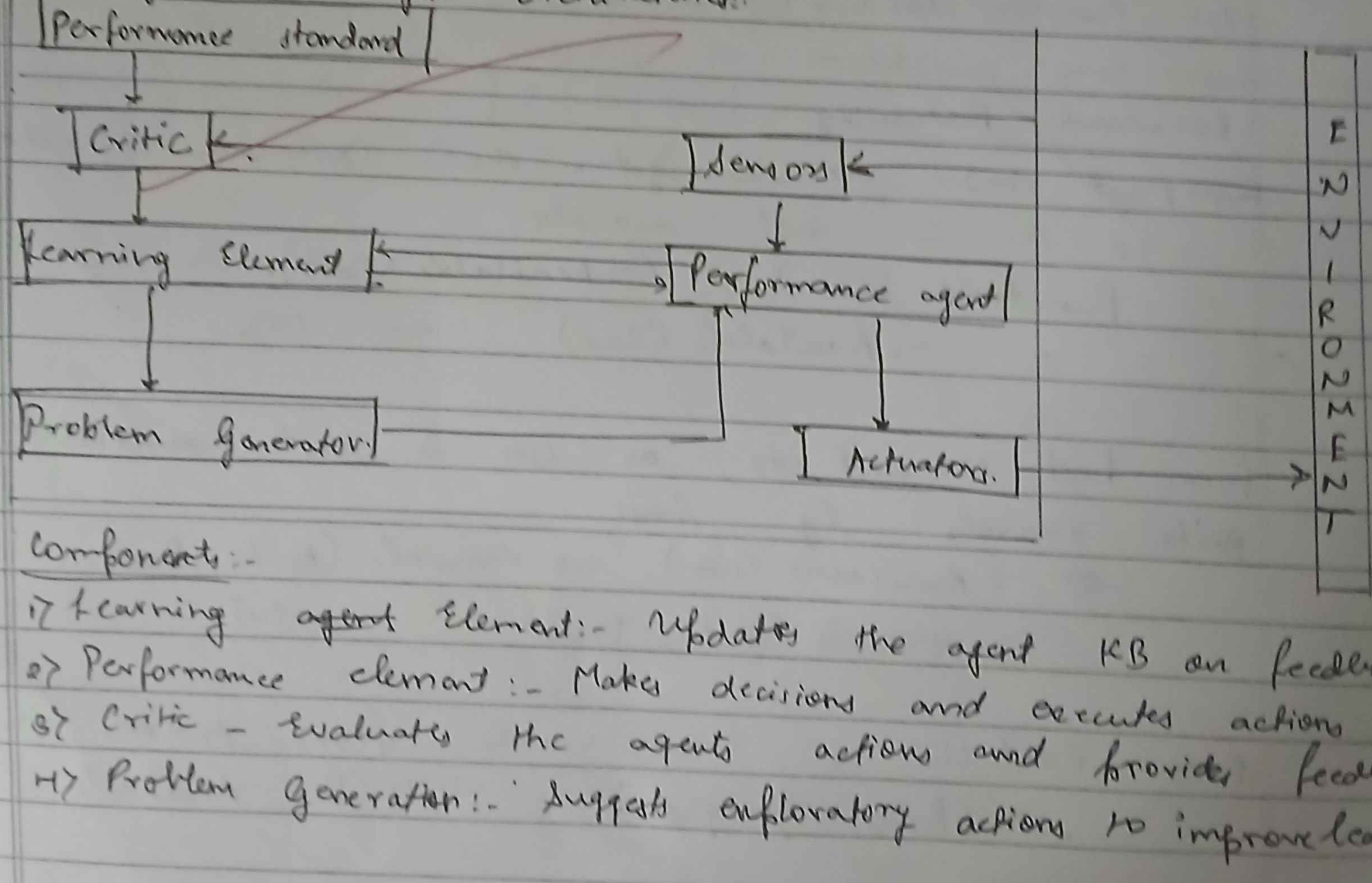
T. Teacher's Sign

A knowledge based agent (KBA) makes decisions using a knowledge base and reasoning mechanisms.

Components :-

1> Knowledge Base stores facts, rules and logical statements.
2> Inference Engine :- Applies logical reasoning to derive conclusions from the KB
3> Perception :- Collects input factors from the environment
4> Action Execution :- Performance actions based on decisions.
5> Updating Mechanism :- Modifies the KB as new information is learning

Learning based agent architectures:



Components :-

1> Learning ~~agent~~ Element :- Updates the agent KB on feedback
2> Performance element :- Makes decisions and executes actions
3> Critic - Evaluates the agents actions and provides feedback
4> Problem Generation :- Suggests exploratory actions to improve learning

Q.9] Convert the following to predicate
→ Anita travels by car if available otherwise travels bus.
→ Bus goes to Andheri via Goregaon
→ Car has puncture so it is not available.
Will Anita travel via Goregaon? Use forward Reasoning.

⇒ (a) Available (car) → travels (Anita, car) —— (i)
¬ Available (car) → travels (Anita, Bus) —— (ii)

(b) visits (Bus, Goregaon) ∧ visits (Bus, Andhari) — (iii)

(c) Puncture (Car) → (¬Available (Car)) —— (iv).

Forward Reasoning
From Fact (iv), we get the Car has Puncture so it is not availabe.
Puncture (Car) → (¬ Available (Car)).
∴ ¬ Available (Car) —— (v).

From Fact (i) and (v), as car is not available, Anita travels by bus.
¬ Available (car) → travels (Anita, Bus).
∴ travels (Anita, Bus) —— (vi)

From Fact (ii), bus travels from Andheri via Goreg
visits (Bus, Goregaon) ∧ visits (Bus, Andhari).

From Fact (iii), Anita travels via bus.
∴ From Fact (ii) and (vi).
∴ travelsvia (Anita, Goregaon)
∴ Anita travels via Goregaon.

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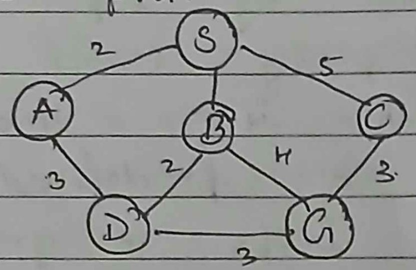
Q.10] Find the route from S to G using BFS.



⇒ For breadth-first search, we consider a queue.

Step 1 :- add source S to queue and mark as visited.

Visited :- {S} | S | |

Step 2 :- Dequeue S, enqueue its neighbours and mark S visited.

Visited :- {S, A, B, C} | A | B | C |

Step 3 :- Dequeue A, enqueue its neighbours and mark visited.

Visited :- {S, A.} | B | C | D |

Step 4 :- Dequeue B, enqueue its neighbours and mark visited.

Visited :- {S, A, B} | C | D | G. |

Goal state G is found.

$\boxed{\text{Route} = S \rightarrow B \rightarrow G.}$

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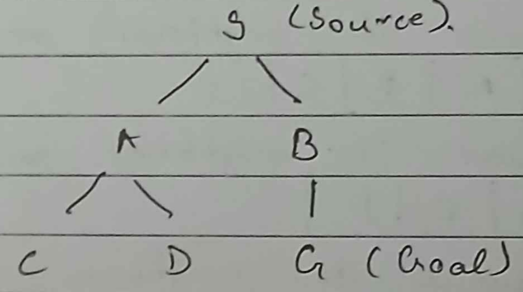
Q.11] What do you mean by Depth Limited Search? Explain Iterative Deepening search with example.

⇒ (i) Depth Limited Search is a modified Depth-first Search (DFS) with a predefined limit.

(ii) It avoids infinite loops in graphs with cycles & saves memory.

(iii) If a goal is not found within the limit fails.

eg:-



If depth = 1.

Depth level 0 → S.

Depth level 1 → A & B

Cannot find goal.

If depth = 2.

Depth level 0 → S

Depth level 1 → A, B.

Depth level 2 → C, D, G.

Goal state G can be found

Time complexity = $O(b^d)$

where b = branching factor, d = depth limit

Space complexity = $O(d)$.

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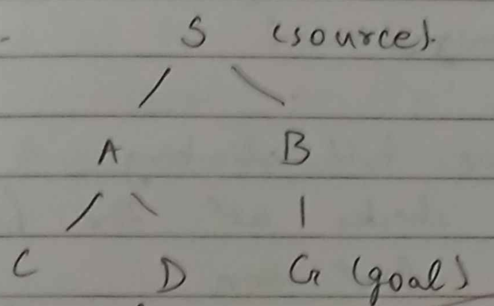
(i) IDS is a combination of DFS and BFS.
(ii) It runs DFS repeatedly, increasing the depth limit one step at a time.
(iii) It finds the shortest path using BFS and uses less memory.

Eg:-



Iteration	Depth limit	Nodes.
1	0	S
2	1	S, A, B
3	2	S, A, B, C, D, G.

IDS finds the shortest path while avoiding deep infinite loops.

Time complexity $= O(b^d)$.
where b = branching factor ; d = depth of goal.
Space complexity $= O(b^d)$.

Q.2] Explain Hill Climbing and its drawbacks in detail with example. Also state limitations of steepest-ascent hill climbing.

⇒ Algorithm:
(i) Start with an initial solution (state).
(ii) Evaluate neighbouring state.
(iii) Move to the neighbour with the highest value.
(iv) Repeat until no better neighbour exists.

→ Hill climbing is a local search algorithm used to find the optimal solution by iteratively making small changes to the current state and choosing the best improvement

Drawbacks of Hill Climbing:-

(i) Local Minima:- May get stuck at a peak that is not the global maximum

(ii) Plateau:- A flat region with no improvement the algorithm may fail to follow

(iii) No Backtracking:- Once a move is made, previous state are not recognized

Limitations of steepest - ascent hill climbing

(i) Computationally expensive:- It checks all the possible moves before choosing the best one.

(ii) Still suffers from local maxima and plateaus

(iii) May oscillate between states if 2 equally good options exist

Q.13] Explain simulated annealing and write its algorithm

⇒ (i) Simulated Annealing is a metaheuristic optimization algorithm that helps in escaping local maxima by sometime accepting worse solutions to explore a better global solution.

(ii) It is inspired by the annealing process in metallurgy where metals are heated and cooled slowly to reach a stable structure.

Algorithm:-

(i) Initialize the solution and set the initial temp

(ii) Repeat until temperature is low:

- Generate a new neighbour state
- Calculate ΔE
- If $\Delta E > 0$ accept new state.
- Else, accept with probability $p = e^{(\frac{\Delta E}{T})}$
- Reduce Temperature using a cooling function.

(iii) Return the best solution

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Q 14] Explain A* algorithm with an example.

⇒ A* is like best-first search algorithm, used in pathfinding and graph traversal. It uses the following formulas:-

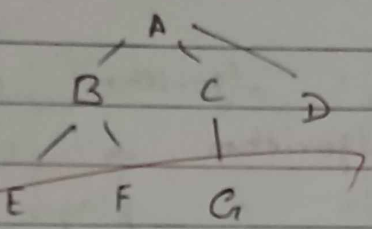
$f(n) = g(n) + h(n)$

$g(n) \rightarrow$ cost to reach 'n' from start.

$h(n) \rightarrow$ heuristic estimate of cost to reach from goal to 'n'.

$f(n) \rightarrow$ total estimated cost

Eg.-



~~For~~ Initial state = A   Goal state = G.

Node	g(A, n)	h(n).
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 initial state A.

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

2) Expand Neighbours.

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

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

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

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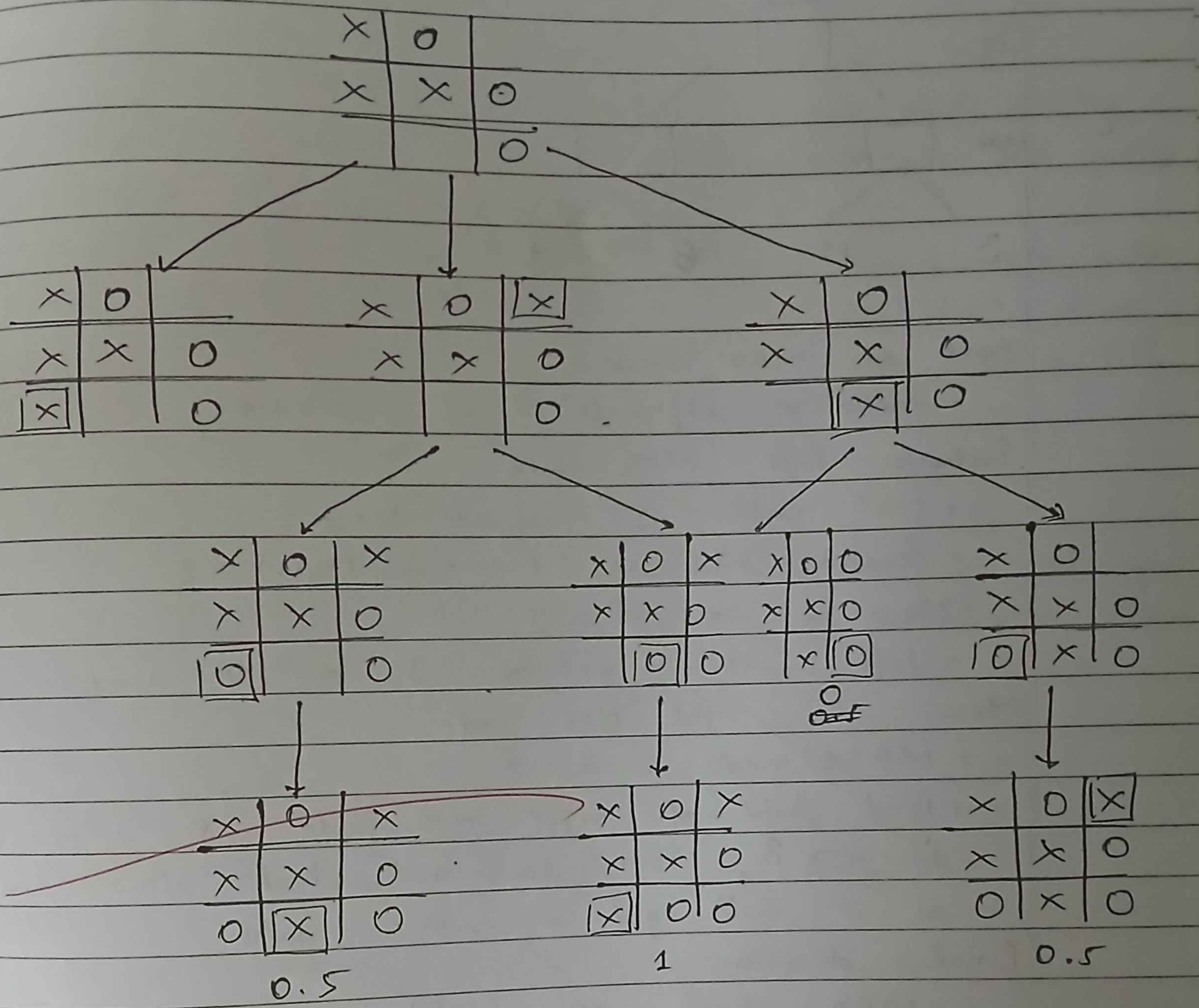
3) Select lowest value that is f(C).
4) Expand neighbours of C.
∴ f(G) = 6+0 = 6.
5) Goal reached at G with cost 6.

Advantages:-
It is efficient for finding shortest path in a wei
graph balances exploration by considering bo
g(n) and h(n).

Q.15] Explain min-max algorithm and draw game tree.
⇒ The min-max algorithm is a decision making algorithm used in 2 player games.
It assumes one player (MAX) tries to maximise score and other player (MIN) tries to minimize score.

Algorithm:-
1) Generate game tree
2) Assign scores
3) MAX picks highest value from children.
MIN picks lowest value.
4) Repeat until root node is evaluated starting bottom up approach.



Q.16] Explain alpha beta pruning algorithm for an adversial search with an example.

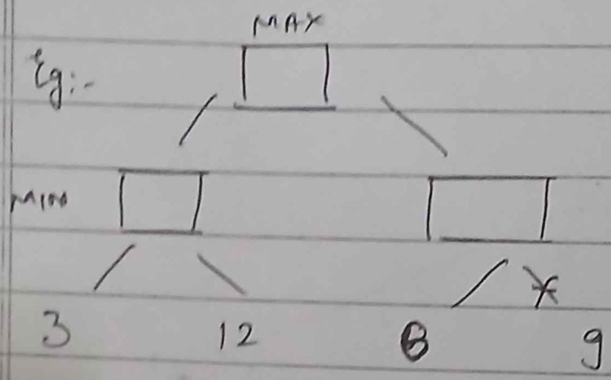
⇒ Alpha Beta pruning is an optimization technique used in min max algorithm to reduce number of nodes evaluated in adversial search problems like game playing AI.

Alpha (α) :- The best maximum score that the maximizing player can guarantee so far.

Beta (β) :- The best minimum score that the minimizing player can guarantee so far.

The algorithm prunes branches that will not influence the final decision.

Eg:-



Start at MAX Node.

- Initialize Alpha (α) = $-\infty$, $\beta = +\infty$.

Evaluate Left MIN node

- First child = 3, update $\beta = 3$.
- Second child = 12, MIN = min (3, 12) = 3.
- Now $\alpha = -\infty$, $\beta = 3$.
- Left subtree returns 3 to MAX node.

Move to right MIN node.

- MAX node :- $\alpha = 3$.
- First child of right MIN node = 8 $\therefore$ MIN (β) = 8

As $\alpha \geq \beta$, MIN does not check other child (9). as it will get a worse value.

Final decision

- MAX chooses max (3, 8) = 8.

Q.17] Explain WUMPUS world Problem, giving its PEAS descript[ion]. Explain how percept sequence is generated.

$\Rightarrow$ The Wumpus world environment is a simple grid le[vel] environment, used in AI to study intelligent agent behaviour in uncertain environments. It is a turn based environment where an agent must navigate a cave to find gold while avoiding hazards like pits and monster called Wumpus.

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PEAS:-

P:- The agent is rewarded for gambling gold and exiting safely. Penalty is imposed for falling into pits and getting eaten by wumpus.

E:- 4x4 grid would containing the agent, wumpus, pit, gold.

A:- The agent can move forward, left, right, shoot, climb.

S:- Agent perceives stench (near wumpus), breeze (near a pit), glitter (near gold), bump and scream.

Percept sequence generation:-

It is the history of all perceptions received by the agent At each time step, the agent ~~at~~ perceives information based on its current location and surroundings.

Example:-

1> Agent starts at (1,1).
   - No breeze, no stench, no glitter (safe space)

2> Agent moves to (2,1)
   - Breeze detected, A pit is nearby, not in current square.

3> Agent moves to (2,2)
   glitter detected → gold is here.

4> Agent moves to (2,1)

5> Agent moves to (1,1)
   climbs out, wins the game.

Teacher's Sign.:

Q.18) Solve the Cryptarithmetic SEND + MORE = MONEY

⇒ Step 1:-

$$\begin{array}{r} SEND \\ +\ MORE \\ \hline MONEY \end{array}$$

M = 1 as the addition of 2 4 digit number cannot value ≥ 20000.

Also, S+M will generate a carry of 1.

$$\begin{array}{r} SEND \\ +\ 1ORE \\ \hline 1ONEY \end{array}$$

Step 2:- Let E+O = 10+N.

Thus, E+O will generate a carry

∴ S must be 8 or 9 as it should generate a carry.

But S ≠ 9 as 9+1+1 = 10+1 → O   O ≠ 1 as M=1.

∴ Let S = 8 and O = 0 (zero).

Step 3:- But now, E + O = N ∴ E = N which is not possible and this cannot generate carry.

∴ Let S = 9.

$$\begin{array}{r} 9END \\ +\ 1ORE \\ \hline 1ONEY \end{array}$$

∴ O = 0 (zero).

Step 4:- E + O = N ∴ E = N which is not true.

∴ E + O + 1 = N

i.e. E + 1 = N. ∴ N+R must generate carry.

Also consider N + R + C1 = 10 + E.

∴ R + C1 = 10 − 1 = 9.

If C1 = 0, ~~But~~ R ≠ 9 as S = 9.

C1 = 1 (Carry). ∴ D + E = Y + 10 ∴ R = 8

Teacher's Sign.

$$
\begin{array}{rccccc}
 & S & 9 & E & N & D \\
+ & & 1 & 0 & 8 & E \\
\hline
 & 1 & 0 & N & E & Y \\
\hline
\end{array}
$$

Now, $N+8+1 = E+10$

$\therefore N - E = 1$

lets assume $E = 5$.

$\therefore N = 6$.

$$
\begin{array}{rccccc}
 & & 9 & 5 & 6 & D \\
+ & & 1 & 0 & 8 & 5 \\
\hline
 & 1 & 0 & 6 & 5 & Y \\
\hline
\end{array}
$$

Now, only equation left is $D+5 = Y+10$.

$\therefore$ Remaining values $= \{2, 3, 4, 7\}$.

As 2, 3, 4 cannot generate carry with 5,

$\therefore D = 7$.

$\therefore 7+5 = Y+10$

$\therefore Y = 2$.

$$
\begin{array}{rccccc}
 & & 9 & 5 & 6 & 7 \\
+ & & 1 & 0 & 8 & 5 \\
\hline
 & 1 & 0 & 6 & 5 & 2 \\
\hline
\end{array}
$$

$\therefore S = 9$

$E = 5$

$N = 6$

$D = 7$

$M = 1$

$O = 0$

$R = 8$.

$Y = 2$.

Teacher's Sign.: ____________

Q.19] Consider the following axioms:

→ All people who are graduating are happy

→ All happy people are smiling.

→ Someone is graduating

(i) Represent in FO predicate logic

(ii) Convert each formula to clause form.

(iii) Prove that "Is someone smiling?" using resolution technique. Draw the resolution tree.

⇒ Consider:-

$G(x)$: ⇒ x is graduating.

$H(x)$: x is happy

$S(x)$: x is smiling.

$\therefore \forall(x) : G(x) \rightarrow H(x)$ —— (i)

$\therefore \forall(x) : H(x) \rightarrow S(x)$ —— (ii).

$\therefore \exists(x) : G(x)$ —— (iii)

Converting to clause form.

Fact 1:- $\therefore$ $\cancel{\forall(x)}$: $\neg G(x) \vee H(x)$ —— (iv)

Fact 2:- $\therefore$ $\cancel{\forall(x)}$: $\neg H(x) \vee S(x)$ —— (v)

Fact 3:- $\therefore$ $G(x)$. —— (vi)

Apply resolution:-

Consider contradiction that ~~No one~~ x is not smiling

$\therefore \neg S(x) \rightarrow$ goal. —— (vii)

Resolve (iv) and (v).

$\therefore \neg G(x) \vee H(x)$ $\quad$ $\neg H(x) \vee S(x)$

$\neg G(x) \vee S(x)$ —— (viii)

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Resolve (vii) and (vi).

$\therefore \neg G(x) \vee S(x)$ $G(x)$.

$\therefore S(x)$. — (~~viii~~ ix)

Resolve (~~viii~~ ix) and (vii).

$\therefore S(x)$ $\neg S(x)$

$\{\emptyset\}$.

As it returns empty set.

$\therefore$ Our assumption of the contradictions is wrong.

$\therefore$ Someone is smiling.

Q.20. Explain modus ponen ~~with example.~~

$\Rightarrow$ Modus Ponen is a fundamental rule of inference in propositional logic that allows us to deduce a conclusion from a conditional statement and its antecedent.

It follows the form.

i.e. $P \rightarrow Q$ (P implies Q).

i.e. If P is true.

Then Q must be true.

Eg:- If it rains, the ground is wet

Let P = rain, Q = ground ~~to~~ is wet.

$\therefore P \rightarrow Q$.

Now, according to Modus Ponen.

If it rains (P is true).

the ground must be wet (Q must be true).

Q.21] Explain forward chaining and backward chaining with an example.

⇒ Forward Chaining:- It starts with given facts and applies inference rules to derive new facts until the goal is reached. It is a data driven approach because it begins with known data and works forward to reach a conclusion.

Backward Chaining:- It starts with a goal and works backwards by checking what facts are needed to support it. It is a goal driven approach.

Example:- Diagnosing a disease.

Rules:-

1) If a person has a fever and cough they have a flu.

Facts:-

1) Patient has ~~cold~~ cough

2) Patient has fever.

Goal:- Prove patient has flu.

Forward chaining

Consider ~~rules~~ facts 1 and 2:-

Patient has cough and fever.

From rule 1:-

$\forall x : fever(x) \wedge cough(x) \rightarrow flu(x)$

~~Thu~~ If x:- patient

∴ Patient has the flu

Backward chaining

We have to prove that patient has flu.

For that, from rule 1.

$\forall x : fever(x) \wedge cough(x) \rightarrow flu(x)$

If patient has flu,

→ patient must have fever and cough.

From fact 1 and 2,

fever(patient) cough(patient)

∴ Patient has the flu.