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D15C - 52

05/05

AIDS-1 Assignment

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

→ Artificial Intelligence is the simulation of human intelligence in machines, enabling them to perform tasks such as learning, reasoning, problem-solving and decision-making. AI systems use techniques like machine learning, deep learning and NLP.

The solution Through AI:

1. Healthcare and Diagnostics
AI powered models were used to detect COVID-19 from medical images like X-rays and CT scans, helping in faster diagnosis. AI assisted chatbots provided initial consultations, reducing the burden on hospitals

2. Vaccine Development
AI accelerated vaccine research by analyzing virus structures, predicting protein interactions and identifying potential drug candidates

3 Contact Tracing and Surveillance:
AI driven contact tracing apps, such as Aarogya Setu, helped track COVID-19 exposure and prevent outbreaks.

4. Supply Chain Optimization
AI helped predict demand for medical supplies, optimize logistics and ensure the timely delivery of essential goods, preventing shortages

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

→ Key terminologies in AI Agents.

① Agent: An agent that perceives the environ and takes actions to achieve a specific goal

eg. A self-driving car perceives traffic conditions and adjusts its speed accordingly

② Perception: (sensors)

The agent gathers information about the environment through sensors.

eg: A robot vacuum cleaner uses infrared sensors to detect obstacles

③ Actuators:

Components that allow the agent to interact with the environment

eg: A robotic arm in a factory moves objects using mechanical actuators.

④ Environment:

The surroundings in which an agent operates

It can be fully or partially observable

eg: A chess-playing AI has a fully observable env, while a personal assistant AI like Siri operates in a partially observable one

Q3) How AI Technique is used to solve 8-puzzle problem?

→ It consists of a 3X3 grid with 8 numbered tiles and one empty space, where the objective is to move the tiles around to match a predefined goal configuration.

Initial State:

1	2	3
4		6
7	5	8

This is the random starting configuration of the 8 puzzle with the tiles placed in a non-goal configuration.

2) Goal State: The goal is to arrange the tiles in a specific order with the blank space at the bottom right

Goal State

1	2	3
4	5	6
7	8	

3) Solving the 8 Puzzle problem

① Breadth first Search (BFS)

- BFS as an uninformed search algorithm that explores all possible state level by level, starting from the initial state
- BFS guarantees that the solution found is the shortest in terms of number of moves, but it can be very slow.

Advantages: Guaranteed to find the optimal
Disadvantages: BFS has a high memory require

(2) Depth First Search (DFS)
DFS is another uninformed search algorithm that explores one branch of the state space tree as deep as possible before backtracking.
Advantages: DFS is more memory efficient than BFS
Disadvantages: DFS is like can get stuck in deep non-optimal paths and may not find the shortest solution.

Q.4) What is PEAS descriptor? Give PEAS descriptor for following
→ 1) Toni Driver:
- P: Min time travel, Fuel efficiency, passenger safety, obey traffic rules
- E: roads, traffic, passengers, weather, obstacle pedestrians
- A: Steering, accelerator, brakes, turn signals, ho
- S: Camera, GPS, speedometer, LiDAR, microph

2) A Medical Diagnosis System
- P: Accuracy of diagnosis, treatment, success rate, response time
- E: Patient records, symptoms, medical tests, hospital database
- A: Display screen, printed prescriptions, notifica
- S: Patient input, lab reports, electronic health r

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3) A music composer:

- P: Quality of music, adherence to genre, audience engagement
- E: digital workspace, music production software, realtime composition settings
- A: Audio output, digital instrument selection, file saving / export
- S: User inputs, style preference, tempo, feedback from listness, music theory constraints

4) An aircraft Autolander

- P: Smooth landing, accuracy in reaching runaway, passenger safety, fuel efficiency
- E: Airspace runaway, weather, wind speed, visibility
- A: Flight control, landing gears, brakes
- S: GPS, airspeed indicator, gyroscope radar, weather sensors

5) An essay evaluator

- P: Accuracy of grading, consistency, fairness, grammer.
- E: Digital text inputs, student essays, predefined, grading criteria
- A: Feedback generation, score assignment, highlighting errors, suggesting improvement
- S: Optical character recognition, NLP, & spell checker

6) A robotic sentry gun for Keck lab

→ P: Target accuracy, threat deflection efficiency

E: Keck lab premises, intruders, lighting conditions, obstacles.

A: Gun aiming system, firing mechanism, camera panning alert system

S: Motion detectors, infrared sensors, camera, LIDAR, radar

Q.5) Categorize a shopping bot for an offline bookstore according to each six dimension (fully / partially observable / deterministic / stochastic, sequential, episodic, static / dynamic, discrete / continuous, single / multi agent

→ 1) Partially Observable: The bot may not have complete visibility

2) Stochastic: The environment is unpredictable. There are chances that it may have too many book vendors so choosing becomes difficult

3) Sequential: Each decision The bot makes affects future states. There is a continuous manner The bot reacts to its obstacles

4) Dynamic: The bookstore environment changes overtime. The new-books may arrive and There can be replacement over new versions of b

5) Discrete: Bot choose or make discrete cho

6) Multi agent: The bot interacts with multiple entities.

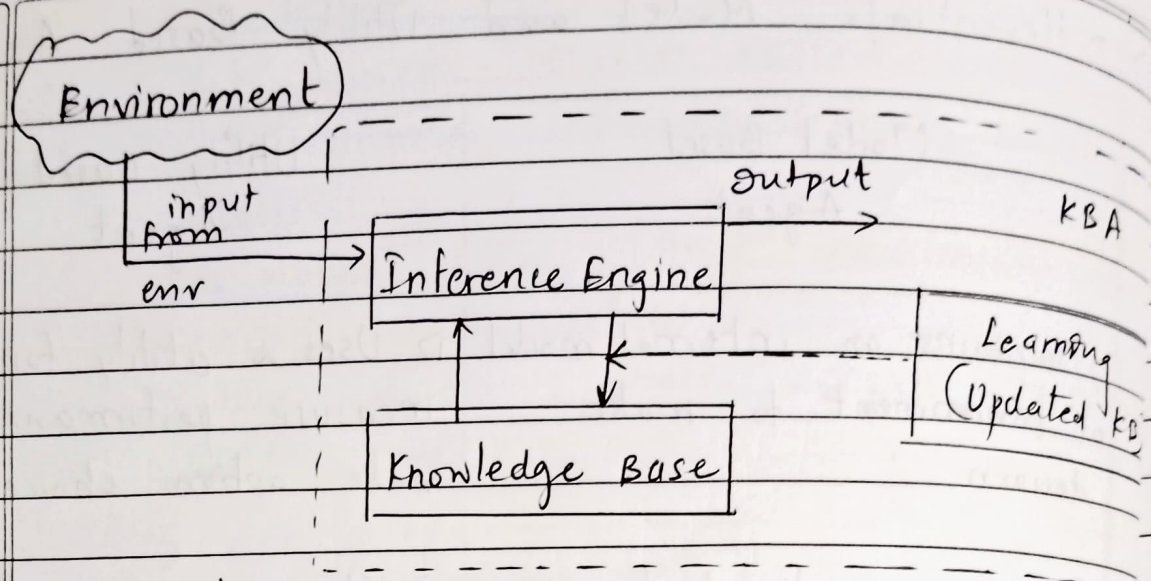
Q.6) Differentiate Model and Utility Based Agent.

Model Based Agent	Utility Based Agent
1) Maintains an internal model of environment to make decision	1) Uses a utility function to measure performance and make option choices
2) Relies on stored knowledge and updates the model	2) Chooses actions based on maximizing expected utility
3) Can adapt to changing environment by updating internal node	3) More flexible & goal-oriented, adapting to changes dynamically
4) Moderate complexity due to model maintainance	4) Higher complexity due to the need to compute utilities for different actions

Q.7) Explain the architecture of a Knowledge Based Agent and Learning Agent

→ ① Knowledge-Based Agent Architecture.

It makes decisions using knowledge base and measuring mechanism.



Component:

1) KB (Knowledge Base): It's the key component of KBA. These deal with the real facts of world. It's the mixture of sentences which are expl in knowledge representation language

2) Inference Engine - It is knowledge-based system engine used to infer new knowledge in system

Actions done by KB Agent

1) It Tells what is recognized from the environm and what it needs to know the knowledge

2) It asks what action to do? and gets answers from The knowledge base

3) It tells the which action is selected, then agent will execute that action

(2) Learning Based Agent

A learning agent improves its performance over ti by learning from past experiences and interacti with the environment

Architecture components:

① Learning element: analyzes feedback from the environment and improves knowledge
② Performance element: makes & executes decisions
③ critic: evaluates the agent's action and provides feedback
④ Problem generator: suggests explatory actions to improve learning

Actions by learning based agent

1. The performance element selects an action
2. Critic evaluates the action of agent and provides feedback
3. The learning element updates the agents knowledge to improve future decisions
4. The problem generator suggests new strategies to explore better solutions.

Q.9) Convert the following to predicates

ⓐ Anita travels by car if available otherwise travels by bus

→ available(car) → travels (Anita, car) ..(1)
¬ available (car) → travels (anita, bus) ..(2)

ⓑ Bus goes via Andheri and Goregoan
ⓒ Car has puncture so is not available
Will Anita travel via Goregoan? Use forward reasoning

→ (b) route (bus, goregoan) ∧ route (bus, Andheri) ..(3)
(c) puncture (car) → ¬ available (anita, car) ..(4)
{ since car is not available for travelling, Anita

won't use the car)
- so its basically true

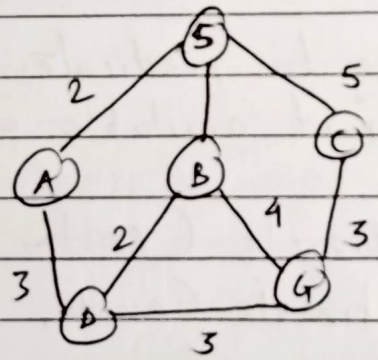
- Now since the car is not available Anita travel by bus ...[from (1)]

¬ available (car) → travels (anita , bus)

also · routes (bus, goregoan) · from (3)
and · routes (anita, bus)

→ ∴ Anita will travel via Goregoan.

(10) Find the route from S to G using BFS

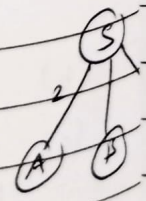


→ <u>Solution</u>

BFS explores all the neighbours of a node before moving to the next level.

1. start at S
Queue = [S]

2. Dequeue S and explore it's neighbour
Queue = [A, B, C]



3. Dequeue A and explore neighbours
Queue = [B, C, D]

A —3— D

4. Dequeue B and explore neighbors D, G
{ D already taken, so consider G}
Queue = [C, D, G]

5. Dequeue C and explore next level
Queue = [D, G]

6. Dequeue D
queue = [G]

7. Dequeue G

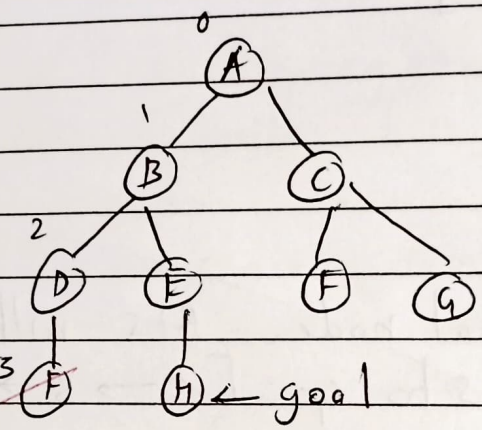
∴ G is our goal node. BFS will stop here.
Route from S to G : [S → B → G]

(ii) What do you mean by depth limited search? Explain Iterative Deepening Search with example.

→ • Depth Limited Search (DLS) is an uninformed search algorithm that modifies DFS by then introducing a depth limit (L), preventing the further exploration beyond the defined limit. This prevents infinite loops in graphs but risks missing goals beyond L.
• Completeness: Doesn't gurantee to reach the goal node
• Does'nt provide optimality
• DLS is memory efficient
• It has space and time complexity of O(b!).

- Iterative Deepening Search:
- IDS is a combination of both BFS and DFS
BFS guranteed to reach goal node and DFS ou
less memory space
- It gradually increases the depth-limit from
0, 1, 2 and so, on and reach the goal no

Example:



- Goal node is H and initial depth-limit = [0]
iteration 1, Nodes visited = [A], goal not found
- Iteration : 2 limit = 1
Terminate with sequence A → B → C
- Iteration : 3, limit = 4
Will expand the nodes from level 0 to level 3
and search terminate with A → B → D → F → E →
Hence, H is the goal node obtained

- It may or maynot provide the Completeness
- It does not give an optimal solution always
- Time and space complexity is O(bd).

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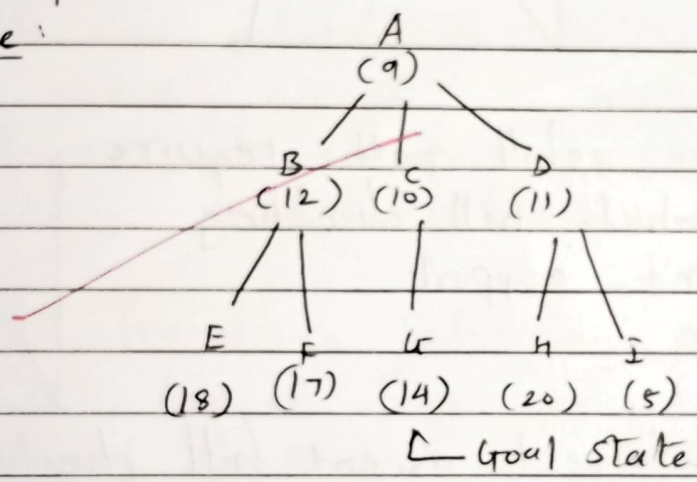
(12) Explain Hill Climbing and its Drawbacks in detail with example. Also state limitations of steeper ascent hill climbing.

→ • Hill climbing is a local state search optimization algorithm which moves forward toward a better neighbouring solution until it reaches a goal

• It is based on the 'heuristic search technique' where the person who is climbing up on the hill estimates the direction which will lead him to the highest peak

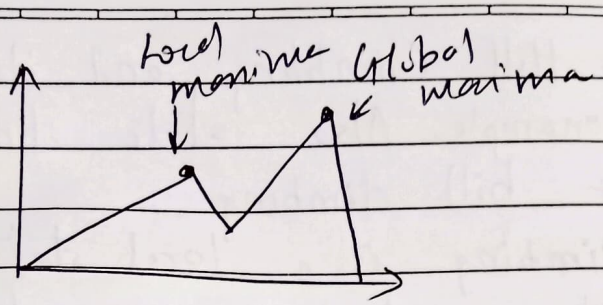
Example:



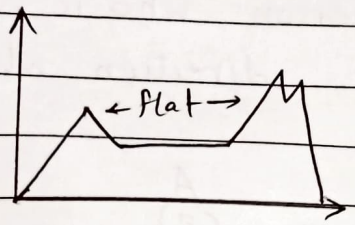
- Start at root node A (10)
- Compare its children B, C, D
- Move to child with highest value i.e B(12)
- Repeat for B's children E & F
- Terminate at E (18)
- Thus algorithm stops at E(18) and doesn't reach goal node

→ Drawbacks

(1) Local Maxima: The algorithm greedily selects the best immediate child and can thus stuck at the local maxima



(2) plateau: If siblings have equal values then the algorithm can't decide the next step & gets stuck



(3) Ridges: Narrow uphill paths require backtracking which hill climbing algorithm doesn't support

- Limitations of steepest ascent hill climbing:
  1. Computationally expensive: Evaluates all neighbors before selecting the best
  2. Stuck: It can still get stuck in local maxima, plateaus or ridges
  3. No global optimality: It only requires favourable immediate improvements

(Q.13) Explain simulated Annealing. Write its Algorithm.

→ Simulated Annealing is a probabilistic optimization algorithm inspired by metallurgical process of annealing where materials are heated and

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to reduce effects and defects. It escapes the local optima by temporarily accepting worse solution with a probability.

Algorithm:

1. Initialize
2. Let an initial solution and define a initial Temperature T
3. Repeat untill stopping condition
   - generate a new neighbour solution
   - compute changes in cost
   - If new solution is better then accept it
   - If worse, accept it with probability
   - Decrease temperature T $\{P(\text{accept}) = e^{-\Delta E/T}\}$
4. Return best solution

Example: Travelling Salesman problem

Since TSP has a huge no. of possible routes (N! factorial growth), brute force methods are impractical for large datasets. SA is an effective approach for solving TSP when exact solutions are impractical.

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

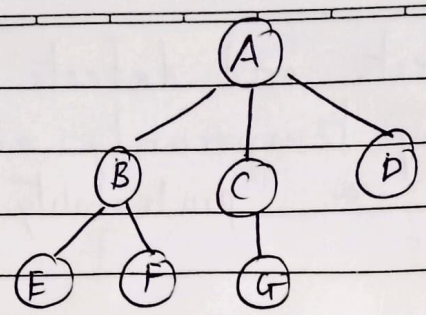
→ A^* is a best first search algorithm used in pathfinding and graph traversal. It uses the following formulas:

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

Here $h(n)$: Heuristic function to estimate of cost to search from goal to n.

$f(n)$: total estimated cost

Goal G:



Node	g (A, n)	h (n, G)
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 root node → A
   $f(A) = g(A) + h(A) = 0 + 6$
   $= 6$

2. Expand neighbors B, C, D
   $f(B) = 1 + 4 = 5$
   $f(C) = 2 + 2 = 4$
   $f(D) = 4 + 7 = 11$

- Choose the lowest value that is f(C)
  Expand neighbours of C

3. $f(G) = 2 + 4 + 0 = 6$
4. Goal reached at G with total cost of $\boxed{6}$

Advantages:

1. Efficient for finding shortest path in weighted graphs
2. Balances exploration by considering both g(n) and h(n)
3. Expands fewer nodes than brute-force methods by prioritizing most promising paths.
4. Useful for robotics and game AI where path conditions may change

(15) Explain Minimax Algorithm and draw game tree for Tic-Tac-Toe game

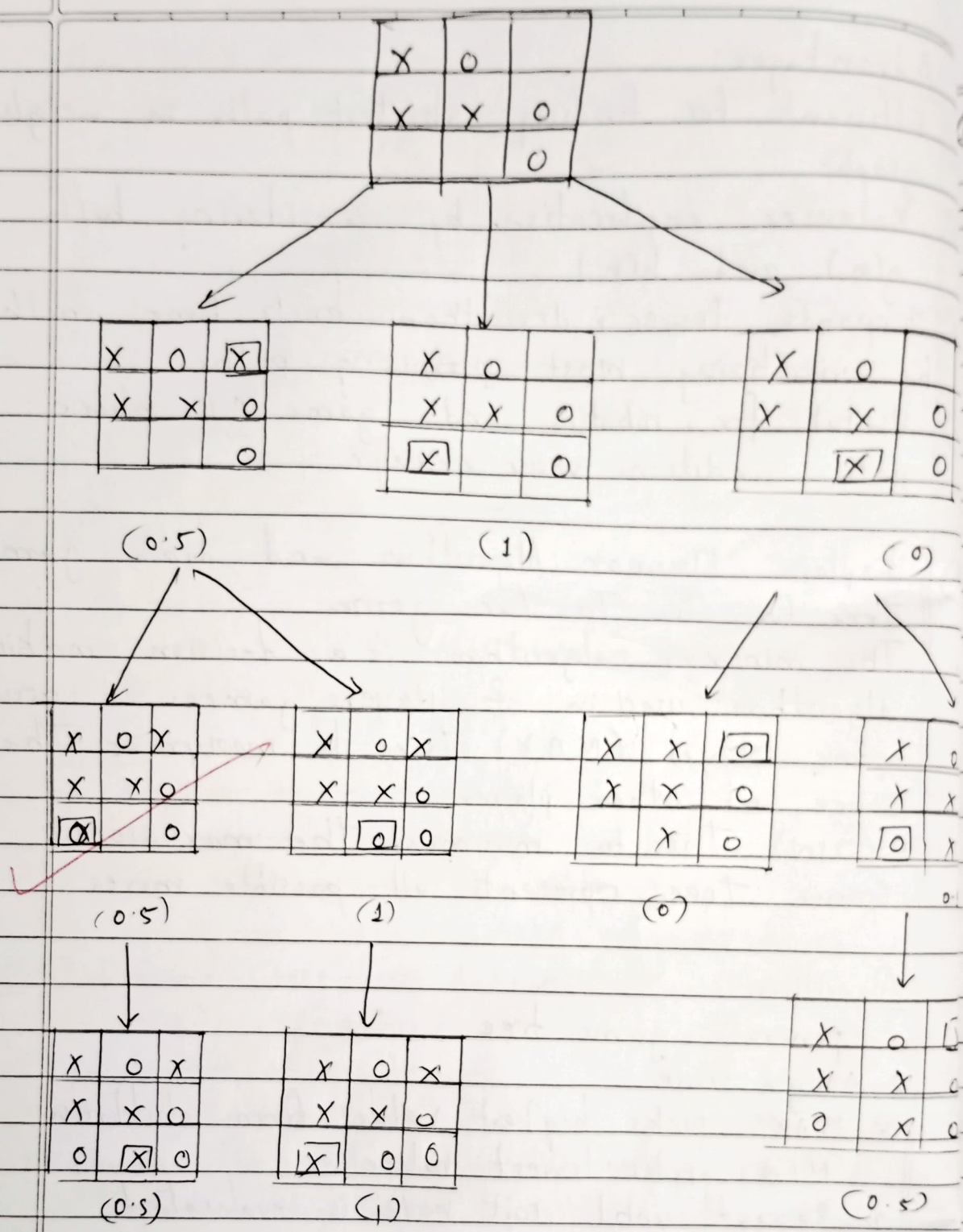
→ The minimax algorithm is a decision making algorithm used in 2 players games. It assumes
- one player (MAX) tries to maximize the score of other player
- (MIN) tries to minimize the max score

Game tree represents all possible moves

Algorithm:

1. Generate game tree
2. Assign score
3. MAX picks highest value from children
   MIN picks lowest value
4. Repeat until root node is evaluated

→ Game tree for tic-tac game:


(0.5)
(1)
(0)
(0.5)
(1)
(0)
(0.5)
(1)
(0.5)

(16) Explain Alpha-beta pruning algo for adversarial search with example

→ Alpha-beta pruning is an optimization technique used in minimax algorithm to reduce the number of nodes evaluated in adversarial search problems like game-playing AI (eg: chess, Tic-tac toe game)

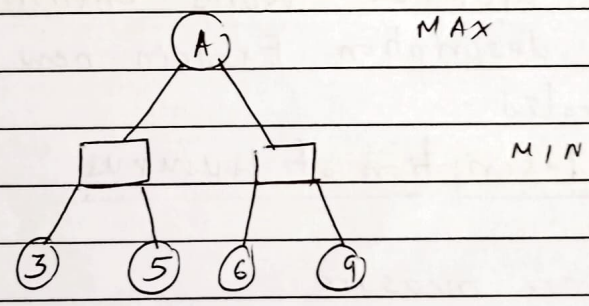
Alpha-beta pruning includes:

(1) Alpha (α) : The best maximum score that the maximizing player can gurantee so far

(2) Beta (β) : The best minimum score that the minimizing player gurantee so far

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

Example :



Process :

1. Start at root node A

$\alpha = -\infty$, $\beta = \infty$

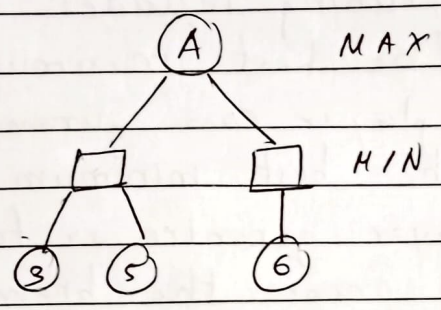
2. Check left min node (child of A)
   - check first child value : 3 → update ($\beta = 3$)
   - check second child value : 5 → β remains 3.
   - Min node returns 3 to MAX

3. Right Min node (Child of A)
   - check first child value = 6 → $\beta = 6$

- here $\alpha = 3$ at MAX Node but $\beta(6) > \alpha(3)$ so no pruning.
- explore 2nd child (9) → Here pruning occur. MIN node already has a value ≤ will never choose 9 and so we prune the with value 9

i) MAX value = 6.

Final tree:



Q.17) Explain WUMPUS world environment, giving its PEAS description. Explain new percept sequence generated.

→ PEAS description of wumpus

1. Performance measure:
- +1000 reward points if the agent comes out of the cave with the gold
- -1000 points penalty for being eaten by the wu or falling into the pit
- -1 for each action and -10 for using an arrow
- The game ends if either agent dies or com out of the cave

2. Environment: 4X4 grid world containing agent, wumpus, walls and pits, gold

3. Actuators: The agent moves forward, left, right, up, down, shoot and climb

4. Sensors: - Agent perceives stench (near to wumpus)
- It experiences breeze (near to pit)
- percieves glitter (when found the gold)
- wumpus is shot, it emits a horrible scream which can be perceived anywhere in the cave

• Percept sequence generation:
It is the history of all perceptions received by the agent at each time step, the agent perceives information based on it's current location and surroundings

Example

1. Agent starts at (1,1):
• No breeze, no stench, no glitter → safe square

2. Agent moves to (2,1):
• Breeze detected → A pit is nearby but not in current square

3. Agent moves at (1,2)
• Stench detected → wumpus is in adjacent cell

4. Agent moves to (2,2)
• Better detected → gold is here

5. Agent moves back to (1,1) and climbs out

(13) Solve the following crypto-arithmetic problem

SEND + MORE = MONEY

→ Solution:

Step 1: M must be 1 [∵ sum of 2 '4' digit cannot be greater + equal to 2k]

```
  S E N D
+ M O R E
  (1)
-----------
M(1) O N E Y
```

Step 2: Assume E + O = 10 + N, then it generates carry so S has to be 8 otherwise S is 9 then carry is 1 but O cannot be 1 {∵ M = 1}

```
  8 E N D
+ 1 2 O R E
-----------
  1 O N E Y
```

{but M = 1}

Step 3: But in this case if S is 8 then it contradicts step 1. So (S → 8)

```
  S E N D          9 E N D
+ M O R E   →      1 O R E
-----------      -----------
  M O N E Y        1 O N E Y
```

Step 4: E + O = N; but (E = N) but this would be contrapositive hence then (N + R) must get a carry! and E + 1 + O = N ∴ N = E + 1

Also N + R + k1 = 10 + E

∴ R + k1 = 10 − 1 = 9

$\therefore R+1 = 9; \quad R = 8$

$$\begin{array}{r} S\,E\,N\,D \\ +\ M\,O\,R\,E \\ \hline M\,O\,N\,E\,Y \end{array} \longrightarrow \begin{array}{r} 9\ E\ N\ D \\ 1\ 0\ 8\ E \\ \hline 1\ 0\ N\ E\ Y \end{array}$$

$\therefore D+E = 10+Y$

Steps:

Also $N+8+1 = 10+E$

but $N = E+1$, lets assume $E=5$ & $N=6$

$$\begin{array}{r} 9\ \overset{1}{5}\ 6\ D \\ 1\ 0\ 8\ 5 \\ \hline 1\ 0\ 6\ 5\ Y \end{array}$$

Step 6:

Now only need is to fill D & Y so it can be filled with remaining numbers 4, 2, 3, 7.
But the best fit $D \to 2$, $Y \to 7$

$$\begin{array}{r} S\,E\,N\,D \\ +\ M\,O\,R\,E \\ \hline M\,O\,N\,E\,Y \end{array} \longrightarrow \begin{array}{r} 9\ 5\ 6\ 2 \\ +\ 1\ 0\ 8\ 5 \\ \hline 1\ 0\ 6\ 5\ 7 \end{array}$$

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

(19) Consider the foll axioms.

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

(1) Represent in FOL

→ $G(x)$: x is graduating

$H(x)$: x is happy

$S(x)$: x is smiling

Axioms to predicate Logic

(1) $\forall x \, (G(x) \rightarrow H(x))$

(2) $\forall x \, (H(x) \rightarrow S(x))$

(3) $\exists x \, G(x)$

(2) Convert each formula in clause form

1. $\forall x \, (G(x) \rightarrow H(x))$

→ Implication removal

$\forall x \, (\neg G(x) \vee H(x))$

→ Clause form

$\{\neg G(x), H(x)\}$

2. $\forall x \, (H(x) \rightarrow S(x))$

→ Implication removed: $\forall x \, (\neg H(x) \vee S(x))$

Clause : $\{\neg H(x), S(x)\}$

3. $\exists x \, G(x)$

→ Clause form : $\{G(x)\}$

(3) Prove "is someone smiling" using resolution

With clauses available apply Resolution

Resolution

(1) $\{\neg G(x), H(x)\}$ with $(3) \rightarrow G(x)$

substitute $x = a \rightarrow \{G(a)\}$

$\{\neg G(a), H(a)\}$

$\therefore$ Resolution gives $\{H(a)\}$

(2) $\{\neg H(x), S(x)\}$ with $\{H(x)\}$

$\rightarrow$ $\{S(a)\}$

[Substitute $(x = a)$:

$\{\neg H(a), S(a)\}$ & $\{H(a)\}$]

(3) we can resolve $S(a)$ with $\{\neg S(a)\}$

(4) So now we are left with ϕ

Our assumption of contradiction is true and then we can say that someone (a) is smiling

(20) Explain modus ponen with suitable example

$\rightarrow$ The Modus ponen rule is one of the most important rules of inference and it states that if P and $P \rightarrow Q$ is true, then we can infer