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05/05

Assignment - I

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

→ AI (Artificial intelligence) enables machines to think, learn, and make decisions like human. It includes technology like ML, NLP & robotics.

Application

1) Healthcare : AI helps in early diagnosis, Vaccine development and chatbot based health assistance.
2) Contact tracing : AI powered apps tracked covid-19 exposure public safety.
3) Remote work & education : AI enhanced virtual meetings, online learning.
4) Supply chain & deliveg : AI optimized logistics & enhanced autonomous deliveries.
5) Mental health support : AI drives apps to provide emotional and fitness assistance.

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

→ 1) Agent : An entity that interacts with environment & makes decision based on inputs.
Ex : A self-driving car perceives traffic signals & adjust speed accordingly.

2) Performance measure : Defines how succesful an agent is achieving its goal.
Ex. Self driving car, fuel efficiency & time travel.

3) Behaviour / Action of Agent: The action an agent based on the its percepts.
Ex: A Robot vacuum cleaner moves around obstacles after detecting them.

4) Percept: The data an agent receives at a specific moment from sensors.
Ex: A spam filter receives an email & detects keywords, sender info.

5) Percept sequence: The entire history of percepts received by an agent.
Ex: A chess playing AI remembers all previous moves in game.

6) Agent function: Mapping from percept sequence to an action.
Ex: A smart thermostat analyzes past data and adjusts heating accordingly.

Q 3) How AI technique is used to solve 8 puzzle Problem?
→ It consists a 3x3 grid with 8 numerical tiles & one empty space where the objective is to move the tiles around to match proffered goal config.

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 non goal config.

⇒ Goal state 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	

* Solving the 8 puzzle problem

· AI search algorithms such as BFS, DFS and A* are commonly used:

⇒ BFS is an uninformed search algo 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 a best solution

Disadvantage

Has high memory requirement, stores states at each level.

⇒ DFS is another uniformed search algo that explores all state space tree as deep as possible before backtracking

Advantage

DFS is more memory efficient than BFS

Disadvantage

Can get stuck in deep non optimal path & may not find shortest optimal path

Steps using A*

- Compute manhattan distance for each possible move
- Choose the best move (lowest f(n))
- Repeat until goal state.

Q.4) What is PEAS Descriptor. Give PEAS descriptor for the following

→ 1) Taxi driver

P → travel time, fuel efficiency, safety, obey traffic rules

E → Roads, traffic, weather, highway

A → accelerator, brake, horn, turn signal.

S → Camera, GPS, speedometer, radar.

2) Medical diagnosis system

P: Accuracy, treatment success rate, response time.

E: Patient records, symptoms medical test, hospital database

A: Display screen, printed prescription, notifications

S: Patient input, lab reports, electronic health records

3) Music composer

P: Quality of music, lyrics, tunes, beats

E: Digital workspace, music production softwar.

A: Audio ~~input~~ output, file sharing / export

S: User input, style / preference, feedback from listners, music theory constraints.

4) Aircraft Autolander
P: Smooth landing, safety, fuel efficiency, braking.
E: Runway, offrunway sites, simulations.
A: Brakes, landing gear, flight control.
S: GPS, airspeed indicator, gyroscope, radar.

5) Essay Evaluator
P: Accuracy of Grading, consistency, Grammar.
E: Student essay, digital input, books etc.
A: Feedback generation, Score assignment, errors suggestion.
S: optical Characters recognition, NLP grammer & spell check.

6) Robotic sentry gun for Keck lab.
P: Target accuracy, threat detection, rate of fire, heat.
E: Shooting range, combat, wars.
A: aiming system, muzzle, trigger
S: motion detector, infrared sensor, LIDAR etc.

2.5) Categorize a shopping bot for an offline bookstore according to each of six dimension (fully / partially observable, deterministic / stochastic, episodic / sequential, static / dynamic, discrete / continous, single / multiagent)

⇒ 1) Partially observable: bot may not have complete visibility.
2) Stochastic: Unpredictable environment.
3) Sequential: Each decesion affects future states
4) Dynamic: Bookstore env changes all time.
5) Discrete: Bot chooses discrete choices (selecting books)
6) multi agent: The bot interact with multiple entities.

Q6) Differentiate between model based & utility based agent.

Model based	Utility Based agent
1) maintains internal model of the environment to make decision.	1) uses utility function to measure performance & make optimal choices
2) Relies on stored knowledge & update the models.	2) chooses actions based on maximizing expected utility
3) can adapt to changing environment by updating the internal mode	3) More flexible & goal oriented adapting to changes dynamically
4) moderate Complexity due to model maintains	4) Higher complexity due to need of diff utility function
5) Ex self driving cars with pedestrian movement	5) A self driving car that evaluates & selects best one.

Q7) Explain Architecture of knowledge based agent & learning agent

→ 1) Knowledge based agent

It is an intelligent agent that makes decisions using knowledge base and reasoning mechanism.

Architecture component

1) Knowledge base: Stores facts, rules, heuristics about the world.
2) Inference engine: Uses FOL to derive new knowledge from the KB.
3) Perception module: Collects data from sensors & update the KB.
5) Action selection module: chooses appropriate actions based on reasoning outcome.

8) Already done

9) Convert the following to predicates.

a) Car available → travel by car (Anita)
   ¬ Car available → travel by bus (Anita)

b. bus goes via Andheri and Goregaon
   goes via (Bus, Andheri) ∧ Goes via (Bus, Goregaon)

c) Car has a puncture and is not available.
   Puncture (Car)
   ¬ Car available → Puncture (car)

Will Anita travel via goregaon? use forward chaining
from (c) puncture car is true
from (a) ¬ car available, we use ¬ car available
from (b) goes via (bus, goregaon)
Since Anita travels by bus, she will follow the same, Anita will travel via goregaon.

5) Communication module: Allows interaction with other agents

Working Process:
- The agent Perceives the environment & updates its KB
- The inference engine applies logical rules to infer new knowledge
- The agent decides an action and executes it.
- The KB is continously updated to improves decesion making.

2) learning agent architecture
- A learning agent improves its performance over time by learning from past experience.

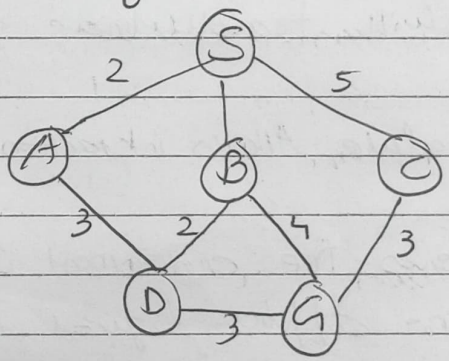
Architecture components

1) Learning element: Analyzes feedback from the environment and improves knowledge action.
2) Performance elements make decision & execution
3) Critic: Evaluates agents action & provides feedback.
5) Problem generator: Suggest, exploratory actions to improve learning.

Working Process

- The performance elements selects an action, the critic evaluates action & provides, feedback, learning element updates agents knowledge, Problem generator suggests new strategies to explore better solutions.

Q.10) Find route from S to G using BFS



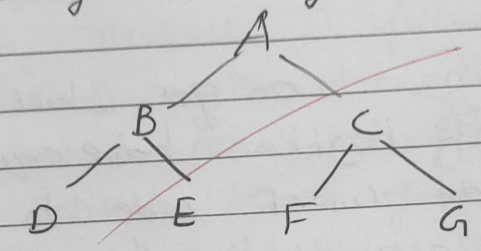
Current node	Queue	Visited Node
S	A B C	S
A	B C D G	S A
B	C D G	S A B
C	D G	S A B C
D	G	S A B C D
G		S A B C D G.

11) What do you mean by depth limited search? Explain IDS with examples.

→ DLS is an uninformed search algorithm that modifies DFS by using depth limit L preventing exploration beyond defined level. This prevents infinite loops in graphs but risks missing goals beyond L.

Iteration deepening search combines DLS with BFS by incrementally increasing the depth limit.

Example



Goal = G

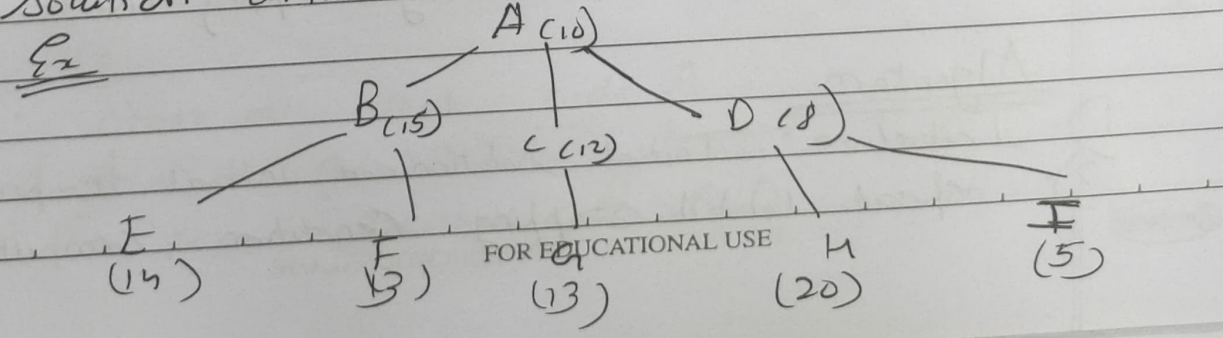
Initial D.L = 0.

limit	Node visited	Goal
0	A	Not found
1	A, B, C	Not found.
2	A B C D E F G	found G.

12) Explain hill climbing and its drawback in detail, with example. Also state limitations of steep ascent climbing.

→ Hill climbing is local search optimization problem which moves forward near better neighbors solution until it reaches a peak.

Ex



Goal = G

Steps

1) Start at root node A (10).
2) Compare children B, C, D.
3) Move to child with highest value.
4) Repeat for B's children E and F.

If new terminate at E (14).

The Algo stops at E (14) not reaching at goal G.

Drawbacks

- Local maxima : can get stuck in local maxima
- Plateau : If neighbors have equal values, cant decide which side to move.
- Ridges : Narrow uphill paths require backtracking that hill climbing does not approaches

Limitation of steepest ascent hill climbing are as follows

- Computationally expensive.
- can get stuck
- No global optimum.

13) Explain simulated annealing and write its algorithm

→ It is a probabilistic optimization algorithm inspired by metallurgical process of annealing where materials are heated & cooled to reduce defe Escapes local optima by accepting worse solutions

Algorithm

1) · Initialize : Initial solution and initial temperature T.
2) · Repeat until stopping condition, compute. Chan

If new solution better than previous then accept it.
- If worse accept with some probability.
- decrease temperature T.
- Return best solution.

Ex travelling salesman problem.

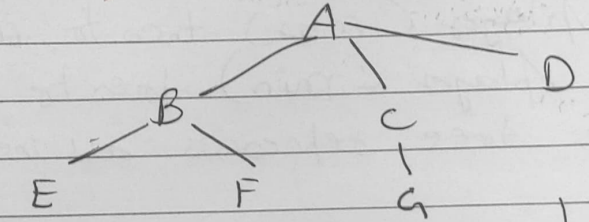
14) Explain A* algorithm with an example.

→ A* is informed search algo used in g. Path finding and graph traversal. It follows the formula.

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

g(n): cost to reach n, from start
h(n): cost to reach goal from node
f(n): total estimated cost.

Goal = G



Node	g(A, n)	h(n, G)
A	0	6
B	1	4
C	2	2
D	3	7
E	4	5
F	5	3
G	6	0

Steps

- Start at root node A.
- f(n) = g(n) + h(n) = 0 + 6 = 6.
- Explored neighbours B, C, D.

f(B) = 5 f(E) = 4 ; f(D) = 11

- Choose lowest value that is f(E).
- expand neighbors of E.
- f(g) = 2+4+0 = 6
- Goal reached at G with total wt = 6.

Advantages

- efficient for finding shortest path in a weighted graph.
- optimal & complete.

15) Explain min-max Algo & draw game tree for Tic tac Toe game.

→ It is a decision making algorithm used in 2 player games. It assumes,

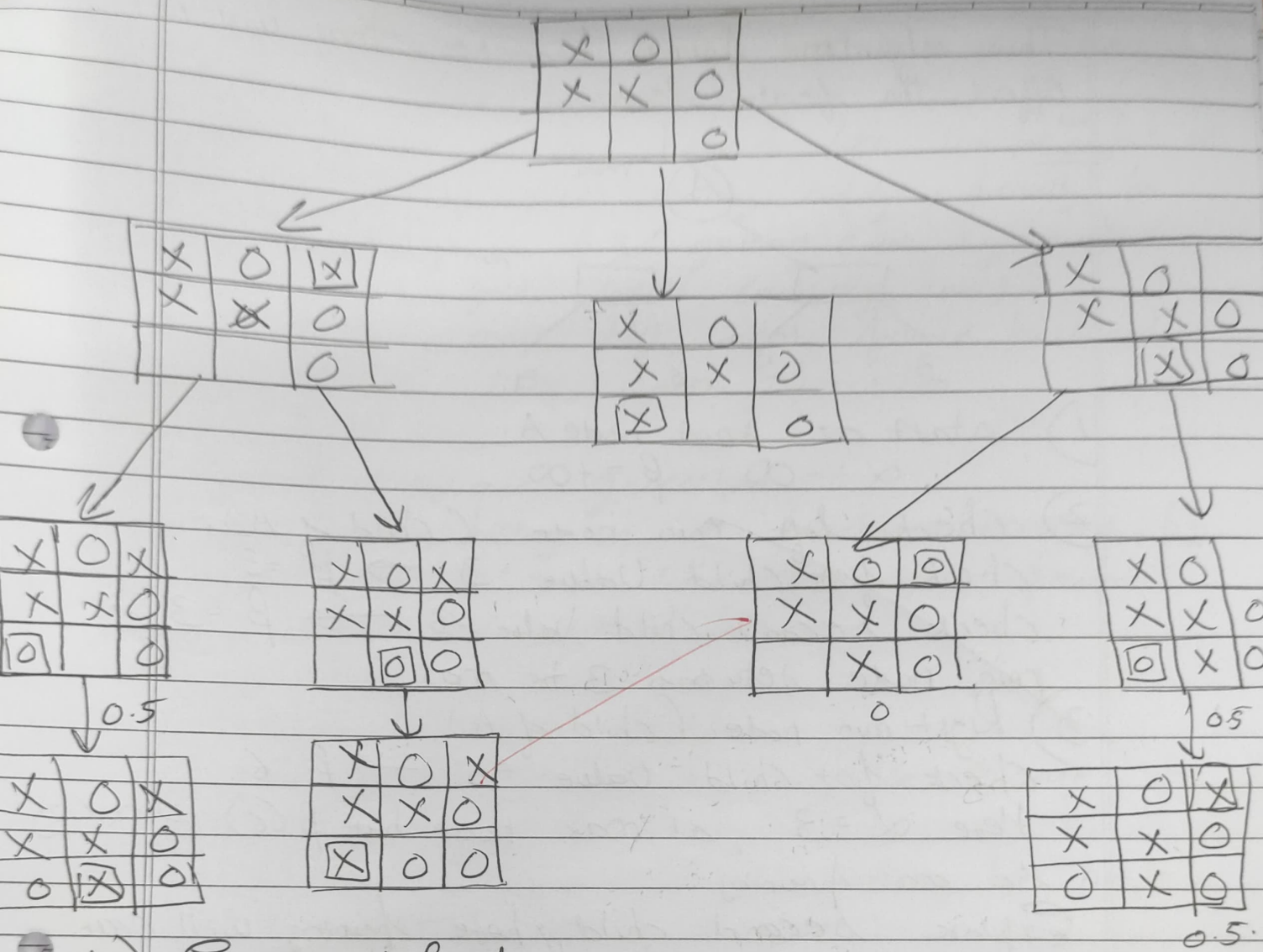
- One player (max) tries to maximize the score.
- other player (min) tries to minimize the sco
- game tree represents all the possible move

Algorithm

1) Generate a game tree
2) assign scores
3) MAX picks highest value from the children, min picks the lowest value.
4) Repeat until root node is evaluated.

The game tree for tic-tac-toe is as follow.

P.T.O



16) Explain α-β pruning algorithm for adversial search with help of an example.

→ It is an optimization technique used in minimax algorithm to reduce the no. of nodes evaluated in adversial search problems like game-Playing AI etc.

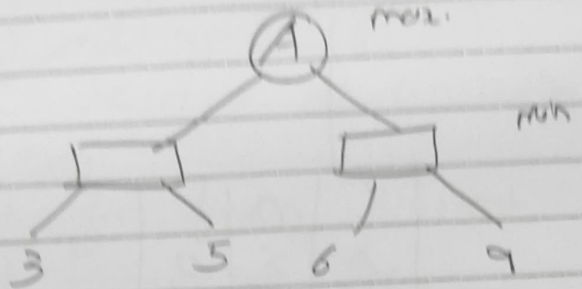
α-β pruning includes

α : The Best maximum score that the demanding player can get so far.

β : The best minimum score that the opposing player can guarantee so far.

This algorithm prunes branches that will not effect the final decision.

Ex



1) start at root node A.
$\alpha = -\infty$, $\beta = +\infty$
2) Check left min node (child of A).
check first child value = 3 → $\beta = 3$.
check second child value = 5 → $\beta = 3$
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 on pruning.
Explore second child, here pruning will occur. min node already has a value ≤ 6, which will never choose 9, and so prune 9.
4) max value = 6.

17) Explain WUMPUS world environment, Give its PEAS description, explain new percept sequence if generated.

→ The wumpus world environment is a simple grid based environment used AI study to find intelligent behaviours.

in uncertain environment, it is a turn based environment where agent (hero) must navigate & cave to find gold while avoiding hazards like wumpus, pits etc.

P: grabbing gold, exiting safely, penalty for falling in pits, getting eaten by wumpus.

E: 4x4 grid world containing wumpus

A: can move left, right, forward, backward,

S: eyes, ears, depth perception

Percept sequence generation

It is the history of all perceptions received by the agent at each time the agent perceives info based on current location.

Ex

1) Agent starts at (1,1)
   - No breeze, No stench, no glitter → safe
2) Agent moves to (2,1)
   Breeze detected, A pit is nearby but not in current square.
3) Agent moves to (1,2)
   Stench detected - WUMPUS is in adjacent cell.
4) Agent moves to (2,2)
   Glitter detected, gold is here.
5) Agent moves back to (1,1) and climbs out.

18) Solve the crypto arithmetic.

1. SEND + MORE = MONEY

→ Step 1 M have be 1, Sum of two 4 digit Num can't be more than 10000.

```
  SEND
+ MORE
-------
 MONEY
```

Step 2 : Now S must be 8 because there is 1 carry over from column E-O-N. O must be 0 (if S=8) and there is a 1 carried or S=9 and there is no 1 carried. If 1 is already taken so O must be 0.

```
  SEND
+ 1ORE
-------
 1ONEY
```

Step 3

There cannot be a carry from column EON because digits + 0 < 10, unless there is a carry from the column NRE column and E=G.

So E < G, there is no carry from this column, S=9 bcs, G+1 = 10

Step 4

Case 1 : No carry : N+R = 10+(N-1) = N+9

R=9

But 9 is already taken

Case 2 : Carry : N+R+1 = 9

R = 9-1 = 8 = R.

Step 5

Let us consider E = 5, or 6

E = 5

Then D = 7, y = 3. This form will work but look at column N&E. There is a ~~Column~~ Carry from the column DEy. N+8+1 = 16

Then N = 7, 7 is taken therefore E = 5.

```
  9 5 N D
    1 0 8 5
  ---------
  1 0 N 5 y
```

Now

N+8+1 = 15, N = 6

```
  9 5 6 D
    1 0 8 5
  ---------
  1 0 6 5 y
```

Step 6

The digits left are 7, 4, 3 & 2. We know there is carry from D3y so only pair that works

D = 7 & y = 2

```
  9 5 6 7
    1 0 8 5
  ---------
  1 0 6 5 2
```

19) Consider the following axioms

All the people who are graduating are happy.

All people are smiling.

Someone is graduating.

→ Represent Axioms in FO predicate logic.

G(x) ⇒ x is graduating.

H(x) is a is happy.

1. Collect clauses
(1) { ¬ G(x), H(x) }
(2) { ¬ h(x) S(x) }.
(3) { G(c) }'

2. Apply resolution.
Resolve (1) { ¬G(x), H(x) } with (3) & G(x).
Substituting x = a
(1) { ¬G(a), H(a) }.
∴ we have h(a) resolving gives.
{ H(a) }
Resolve (2) { ¬ H(a), S(a) }.
Since we derived S(a), we conclude that someone (a) is smiling.

20) Explain modus Ponen with suitable example.
Ans Modus Ponen is a fundamental rule of inference in propositional logic that allows us to deduce a conclusion from conditional statement.
It follows a form
1: P → q (if P then Q)
2: P (P is true).
∴ Q (Q must be true)

Ex
1) If it ~~rains~~ raining the ground will be wet
→ P → Q.
2) It is raining → P
Ground is wet → Q.

21) Explain forward & backward chaining with help of 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 conclusion.

Example: Diagnosing a disease.

Rule

1) If a person has a fever and cough, they might have flu.
2) If a person has sore throat and fever, they might have cold.

facts

- The patient has fever
- The patient has cough.

Inference

1. Fever + cough → flu (rule 1 applies)
2. Conclusion: The patient might have flu.

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

Example: ~~Diagnosing~~ Diagnosing a disease.

Goal: Determine if a patient has flu.

Rules

1) (Fever ∧ cough) → flu
2) (Sore throat ∧ fever) → cold

Process using backward chaining.

1) We want to prove flu.
2) looking at Rule 1 : (fever ∧ cough) → flu, w
   need to check if patient has cough and fev
3) We check our known facts
   - Patients has fever
   - Patient has cough.
4) Since, both conditions are met, we confirm,
   flu is true.