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DISC - 56

05/05

AIDS Assignment

Q1] What is AI? Considering the covid-19 pandemic situation, how did AI help to survive and renovate our way of life with different application?

- AI is the replication of human intelligence in machines, enabling them to learn, reason, solve problems and make decisions without direct human intervention.
- AI played a vital role in managing the covid 19 crisis by detecting outbreaks early through data analysis, accelerating drug and vaccine development, automating medical diagnoses with imaging and predictive models, supporting telemedecine and enhancing remote work and online education through AI driven automation

Q2] What are AI agents ~~terminology~~? Explain with examples.

- AI agents are systems that perciere their environment, process information and take actions to achieve specific goals.

1) Agent - An entity that interacts with the environment
2) Environment - The external system where agent operates
3) Perception - Data collected from sensors
4) Actuators - Components that execute actions
5) Rationality - The ability to make optimal decisions
6) Autonomy - The degree of independence an agent has

- Types of Agents: simple reflex, model-based, goal-based, utility-based and learning agents.

Q3] How is the AI technique used to solve the 8 puzzle proble...?

- The 8 puzzle problem is solved using AI search techniques

1) Uninformed search :
- BFS (Breadth first search) : explores all possible moves level by level but is inefficient for large problems.
- DFS (Depth First search) : explores one path deeply before backtracking but may get stuck in loops.

2) Informed search (Heuristic Based) :
- Best-First search (greedy algorithm) : selects moves based on heuristic values like misplaced tiles.
- A* Algorithm : uses the heuristic function $f(n) = g(n) + h(n)$ where $g(n)$ is cost to reach current state and $h(n)$ is the estimated cost to the goal.

Q4] What is PEAS descriptor ?
- PEAS is a framework with Performance measure, Environment, Actuators, Sensors that is used to define the components of an AI agents by specifying how it interacts w/ environt.

o Taxi Driver
- P : Safety, speed, customer satisfaction, fuel efficiency
- E : Roads, traffic, pedestrians, weather conditions
- A : Steering, acceleration, brakes, turn signals
- S : GPS, cameras, speedometer, LiDAR, fuel garage.

2) Medical Diagnosis system

- P - Accuracy of diagnosis, recovery rate, response time
- E - Patient Data, Medical records, Symptoms, lab reports
- A - Display diagnosis, prescribe medication, test recommendation
- S - Patient input, test results, doctor's notes.

3) A music composer

- P - musical quality, originality, pitch, tune
- E - Genres, preferences, historical compositions
- A - generating notes, melodies, instrument selection
- S - user feedback, music database, emotional tone

4) An aircraft Autolander

- P - Safe landing, smooth touchdown, comfort
- E - weather conditions, runway, airtraffic, altitude
- A - Flaps, landing gear, brakes, engine thrust control.
- S - Altimeter, GPS, wind speed sensors, radar, cameras

5) An essay evaluator

- P - Grammar accuracy, coherence, relevance
- E - Essays, writing rules, predefined grading criteria
- A - Store assignment, grammar suggestions, feedback
- S - Text input, grammar, plagiarism check, semantic.

6) Robotic sentry gun for KCLK lab.

- P - Accuracy, target identification, security, effectiveness
- E - Lab perimeter, threats, lighting
- A - Rotating turret, firing mechanism, alarm system
- S - Motion detectors, infrared sensors, camera, radar.

Q5] Categorizing a shopping bot for an offline bookstore

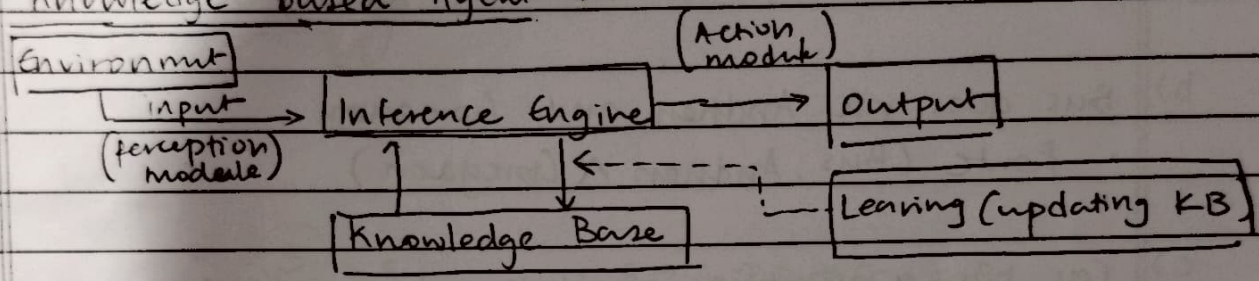
1. Observability :- Partially observable - the bot may not have full knowledge of customer's preferences making its knowledge incomplete.
2. Stochastic :- Book availability, customer behaviour and price changes introduces randomness, making it unpredictable
3. Sequential :- Each decision affects future interactions
4. Dynamic - The environment can change as customers go in and out, stock and price changes
5. Discrete - discrete choices such as recommending a book or checking stock or processing a purchase.
6. Multi-Agent - The bookstore staff, customers, stock and other AI systems make it a multi-agent system

Q6] Differentiate Model vs Utility based Agent-

Model based Agent	Utility based Agent
◦ uses an internal model of the environment to make decisions	◦ chooses actions based on maximizing a utility function
◦ predicts future states using the model before acting	◦ evaluates multiple possible actions & selects best based on utility
◦ Focuses on how the environment works	◦ Aims to achieve the best possible outcome.
◦ May not always take the best possible action, only feasible one	◦ Always selects the action with the highest benefit
◦ A self driving car using a traffic model to predict congestion	◦ A stock trading AI selecting the trade with the highest expected profit.

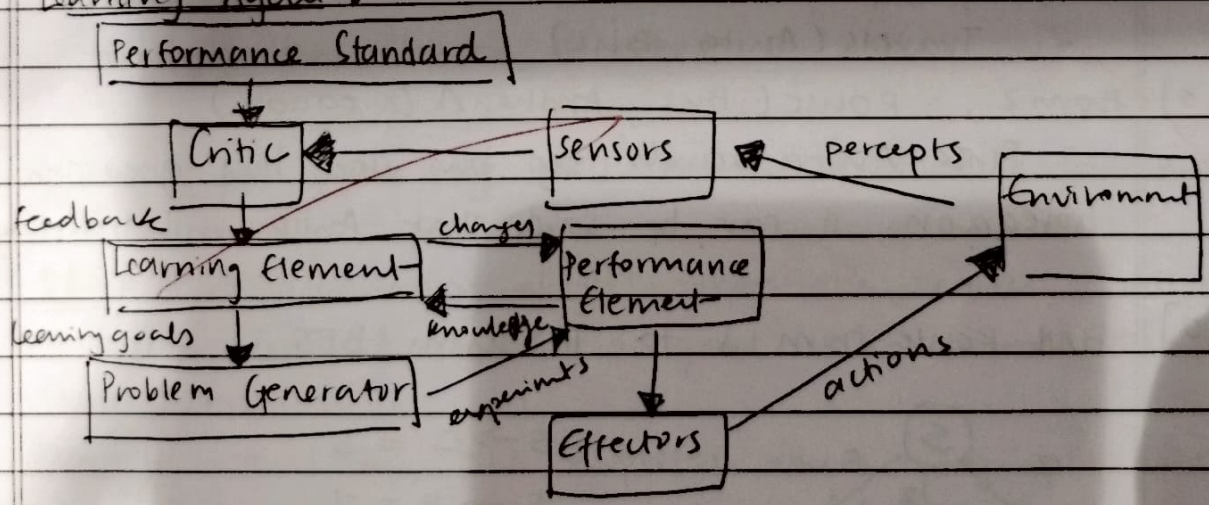
Q7) Explain the architecture of a knowledge based agent and learning agent.

→ Knowledge Based Agent:



- KB: stores facts, rules and background knowledge structured
- Inference Engine: Applies logical reasoning to drive conclusions
- Perception module: gather inputs from sensors
- Action module: Execute actions based on drived conclusions
- Learning module: updates KB with new information.

→ Learning Agent:



- Learning element: learns from interaction & updates knowledge
- Performance element: uses the learned knowledge
- Critic: Evaluates agents performance
- Problem generator: Suggests new exploratory actions.

Q9] Convert the following to predicates:

a] Anita travels by car if available, otherwise by bus.

- Available (car) ⇒ Travels (Anita, car)
- ¬Available (car) ⇒ Travels (Anita, Bus)

b) Bus goes via Andheri and Goregaon

- Route (Bus, Andheri ∧ Goregaon)

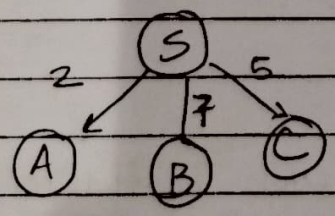
c) Car has a puncture, so it is not available

- Puncture (car) ⇒ ¬ Available (car)
- Given : Puncture (car)
- Therefore, ¬ Available (car)

Forward reasoning:

1) From 3, ¬ Availble (car)
2) From 1, ¬ Available (car) ⇒ Travels (Anita, Bus)
   ∴ Travels (Anita, Bus)
3) From 2, Route (Bus, Andheri ∧ Goregaon)
   ∴ Since Anita travels by bus and bus goes through Goregaon, it can be said that Anita will travel by Goregaon

Q10] Find Route from S to G using BFS:

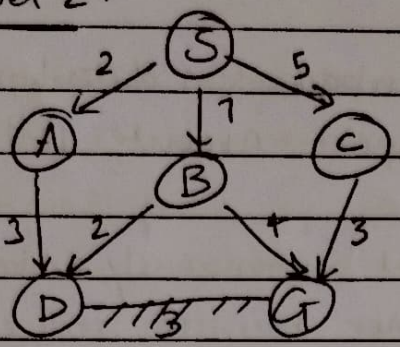


S → C = 5

S → B = 7

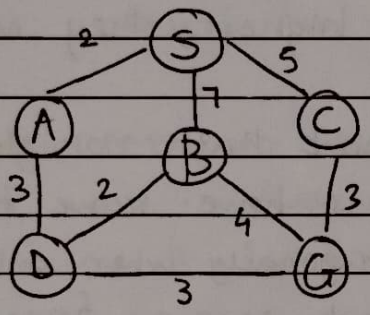
S → A = 2

Level 2:



S → A → D = 5
S → B → D = 9
S → B → G = 11
S → C → G = 8

Level 3:



S → A → D → G = 8
S → B → D → G = 9
S → B → G = 11
S → C → G = 8

So the minimum cost is through S → A → D → G and by S → C → G which is 8 units. Since they have the equal cost, we can choose S → C → G since it has lesser number of nodes.

Q11] What do you mean by DFS? Explain iterative DS with example.

→ **DLS**: It is a variation of DFS where the search is restricted to a specific depth limit. If a goal is not found, the search terminates.

Example: If L=2, DLS explores nodes only upto depth 2.

→ **IDS**: It is the combination of DFS and BFS by running DLS with increasing depth limits (L=0, 1, 2 ...) until goal is found.

Example: DLS with L=2, expands S to A, B, C, and then to D and G until goal is found at depth 2.

Q12] Explain hill climbing and its drawbacks in detail with example and state limitations of steepest-ascent hill climbing.

- It is a local search algorithm that continuously moves toward the best neighbouring state with a higher heuristic value.
- Example: imagine a mountain climbing scenario where a hiker moves uphill based on the steepest slope, if they reach a peak that is not the highest, they may get stuck.
- Drawbacks:
  - the algorithm may stop at a peak that is not global optimum.
  - flat region where all neighbours have same heuristic value.
  - algorithm may fail to climb diagonally when only direct moves.
  - Once it moves forward, it cannot recover from a bad decision.
- limitations of steepest Ascent hill climbing:
  - If algorithm has to do small incremental changes, it gets stuck midway.
  - choosing only the steepest path can cause premature convergence.
  - Evaluating all neighbours increases computation time.

Q13] Explain stimulate annealing and write its algorithm.

- It is a probabilistic optimization algorithm inspired by the annealing process in metallurgy. It helps in finding global optimum.

Algorithm:

- initialize current state and temperature T.
- select a random neighbour state, compute energy differences
- if $\Delta E \leq 0$, move to the new state
- Else accept it with probability $e^{-\Delta E/T}$ and reduce T
- Return the best solution.

Q14] Explain A* algorithm with an example.

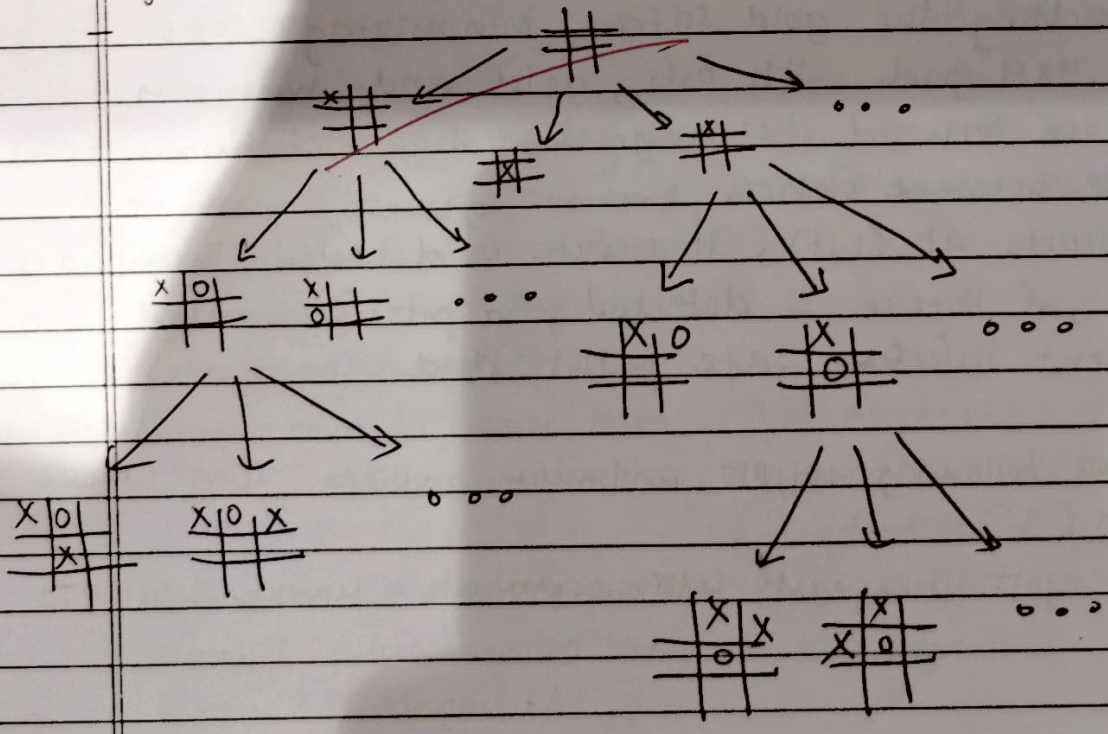
– This is an informed search algorithm that finds the optimal path by considering both the cost to reach g(n) and the estimated cost to goal h(n) : f(n) = g(n) + h(n)

Example: In a graph search problem, if S starts and G is the goal, A* expands nodes based on the lowest f(n) value. Used in video games, maps, maze solver.

Q15] Explain minmax Algorithm and draw game tree for Tic Tac Toe.

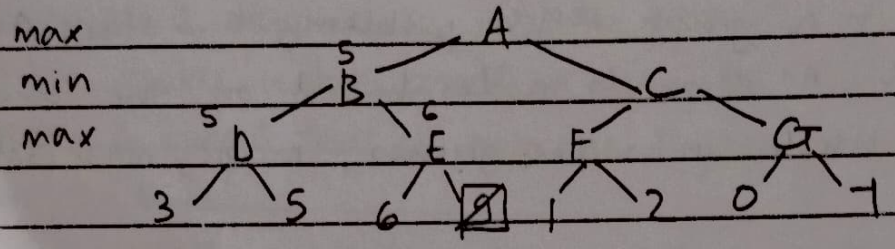
– It is used in adversarial search (eg 2 player games) to determine the optimal move by assuming both players play optimally.

– Maximizer tries to get highest score and minimizer tries to get the lowest.



Q16] Explain α-β pruning algorithm for adversarial search w/ example.

- α-β pruning optimizes minimax by skipping unnecessary branches, reducing computations. α is the best score maximizer can achieve and β is the best score minimizer can achieve.



Q17] Explain WUMPUS World Environment giving its PEAS description. Explain how percept sequence is generated?

- The WUMPUS world is a grid based AI environment where an agent explores a cave while avoiding hazards like pits.
- PEAS descriptor:
  - P - reaching the gold safely, minimizing steps
  - E - A 4x4 grid with pits, gold and wumpus
  - A - Move forward, turn, grab, shoot, climb
  - S - perceive stench, breeze, glitter.
- Agent starts at (1,1), if stench is detected, wumpus is nearby, if breeze is detected, a pit is nearby
- The agent infers safe paths and navigates to gold

Q18] Solve the following cryptoarithmetic problem: SEND + MORE = MONEY

- In the cryptarithm, each letter represents a unique digit 0-9

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

let M=1 and O=0

$\therefore S+1 = 10 \rightarrow S=9$

```
  SEND
+ 10RE
------
 10NEY
```

let R=7 and E=5

$\therefore Y = 2$

```
  9 5 N 7
+ 1 0 7 5
---------
 1 0 N 5 2
```

$\therefore$

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

N=6, E=5

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

Q9] Consider the following axioms:

1) Represent these axioms in first Order Predicate Logic:

$\forall x$ (Graduating(x) $\rightarrow$ Happy(x))

$\forall x$ (Happy(x) $\rightarrow$ Smiling(x))

$\exists x$ (Graduating(x))

2) Convert each to clause form: $\neg$Graduating(x) $\vee$ Happy(x)

$\neg$Happy(x) $\vee$ Smiling(x)

Graduating(A)

3) Prove that "is someone smiling"

from 3: Graduating(A)

from 1: Happy(A)

from 2: Smiling(A)

Q20) Explain Modus Ponens with a suitable example.

- Modus Ponens (law of detachment) is a rule of inference stating : $P \rightarrow Q$, $P \Rightarrow Q$
- Example :

1) If it rains, the ground gets wet (Rain → WetGround)
2) It is raining
3) conclusion : The ground is wet (Applying modus ponens)

Q21] Explain forward chaining and backward chaining algorithm.

→ Forward chaining is data driven inference that starts from known facts and applies rules to reach a goal. It is used in expert system

- Example - Fact : "sore throat"

Rule : "If sore throat → infection"
New fact : "Infection"
Rule : "If infection → need antibiotics", conclusion: "need antibiotics"

→ Backward chaining are goal driven inferences where you start from the goal and works backward to find supporting facts that is used in AI reasoning & theorem proving.

- Example - Goal : Does the patient need antibiotics?

1) check - does the patient have an infection?
2) check - does the patient have a sore throat?
3) If both hold, conclude "need antibiotics"

This reduces unnecessary computations by only exploring relevant facts.