Name : Dev Gaonkar Div : D15C Roll no : 12

05/05

Assignment - 1

Q1> What is AI? Considering the COVID-19 pandemic situation, how AI helped to survive and renovated our way of life with different application?

Ans. Artificial Intelligence (AI) enables machines to ~~thik~~ think, learn and make decisions like humans. It includes technologies like machine learning, NLP and robotics.

Applications :

1) Healthcare : AI helped in early diagnosis vaccine development, and chatbot-based health assistance.
2) Contact Tracing : AI-powered apps tracked COVID-19 exposure ensuring public safety.
3) Remote work and Eduction : AI enhanced virtual meetings, online learning and productivity tools.
4) Supply chain and Delivery : AI optimized logistics and enabled autonomous deliveries.
5) Mental Health Support : AI driven apps provided emotional and fitness assistance.

Q2> What are AI Agents terminology, explain with examples.

Ans. 1) Agent : An entity that interacts with the enviroment and makes decision based on inputs.

ex. : A self-driving car perceives traffic signals and adjusts speed accordingly.

2) Performance measures : Defines how successful an agent is in achieving its goal.

ex. A self-driving cars performance measures could be minimizing accidents, fuel efficiency and travel time.

3) Behavior / Action of Agent : The action an agent takes based on its ~~pr~~ percepts.

ex. A robotic vaccum cleaner moves around obstacles after deleting them.

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

5) Percept sequence : The entire history of percepts received by an agent. ex.: A chess playing AI remembers all previous moves in the game before making it's next move.

6) Agent Function : A mapping from the preercept sequence to an action. ex. A smart thermostat analyzes past tempreture changes and adjusts heating accordingly.

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

Ans. It consists of a 3×3 grid with 8 numbered tiles and one empty space, where the objective is to move the tiles around to match a predefines 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.

Goal state : The goal is to arrange the tiles in a specific order with the blank space at the bottom righ.

Goal State,

1	2	3
4	5	6
7	8	

★ Solving the 8 Puzzle problem

• AI search algorithms, such as breadth-first search (BFS), depth-first search (DFS) and A*, are commonly used:

1) Breadth First Search (BFS):

• BFS is 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 solution.

Disadvantages:

BFS has a high memory requirement, as it must store all the states at each level of exploration.

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 can get stuck in deep, non-optimal paths and may not find the shortest solution.

Steps using A*:

• Compute Manhattan distance for each possible move.

• Choose the best move (lowest F(n))

• Repeat until reaching the goal state.

FOR EDUCATIONAL USE

Q.4> What is PEAS descriptor ? Give PEAS descriptor for following.

1) Taxi driver :
- P : Minimize travel time, fuel efficiency, passenger safety, obey traffic rules.
- E : Roads, traffic, passengers, weather, obstacles, pedestriams
- A : Steering, accelerator, brakes, turn signals, horn.
- S : Camera, GPS, Speedometer, radar, liDAR, microphone.

2) 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, notifications.
- S : Patient input, lab reports, electronic health records.

3) A music composer :
- P : Quality of music, adherence to genre, audience engagement.
- E : Digital workspace, music production software, real time composition settings.
- A : Audio output, digital instrument selection, File saving / export
- S : User inputs, style preferences, tempo, feedback from listners, music theory contraints.

4) An aircraft autolander :

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

5) An ess...
P : Accura...
E : Digit...
Feed...

5) An essay Evaluator.
P: Accuracy of grading, consistency, fairness, grammer
E: Digital text input, student essays, predefined grading criteria
A: Feedback generation, score assignment, highligthing errors, suggesting improvement.
S: Optical character recognition, NLP, grammer and spell checkers.

6) A robotic sentory gun for the Keck lab.
P: Target accuracy, threat detection efficiency, response speed.
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.

Q5) Categorize a shopping bot for an offline bookstore according to each of six dimension (fully / partially observable, deterministic / stochastic episodic / sequential, static / dynamic, discrete / continuous, single / multiagent)

Ans. 1) Partially Observable : The bot may not have complete visibility.
2) Stochastic : The environment is ~~up~~ unpredictable.
3) Sequential : Each decision bot makes affects future states.
4) Dynamic : The bookstore environment changes over time.
5) Discrete : Bot ~~chases~~ choose discrete choices (selecting books)
6) Multiagent : The bot interacts with multiple entities.

Q6> Differentiate model based and utility based agent.

Ans.

	Model based agent	Utility based agent
1.	Uses an internal model of environment to make decisions.	Chooses actions based on utility ~~based~~ function that measures performance.
2.	Decisions are based on past and present percepts	~~St~~ Selects action based on minimizing utility.
3.	Can be goal based but doesn't necessarily optimize for best outcomes.	Is goal based and searches for the most optimal solution.
4.	Example: Robot vacuum using a map to navigate	Example: Self driving car.

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

Ans. Architecture of Knowledge based agent:

It uses stored knowledge to make decisions and consists of the following:

- Knowledge base → Stores facts, rules and logic.
- Inference engine → Uses reasoning to derive conclusions.
- Perception (Sensors) → Gather new information from environment.
- Action mechanism → Performs appropriate actions based on reasoning.

Architecture of Learning agent:

This agent improves performance over time and consists of the following:

- Learning element → Updates knowledge based on experience.
- Performance element → decides actions based on current knowledge.
- Critic → Provides feedback by evaluating actions.
- Problem generator → Suggests new action to improve learning.

Q9) Convert the following to Predicates.

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

→ CarAvailable → TravelsByCar(Anita)

¬CarAvailable → TravelsByBus (Anita)

b. Bus goes via Andheri and Goregaon.

→ goesvia(Bus, Anderi) ∧ goesvia(Bus, Goregaon)

c. Car has puncture so is not available.

Puncture (Car)

Puncture(Car) → ¬Car Available.

Will Anita travel via Goregaon? Use forward reasoning.

From (c)

Puncture (car) is true

As Puncture (car) → ¬ CarAvailable

From (a)

¬ CarAvailable, we use ¬ CarAvailable → Travels By Bus (Anita)

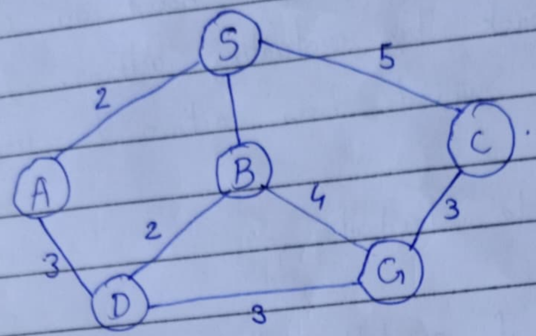
From (b)

Goes via (Bus, Goregaon)

~~An~~ Anita travels by bus she will follow this route.

Thus, Anita will travel via goregaon.

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



Ans. 1. Start at S
Queue = [S]
2. Dequeue S and explore its neighboring nodes.
Queue = [A, B, C]
3. Dequeeu A and explore neighbours.
Queue = [B, C, D]
4. Dequeue B and explore neighbours
Queue = [C, D, G]
5. Dequeue C and explore neighbours.
Queue = [D, G]
6. Dequeue D
Queue = [G]
7. Dequeue G

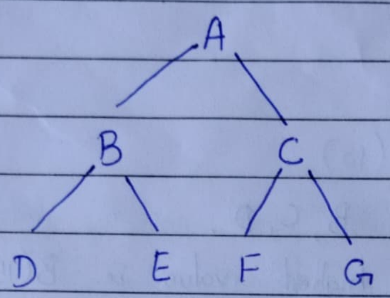
∴ G is our destination node, BFS will stop here.
Route from S to G : S → B → G.

Q11> What do you mean by depth limited search? Explain Iterative Deepening search with example.

Ans. Depth Limited Search (DLS) is an uninformed search algorithm that modifies DFS by introducing a depth limit L, preventing information ~~by~~ beyond the defined level. This prevents infinite loops in graphs but risks missing goals beyond L.

Iterative Deepening Search (IDS) ~~contain~~ ~~cobr~~ combines DLS with BFS by incrementally increasing the depth limit.

Example :



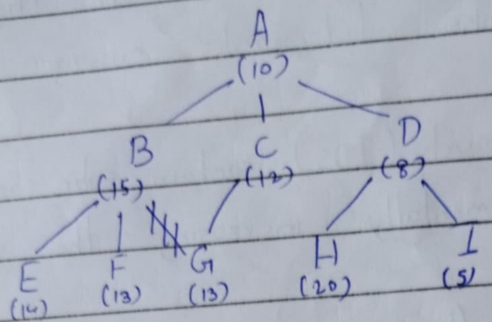
Goal = G

- Initially the depth limit is 0 for iteration 1.
  Nodes visited = A
  Goal not found
- Iteration 2, Limit = 1
  Nodes visited = A → B → C
  Goal not found
- Iteration 3, limit = 2
  Nodes visited = A → B → D → E → C → F → G
  Goal G is found.

Q12) Explain Hill Climbing and its drawbacks in detail with example. Also state limitations of steepest ascent hill climbing.

Ans. Hill Climbing is a local search optimization algorithm which moves forwards towards a better neighbouring solution until it reaches a peak.

Example :



Goal = G

Steps :

1. Start at root node A (10).
2. Compare its children B, C, D.
3. Move to child with highest value i.e. B(15)
4. Repeat for B's children E and F.
5. Terminate at E(14)

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

Drawbacks :

1. Local Maxima - The algorithm greedily selects the best immediate child and can thus get stuck on local maxima.
2. Plateau - If siblings have equal values, the algorithm can't decide the next step and gets stuck.
3. Ridges - Narrow uphill paths require backtracking which hill climbing algorithm does not support.

Limitations of steepest ascent hill ~~ch~~ climbing :

1. Computationally expensive : Evaluates all neighbours before selecting the best.
2. Can get stuck : It can still get stuck in local maxima, plateaus or ridges.
3. No global optimality : It only focuses on immediate improvements.

Q 13> Explain simulated annealing and write its algorithm.

Ans. Simulated annealing is a probabilistic optimization algorithm inspired by metallurgical process of annealing where materials are heated and cooled to reduce defects. It escapes the local optima by temporarily accepting worse solution with a probability.

Algorithm :

1. Initialize.
- Set an initial solution and define an initial temperature T.

2. Repeat until 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 its temperature T.

3. Return best solution.

Example : Travelling salesman problem.

Q.14> Explain A^* algorithm with an example.

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

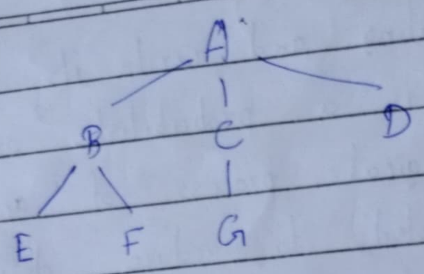
$f(n) = g(n) + h(n)$

$g(n) \rightarrow$ 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.

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 neighbours B, C, D

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

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

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

3. Choose lowest value that is $f(C)$.
4. Expand neighbours of C.

$f(G) = 2 + 4 + 0 = 6$

5. Goal reached at G with total cost 6.

Advantages:

- efficient for finding shortest path in weighted graphs.
- Balances exploration by considering both $g(n)$ and $h(n)$.

Q15> Explain MinMax algorithm and draw game tree for Tic Tac Toe game.

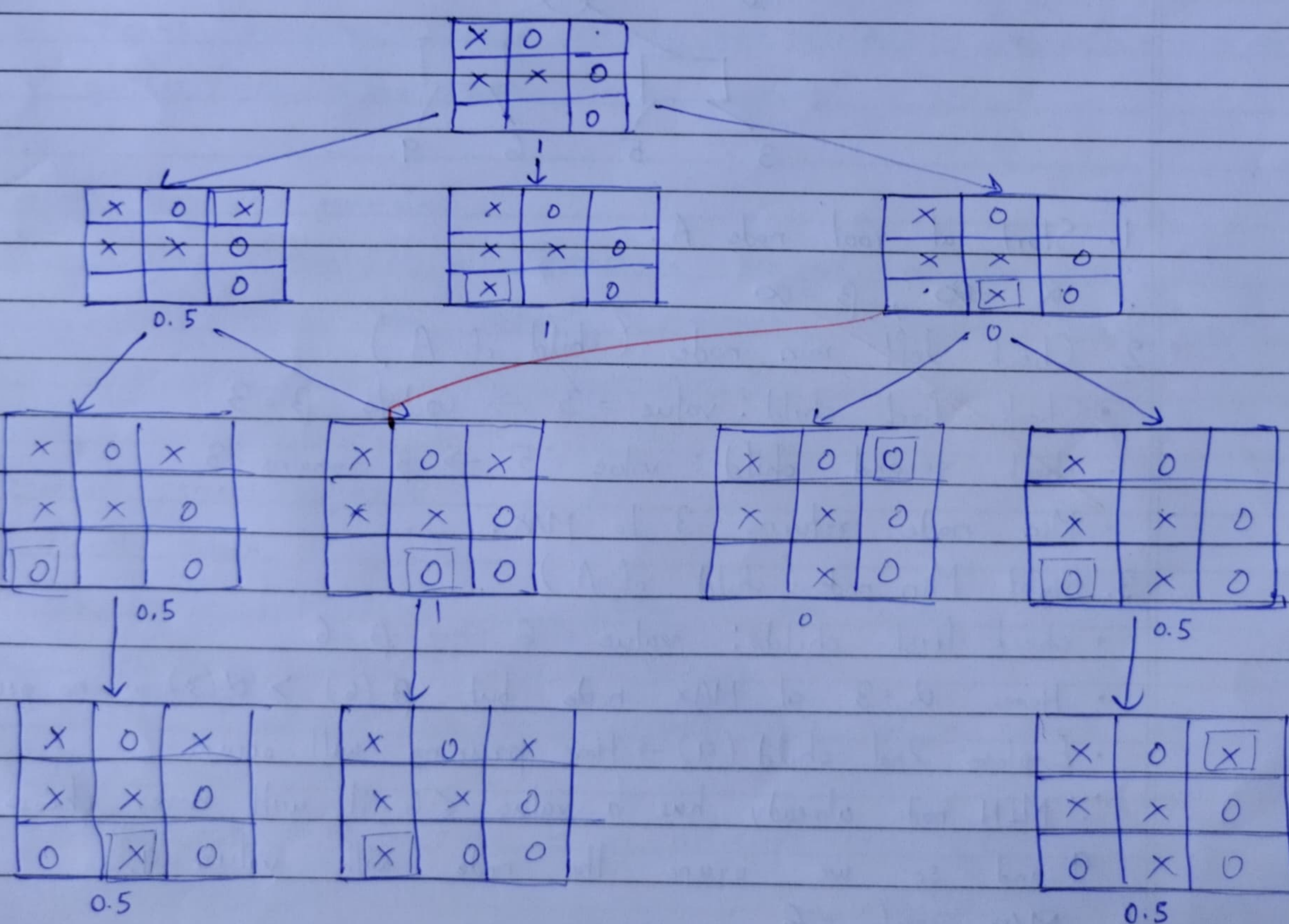
Ans. The min-max algorithm is a decision making algorithm used in 2 player games. It assumes:

- One player (MAX) tries to maximize the score.
- Other player (MIN) tries to minimize the score.
- Game tree represents all possible moves.

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.

Game tree for tic tac toe game:



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

Ans. Alpha beta pruning is an optimization technique used in minimax algorithm to reduce the number of nodes evaluated in adversial search problems like game-playing ~~(AI)~~ AI (eg chess, tic-tac-toe).

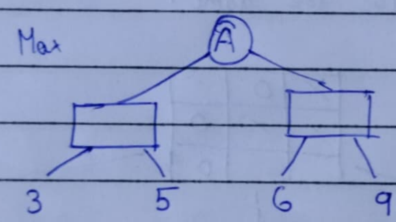
Alpha beta pruning including :

Alpha (α) : The ~~Too~~ best ~~minimum~~ maximum score that the maximising player can ~~go~~ guorontee so far.

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

The algorithm prunes branches that will not influence final decision.

Example :



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 will occur.

   ∵ MIN node already has a value ≤ 6, it will never choose 9 and so we prune the node with value 9.
4. MAX value = 6

Q17) Explain WUMPUS world environment giving its PEAS description. Explain new percept sequence is generated.

Ans. The WUMPUS world environment is a simple grid-based enviroment used in AI to study intelligent agent behaviour in uncertain environments. It is a turn based environment where an agent must navigate to find gold while avoiding hazards like pits and a monster called ~~ty~~ WUMPUS.

PEAS :

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

E : 4x4 grid world containing the agent, WUMPUS, pits, gold.

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

S : Agent perceives ~~stend~~ 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 perceives information based on its current location and surroundings.

Example percept sequence :

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

Q18) Solve the following Crypto-arithmetic problem :

SEND + MORE = MONEY.

Ans. Step 1:

M must be 1. The sum of 2 four digit numbers cannot be more than 10,000.

$$\begin{array}{r} S\ E\ N\ D \\ +\quad 1\ O\ R\ E \\ \hline 1\ O\ N\ E\ Y \end{array}$$

Step 2:

Now the S must be 8 because there is 1 carry over from column EON. O must be 0 (if S=8) and there is a 1 carried or S=9 and there is no 1 carried or (if S = 9 and there is a 1 carried) But 1 is already taken, so O must be 0.

$$\begin{array}{r} S\ E\ N\ D \\ +\quad 1\ 0\ R\ E \\ \hline 1\ 0\ N\ E\ Y \end{array}$$

Step 3:

There cannot be a carry from column EON because any digit + 0 < 10, unless there is a carry from the column NRE and E = 9. But this cannot be the case because then N would be 0 and 0 is already taken. So E < 9 and there is no carry from this colum. Therefore S = 9 because 9 + 1 = 10

Step 4:

case 1:

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

$R = 9$

But 9 is already taken so will not work.

Case 2:

carry : $N + R + 1 = 9$

$R = 9 - 1 = 8$. This must be the solution of R.

Step 5:

Let's consider $E = 5$ or 6

$E = 5$

Then, $D = 7$ and $Y = 3$. So this ~~must be~~ part will work but look at the column N8E. There is a carry from the column D5Y. $N + 8 + 1 = 16$. But then $N = 7$ and 7 is taken by D therefore $E = 5$.

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

Now,

$N + 8 + 1 = 15$, $N = 6$

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

Step 6:

The digits left are 7, 4, 3 and 2. We know there is carry from column D5Y, so ~~not~~ only pair that works is $D = 7$ and $Y = 2$.

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

Q19) Consider the following axioms.

All people ~~who~~ who are graduating are happy.

All happy people are smiling.

Someone is graduating.

Ans. ① Represent these axioms in first order predicate logic.

We define the following predicates:

- $G(x)$: x is graduating.
- $H(x)$: x is happy.
- $S(x)$: x is smiling.

Translating axioms into predicate logic:

1. All people who are graduating are happy.
   $\forall x \, (G(x) \rightarrow H(x))$
2. All happy people are smiling.
   $\forall x \, (H(x) \rightarrow S(x))$
3. Someone is graduating.
   $\exists x \, G(x)$.

② Convert each formula to clause form:

1. $\forall x \, (G(x) \rightarrow H(x))$
   - using implication removal:
     $\forall x \, (\neg G(x) \lor H(x))$
   - In clause form:
     $\{ \neg G(x), H(x) \}$
2. $\forall x \, (H(x) \rightarrow S(x))$
   - using implication removal:
     $\forall x \, (\neg H(x) \lor S(x))$
   - In clause form:
     $\{ \neg H(x), S(x) \}$
3. $\exists x \, G(x)$
   - In clause form: $\{ G(a) \}$

③ Prove "is someone smiling?" using resolution.

1. Collect all clauses.
   (1) $\{ \neg G(a), H(x) \}$
   (2) $\{ \neg H(x), S(x) \}$
   (3) $\{ G(a) \}$

2. Apply resolution.

- Resolve (1) $\{\neg G(x), H(x)\}$ with (3) $\{G(a)\}$:

  Substituting $x = a$,

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

  $\because$ we have $G(a)$, resolving gives $\{H(a)\}$

- Resolve (2) $\{\neg H(x), S(x)\}$ with $\{H(a)\}$:

  Substituting $x = a$:

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

  Since we have $H(a)$ resolving gives : $\{S(a)\}$

Since we have derived $S(a)$ we conclude that someone (a) is smiling.

Q20) 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 a conditional statement and its antecedent.

It ~~at~~ follows the form:

1. $P \rightarrow Q$ (if P then Q)
2. P (P is true)

   Q (Q must be true)

Example :

1. If it rains, the ground will be wet.

   $P \rightarrow Q$

2. It is ~~rea~~ raining $\rightarrow P$

   $\therefore$ Ground is wet $\rightarrow Q$.

Q21) Explain forward chaining and backward chaining algorithm with the help of example.

Ans. **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 forword to reach a conclusion.

Example: Diagnosing a disease.

Rules:

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

Facts:

- The patient has a fever
- The patient has cough.

Inference:

1. Fever + Caugh → flu (rule 1 applies)
2. Conclusion the patient might have flu.

Backword Chaining: It starts with goal and works backwords by chaining what facts are needed to support it. It is a goal driven approach.

Example: Diagnosing a disease.

Goal: Determine if patient has flu.

Rules:

1. $(Fever \land Cough) \rightarrow flu$.
2. $(Sore\ throat \land Fever) \rightarrow Cold$.

Process using backword chaining:

1. We want to prove flu.
2. Looking at rule 1; $(Fever \land Cough) \rightarrow Flu$, we need to check if patient has fever and cough.
3. We check our known facts: • Patient has fever.
   • Patient has cough.
4. Since both conditions are met, we confirm flu is true.