Name : Nayaab Jindani Class & Div.: D15 C Page No.:

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AIDS Assignment 1.

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

→ AI is a technology that enables computers and machines to simulate human learning, comprehension, problem solving, decision making, creativity and autonomy. Devices equipped with AI can understand and respond to human language, learn from new information and can act independently.

AI's help during COVID-19:
Amid the crisis of COVID-19, AI emerged as a critical tool for addressing the pandemic's multifaceted challenges.
1. During the early stages of the pandemic, china implemented AI technologies to manage and mitigate virus spread.
2. AI also enabled contact tracing and diagnostic tools that played key roles in several provinces.
3. Major cities employed AI based thermal imaging and facial recognition at transport hubs to efficiently identify symptomatic individuals and enforce quarantine measures.
4. AI-powered chatbots and virtual assistants became integral in healthcare offering patients remote consultations and medical advice.

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

→ • Performance measure of agent: Determine the success of an agent
• Behaviour / action of agent: It is the action performed

by an agent after any specified sequence of percepts.
- Percept : Agent's perceptual inputs at a specified instance.
- Percept sequence : History of everything that an agent has perceived till date.
- Agent function : Map the percept sequence to action

Example : Vacuum cleaner problem.
- Performance measure :- All rooms are well ~~cleaned~~ cleaned.
- Behaviour :- Left, right, suck and no-op (Doing nothing)
- Percept - Location and status
- Agent function - Mapping (percept sequence, action)

Eg.

Percept sequence	action
[A, clean]	right
[A, Dirty]	suck
[B, clean]	left

3. How AI technique is used to solve 8 puzzle problem.

—> AI techiques are used to solve 8 puzzle problem by applying search algorithms and heuristic functions.

1. Problem representation : The 8 puzzle is represented as a state space where each state is a 3×3 grid configuration.

Initial state :
1 2 3
4 0 6
7 5 8

Goal state :
1 2 3
4 5 6
7 8 0

Steps to solve 8 puzzle problem by A* :
1. Initialize a priority queue.
2. Insert the initial state with $f(n) = g(n) + h(n)$

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3. While queue not empty :
   Remove state with lowest $f(n)$
   If state = goal, return solution
   Generate valid moves (up, down, left, right)
   Compute $g(n)$ and $h(n)$ for new states.
   Insert new states into queue.
4. Repeat ~~up~~ until goal is reached.

4. What is PEAS descriptor ? Give PEAS descriptor for following :

→ PEAS stands for Performance, Environment, Actuators and Sensors.
P → criteria to evaluate agent's success.
E → surroundings / external area where agent operates
A → components that allow agent to take actions
S → components that help agent perceive its environment.

PEAS for following :

1. Taxi driver
   P - Reaching destination, fuel efficiency
   E - Roads, traffic, pedestrians
   A - Steering wheel, brakes, accelerator
   S - Camera, GPS, speedometer

2. Medical diagonosis system :
   P - Accuracy of diagnosis, speed of ~~dig~~ diagnosis
   E - Medical records, test results, ~~symptoms~~, hospitals
   A - Recommending treatments, sending alerts to patients and doctors, updating medical records.

S - Wearable sensors, medical imaging devices

3. Music composer
P - User satisfaction, quality of composition
E - music production studio, streaming platforms
A - Adjusting pitch and key of compositions, suggesting chord progressions and melodies.
S - MIDI inputs, music databases, lyrics or text for melody generation

4. Aircraft autolander
P - Smooth and safer landing
E - weather, runway
A - gear, throttle, flaps.
S - altitude sensor, GPS, wind direction sensor.

5. Essay evaluator
P - Grading accuracy, feedback quality, accuracy in error checking
E - ~~Submitted Essays~~ Educational institutes, competitive exams
A - Highlighting grammar and spelling errors, checking for plagiarism
S - Text input, NLP, AI based readability assessment tools.

6. Robotic sentry gun for Keck lab
P - correctly identifying threats and targets, speed of response
E - Keck lab facility, research centers
A - Tracking, alerting security personnel.
S - Cameras, motion ~~sensors~~ sensors, AI based threat recognition

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5. Categorize a shopping bot for an offline bookstore according to each of the ~~six~~ six dimensions.

→ • Partially observable - The bot cannot fully observe customer preferences or book placements.
• Stochastic - customer behaviour and book availbility are unpredictable.
• Sequential - Each interaction depends on previous queries and actions.
• Dynamic - The bookstore environment constantly changes.
• Discrete - The bot operates with a finite set of books, actions and interactions.
• ~~Mu~~ Multi - agent - The bot interacts with customers, employees and inventory systems.

6. Differentiate model based and utility based agent.

→

Model based agent	Utility based agent
1. Uses an internal model of environment to make decisions	1. chooses actions based on utility function that measures performance.
2. Decisions are based on past and present percepts	2. Selects action based on maximizing utility.
3. Can be goal based but doesn't necessarily optimize for best outcomes.	3. Is goal based and searches for the most optimal solution

Attitude

4. Example: Robot vacuum using a map to navigate	4. Example: self driving car.

7. Explain the architecture of a knowledge based agent and learning agent.

→ 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 actions to improve learning

9. Convert the following to predicates:

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

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→ CarAvailable → Travels By Car (Anita)
¬ CarAvailable → Travels By Bus (Anita)

b. Bus goes via Andheri and goregaon

→ GoesVia (Bus, Andheri) ∧ GoesVia (Bus, Goregaon)

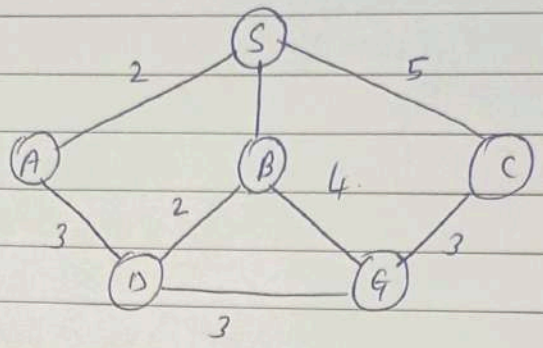
c. Car has puncture so is not available.
Puncture (car)
Puncture (car) → ¬ CarAvailable.

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)
~~¬CarAvailable, we use~~
Goes via (Bus, Goregaon)
Since Anita travels by bus she will follow this route

Thus, Anita will travel via goregaon.

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



→ 1. Start at S
Queue = [S]
2. Dequeue S and explore its ~~children~~ neighbouring nodes
Queue = [A, B, C]
3. Dequeue 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

11. 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~~ by introducing a depth limit L preventing exploration beyond the defined level. This prevents infinite ~~loo~~ loops in graphs but

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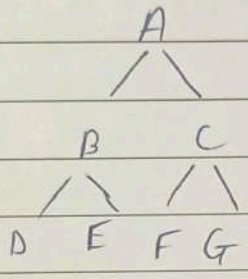
risks missing goals beyond L.

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

Example :



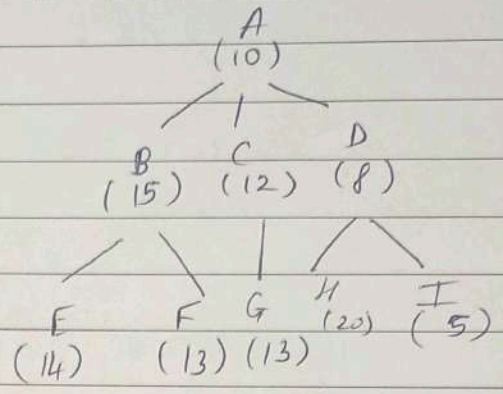
Goal : G

- 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.

12. Explain hill climbing and its drawbacks in detail with example. Also state limitations of steepest ascent hill climbing

-> 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 ie 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 climbing :
1. Computationally expensive : Evaluates all neighbours

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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.

13. Explain simulated annealing and write its algorithm.

→ 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 temperature T
3. Return best solution

Example: Travelling salesman problem.

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

AASTMT

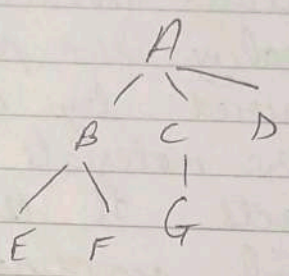
$f(n) = g(n) + h(n)$

$g(n)$ → cost to reach n from start

$h(n)$ → heuristic estimate of cost to reach 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
   $f(B) = 1 + 4 = 5$
   $f(C) = 2 + 2 = 4$
   $f(D) = 4 + 7 = 11$
3. Choose lowest value that is $f(C)$
4. Expand neighbours of C

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

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 $h(n)$.

15. Explain min max algorithm and draw game tree for Tic Tac Toe game.

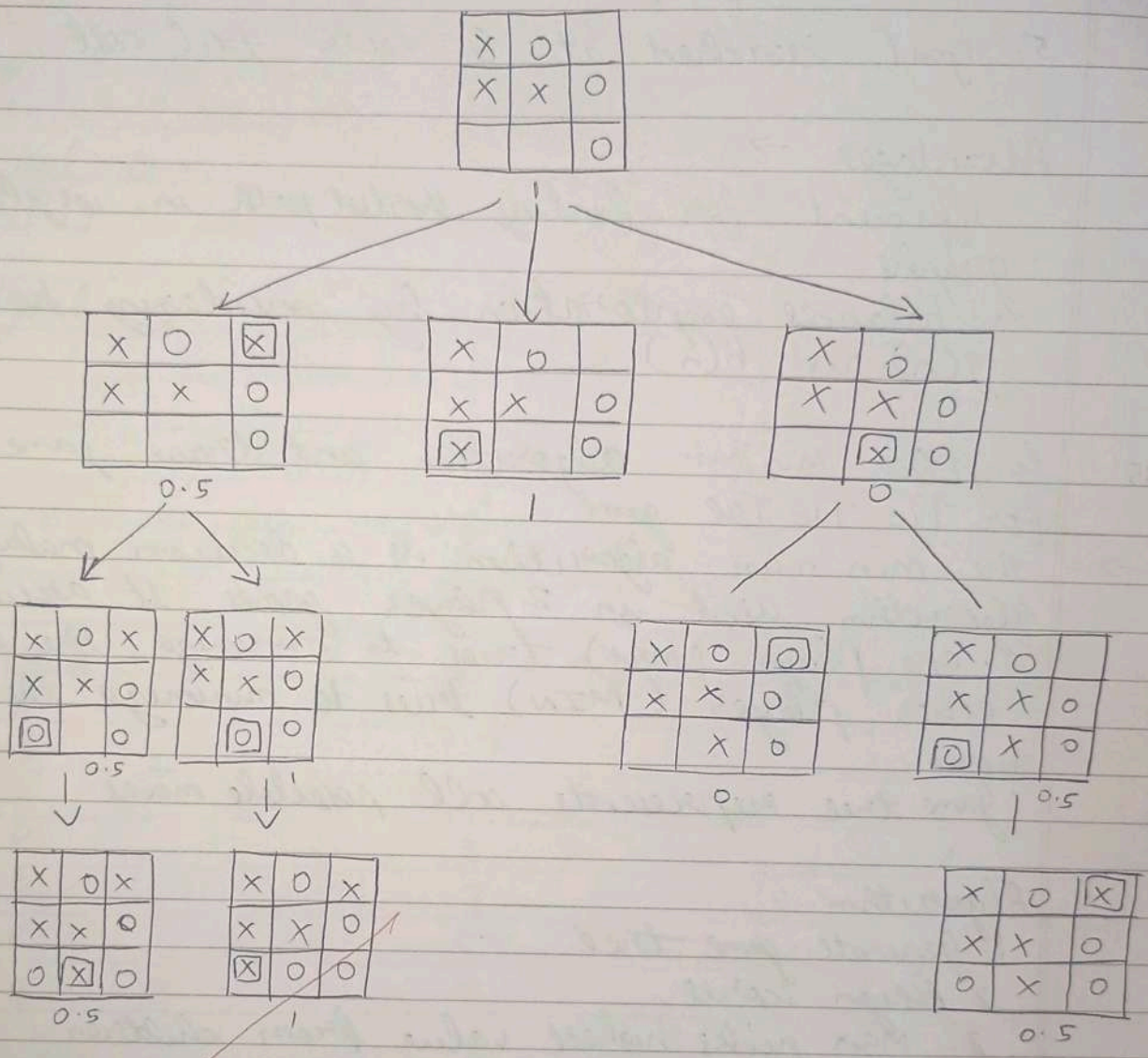
→ The min max algorithm is a decision making algorithm used in 2 player games. It assumes.

- 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 :



16. Explain alpha beta pruning algorithm 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)

Alpha beta pruning includes:

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

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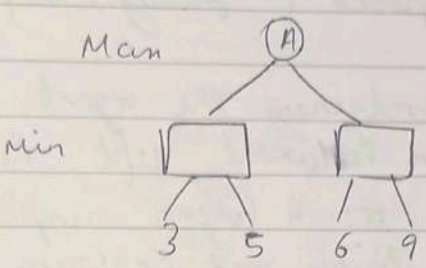
Beta (β) : The best minimum score that the minimizing player can guarantee so far.
The algorithm prunes branches that will not influence final decision

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 -> $\beta = 6$
   - pruning will occur : $\beta(6)$
   - 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.

17. Explain WUMPUS world environment, giving its PEAS description. Explain how percept sequence is generated.

-> The wumpus world environment is a simple grid-based environment used in AI to study intelligent 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 a monster called wumpus.

PEAS:

P: The agent is ~~reward~~ 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 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, 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 to (1,2):
   - Stench detected → wumpus is in an 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 following crypto-arithmetic problem:

1. SEND + MORE = MONEY.

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

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

Step 2:
Now 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 (if S=9 and there is a 1 carried) But 1 is already taken, so O must be 0.

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

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 column. 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~~ not work.
case 2:
Carry : N+R+1 = 9
R = 9-1 = 8. This must be the solution of R.

AASMAN

Step 5:
Let's consider E = 5 or 6.
E = 5,
then D = 7 and Y = 3. So this 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

```
  95ND
+ 1085
------
 10N5Y
```

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

```
  956D
+ 1085
------
 1065Y
```

Step 6:
The digits left are 7, 4, 3 and 2. we know there is carry from column D5Y, so only pair that works is D = 7 and Y = 2

```
  9567
+ 1085
------
 10652
```

19. Consider the following axioms:
All people who are graduating are happy.
All happy people are smiling
Someone is graduating.

-> (1) Represent these axioms in first order predicate logic.

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We define the following predicates :

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

Translating axiom 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. Convert implications to clausal form
   $\forall x \, (G(x) \rightarrow H(x))$
   - Using implication removal :
     $\forall x \, (\neg G(x) \vee H(x))$
   - In clause form :
     $\{ \neg G(x), H(x) \}$

2. $\forall x \, (H(x) \rightarrow S(x))$
   - Using implication removal :
     $\forall x \, (\neg H(x) \vee S(x))$
   - 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) { ¬ G (x), H (x) }
   (2) { ¬ H (x), S (x) }
   (3) { G (a) }

2. Apply resolution
   · Resolve (1) { ¬ G (x), H (x) } with (3) { G (a) } :
      · Substituting x = a :
        { ¬ G (a), H (a) }
      · ∵ we have G (a), resolving gives :
        { H (a) }
   · Resolve (2) { ¬ H (x), S (x) } with { H (a) } :
      · Substituting x = a :
        { ¬ 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.

20. → Explain modus ponen with suitable example.
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.

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It follows the form:

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

$\therefore$ Q (Q must be true)

Example:

1. ~~It~~ If it rains, the ground will be wet. $\rightarrow P \rightarrow Q$
2. It is raining $\rightarrow P$

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

21. Explain forward chaining and backward chaining algorithm with the help of 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 to approach because it begins with known data and works forwards to ~~reach~~ 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 + cough → flu (rule 1 applies)
2. Conclusion: The patient might have flu.

Backward chaining: It starts with goal and works ~~to~~ backwards by checking 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 ∧ 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, 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 that flu is true.