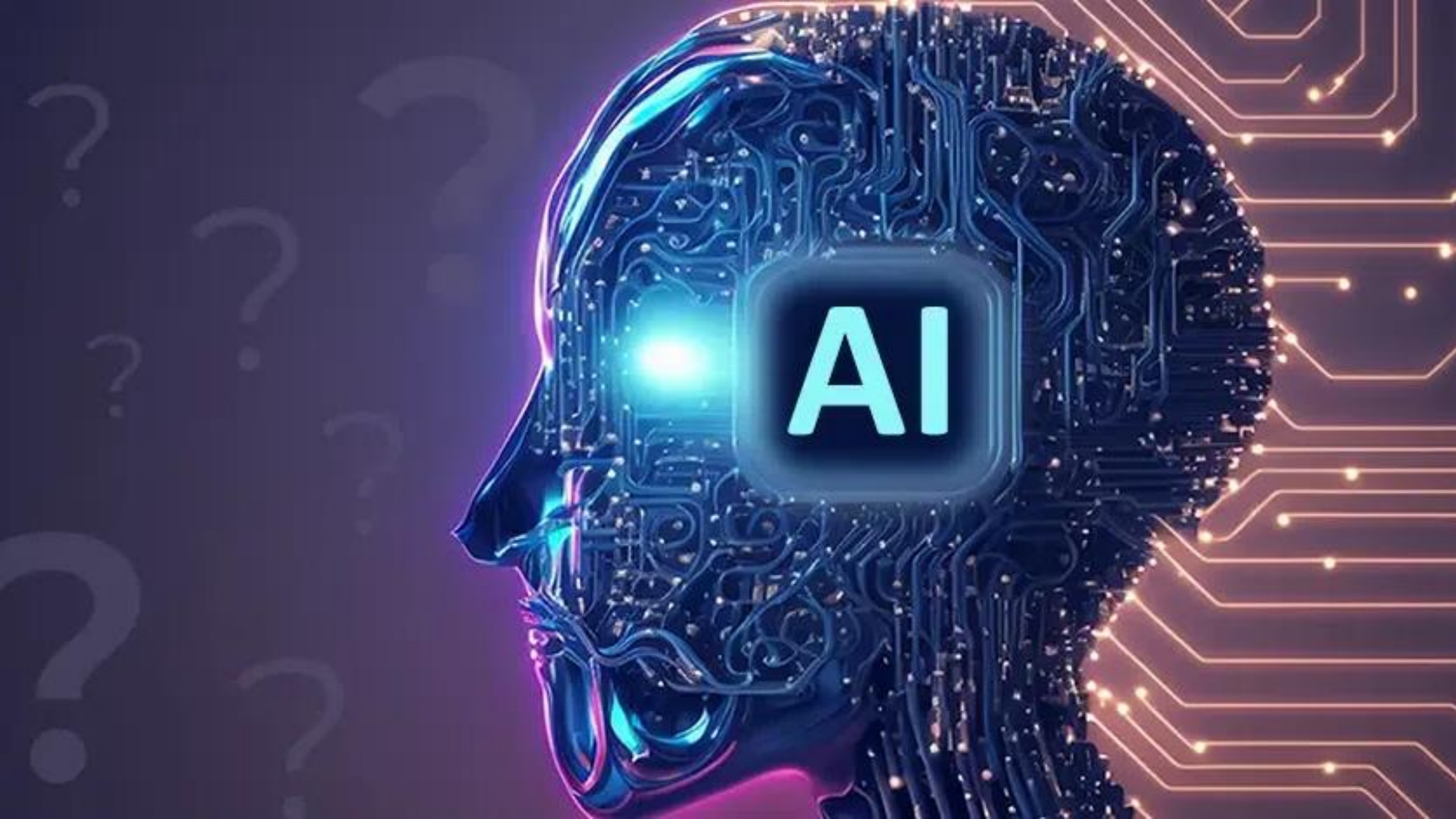
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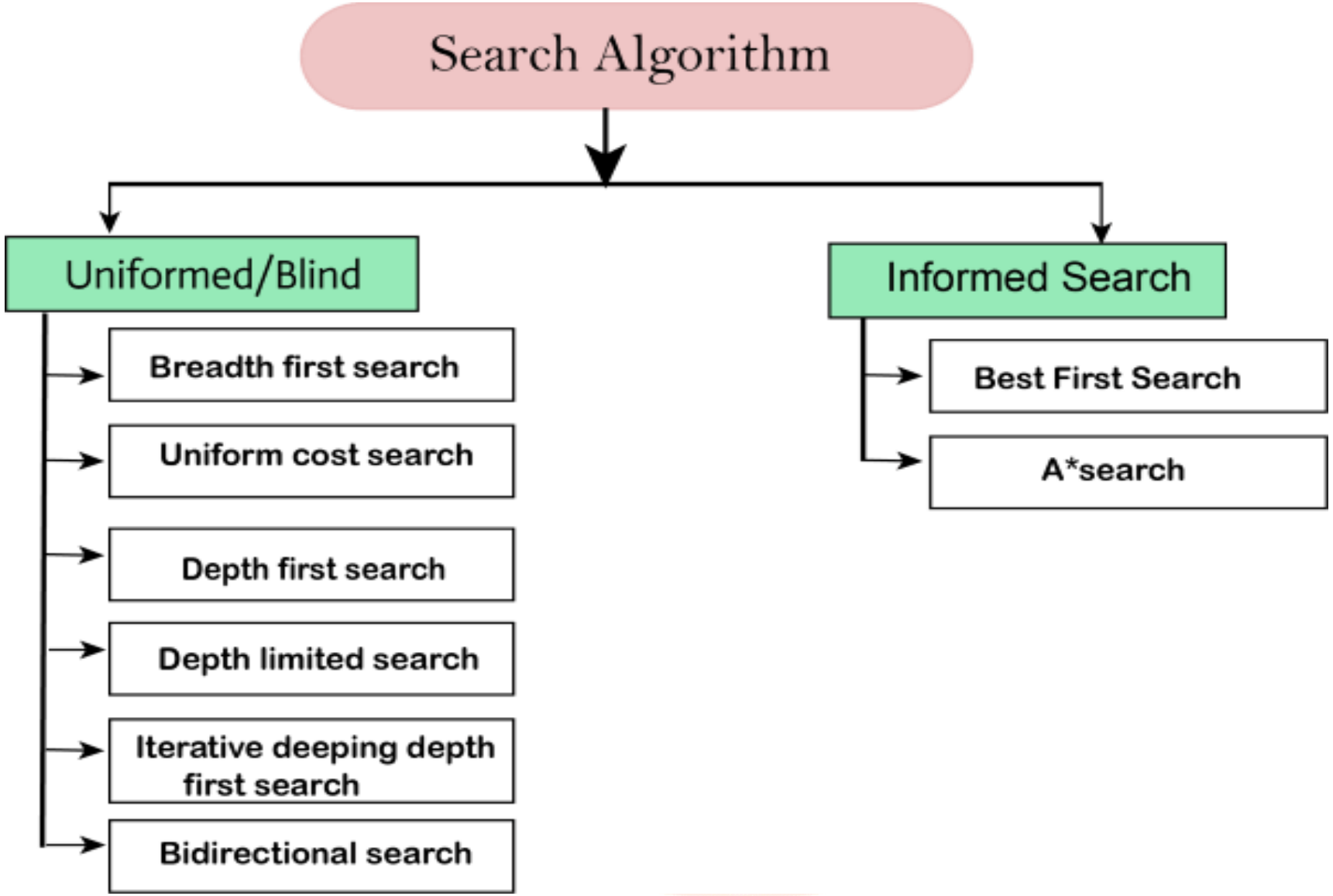


✓ Uninformed/Blind Search:

- ✓ The uninformed search does not contain any domain knowledge such as closeness, the location of the goal. It operates in a brute-force way as it only includes information about how to traverse the tree and how to identify leaf and goal nodes. Uninformed search applies a way in which search tree is searched without any information about the search space like initial state operators and test for the goal, so it is also called blind search.It examines each node of the tree until it achieves the goal node.

✓ Informed Search

- ✓ Informed search algorithms use domain knowledge. In an informed search, problem information is available which can guide the search. Informed search strategies can find a solution more efficiently than an uninformed search strategy. Informed search is also called a Heuristic search.

- ✓ A heuristic is a way which might not always be guaranteed for best solutions but guaranteed to find a good solution in a reasonable time..

Informed Search Algorithms

Informed search algorithm uses the idea of heuristic, so it is also called Heuristic search.

Heuristics function: Heuristic is a function which is used in Informed Search, and it finds the most promising path. It takes the current state of the agent as its input and produces the estimation of how close agent is from the goal. The heuristic method, however, might not always give the best solution, but it guaranteed to find a good solution in reasonable time. Heuristic function estimates how close a state is to the goal. It is represented by h(n), and it calculates the cost of an optimal path between the pair of states. The value of the heuristic function is always positive.

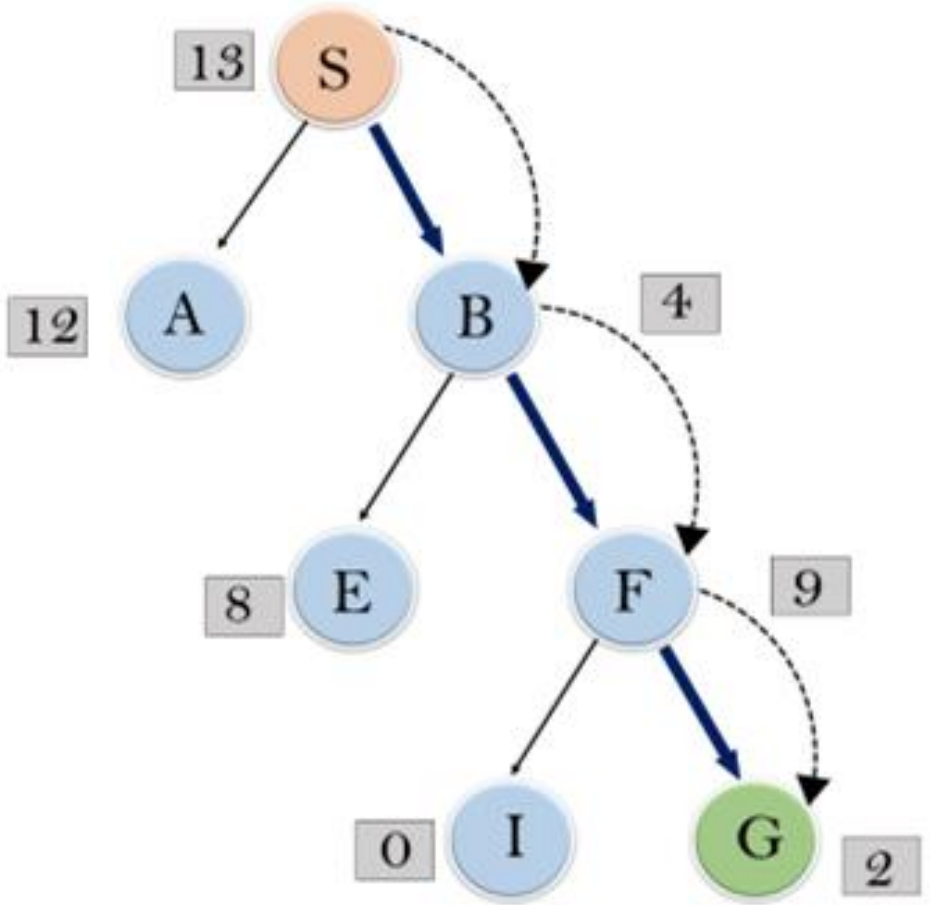
1.) Best-first Search Algorithm (Greedy Search):

Greedy best-first search algorithm always selects the path which appears best at that moment. It is the combination of depth-first search and breadth-first search algorithms. It uses the heuristic function and search

1.) Best-first Search Algorithm (Greedy Search):

Step 1: Place the starting node into the OPEN list.
Step 2: If the OPEN list is empty, Stop and return failure.
Step 3: Remove the node n, from the OPEN list which has the lowest value of h(n), and places it in the CLOSED list.
Step 4: Expand the node n, and generate the successors of node n.
Step 5: Check each successor of node n, and find whether any node is a goal node or not. If any successor node is goal node, then return success and terminate the search, else proceed to Step 6.
Step 6: For each successor node, algorithm checks for evaluation function f(n), and then check if the node has been in either OPEN or CLOSED list. If the node has not been in both list, then add it to the OPEN list.
Step 7: Return to Step 2.

1.) Best-first Search Algorithm (Greedy Search):



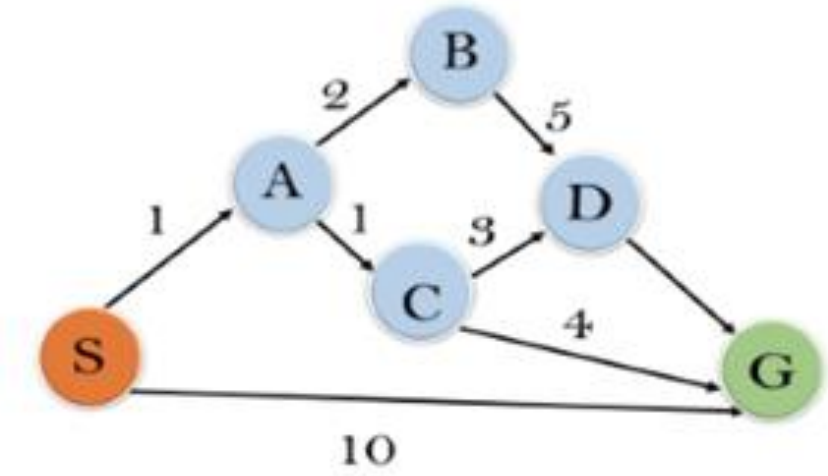
2.) A* Search Algorithm:

A* search is the most commonly known form of best-first search. It uses heuristic function h(n), and cost to reach the node n from the start state g(n). It has combined features of UCS and greedy best-first search, by which it solve the problem efficiently. A* search algorithm finds the shortest path through the search space using the heuristic function. This search algorithm expands less search tree and provides optimal result faster. A* algorithm is similar to UCS except that it uses g(n)+h(n) instead of g(n).

In A* search algorithm, we use search heuristic as well as the cost to reach the node. Hence we can combine both costs as following, and this sum is called as a fitness number.

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

- $f(n)$: Estimated cost of the cheapest solution.
- $g(n)$: Cost to reach node n from start state.
- $h(n)$: Cost to reach from node n to goal node



State	h(n)
S	5
A	3
B	4
C	2
D	6
G	0

Hill Climbing Algorithm in Artificial Intelligence

- ✓ Hill climbing algorithm is a local search algorithm which continuously moves in the direction of increasing elevation/value to find the peak of the mountain or best solution to the problem. It terminates when it reaches a peak value where no neighbor has a higher value.

- ✓ Hill climbing algorithm is a technique which is used for optimizing the mathematical problems. One of the widely discussed examples of Hill climbing algorithm is Traveling-salesman Problem in which we need to minimize the distance traveled by the salesman.

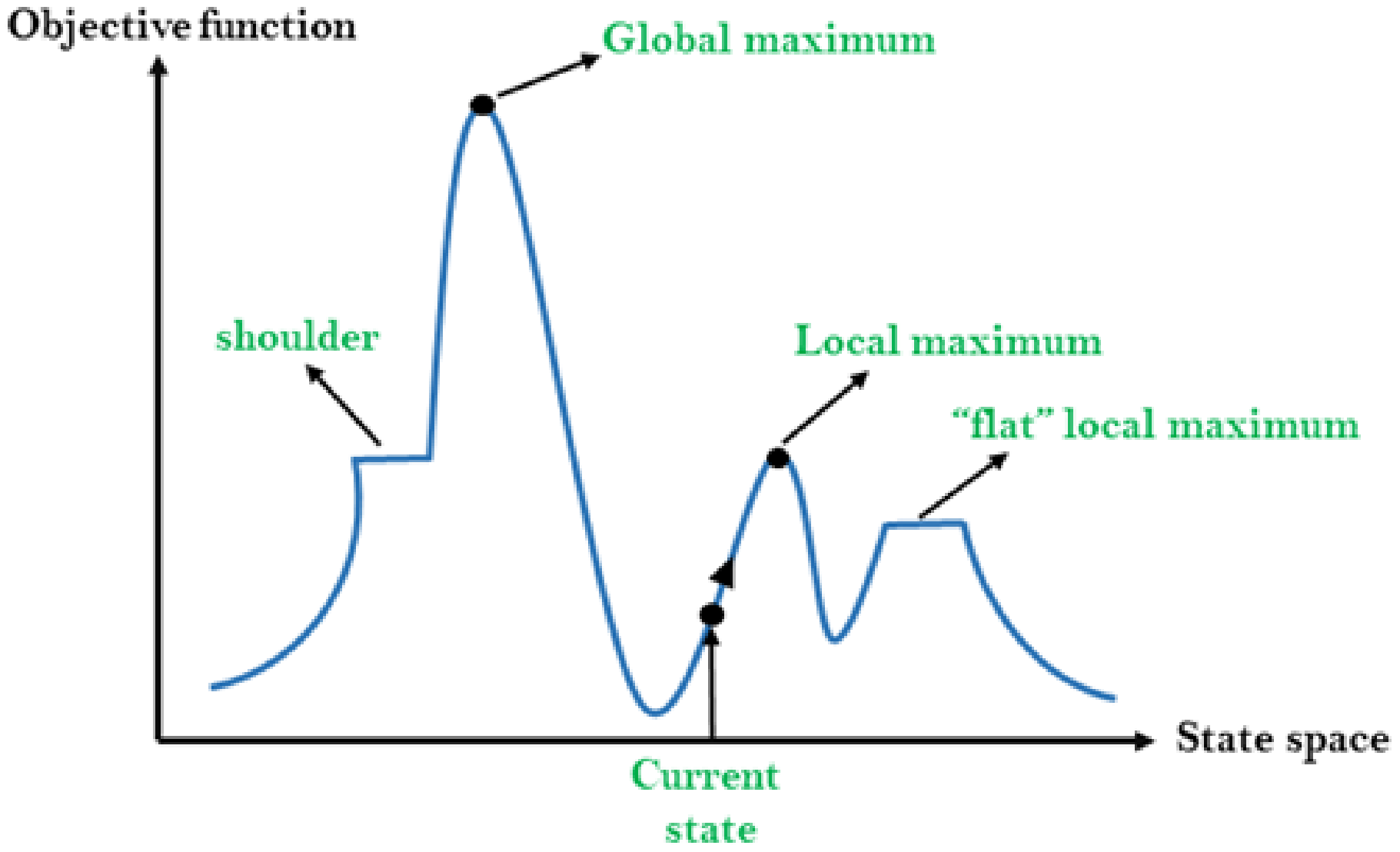
Hill Climbing Algorithm in Artificial Intelligence

- ✓ It is also called greedy local search as it only looks to its good immediate neighbor state and not beyond that.
- ✓ A node of hill climbing algorithm has two components which are state and value.
- ✓ Hill Climbing is mostly used when a good heuristic is available.
- ✓ In this algorithm, we don't need to maintain and handle the search tree or graph as it only keeps a single current state.

Hill Climbing Algorithm in Artificial Intelligence

- ✓ Features of Hill Climbing:

- ✓ Generate and Test variant: Hill Climbing is the variant of Generate and Test method. The Generate and Test method produce feedback which helps to decide which direction to move in the search space.
- ✓ Greedy approach: Hill-climbing algorithm search moves in the direction which optimizes the cost.
- ✓ No backtracking: It does not backtrack the search space, as it does not remember the previous states.



Hill Climbing Algorithm in Artificial Intelligence

Types of Hill Climbing Algorithm:

- ✓ Simple hill Climbing:
- ✓ Steepest-Ascent hill-climbing:
- ✓ Stochastic hill Climbing:

Adversarial Search

Adversarial search is a search, where we examine the problem which arises when we try to plan ahead of the world and other agents are planning against us.

The environment with more than one agent is termed as multi-agent environment, in which each agent is an opponent of other agent and playing against each other. Each agent needs to consider the action of other agent and effect of that action on their performance.

Adversarial Search

So, Searches in which two or more players with conflicting goals are trying to explore the same search space for the solution, are called adversarial searches, often known as Games.

Games are modeled as a Search problem and heuristic evaluation function, and these are the two main factors which help to model and solve games in AI.

Types of Games in AI:

- Perfect information: A game with the perfect information is that in which agents can look into the complete board. Agents have all the information about the game, and they can see each other moves also. Examples are Chess, Checkers, Go, etc.

- Imperfect information: If in a game agents do not have all information about the game and not aware with what's going on, such type of games are called the game with imperfect information, such as tic-tac-toe, Battleship, blind, Bridge, etc.

Types of Games in AI:

- Deterministic games: Deterministic games are those games which follow a strict pattern and set of rules for the games, and there is no randomness associated with them. Examples are chess, Checkers, Go, tic-tac-toe, etc.
- Non-deterministic games: Non-deterministic are those games which have various unpredictable events and has a factor of chance or luck. This factor of chance or luck is introduced by either dice or cards. These are random, and each action response is not fixed. Such games are also called as stochastic games.
- Example: Backgammon, Monopoly, Poker, etc.

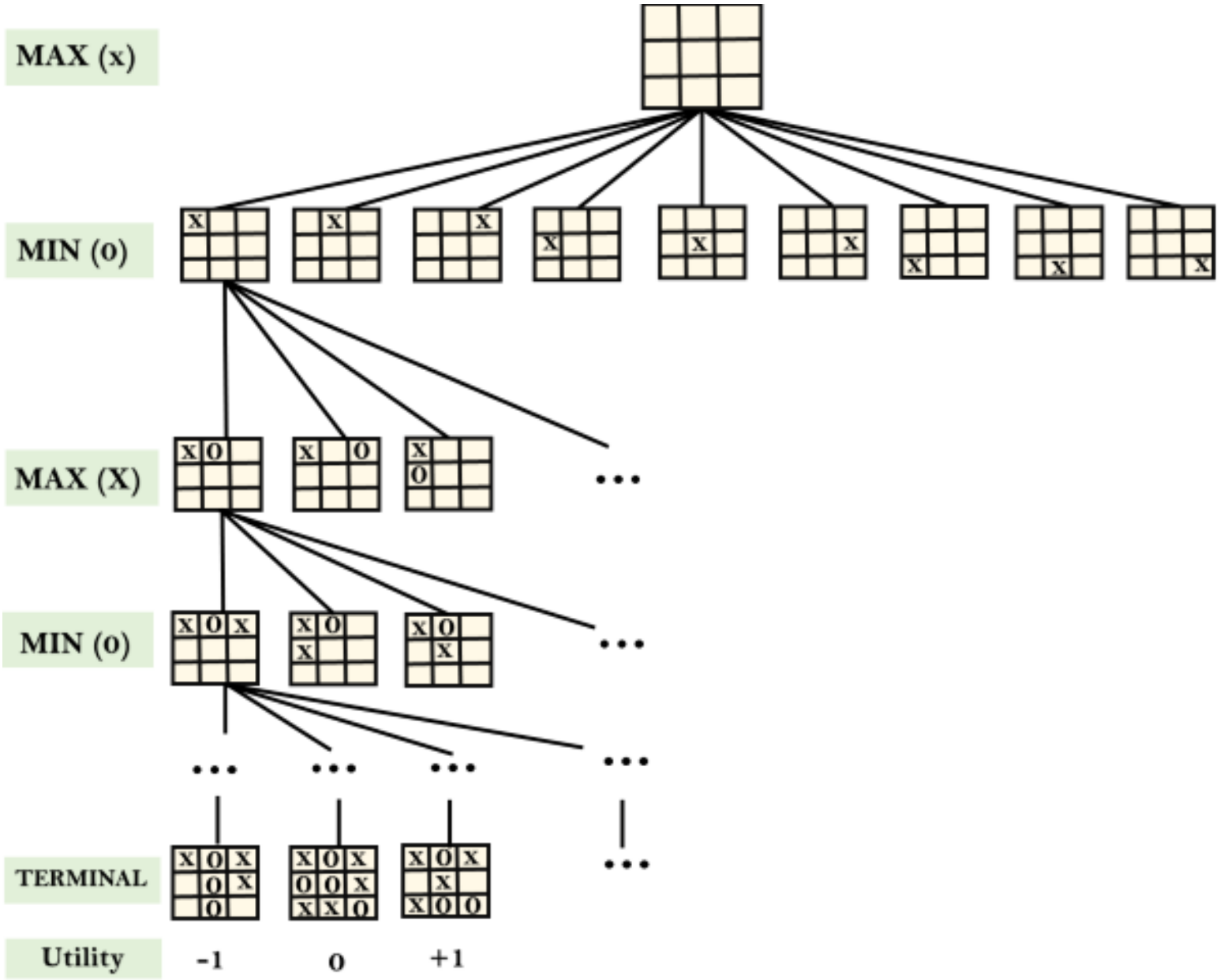
Game tree:

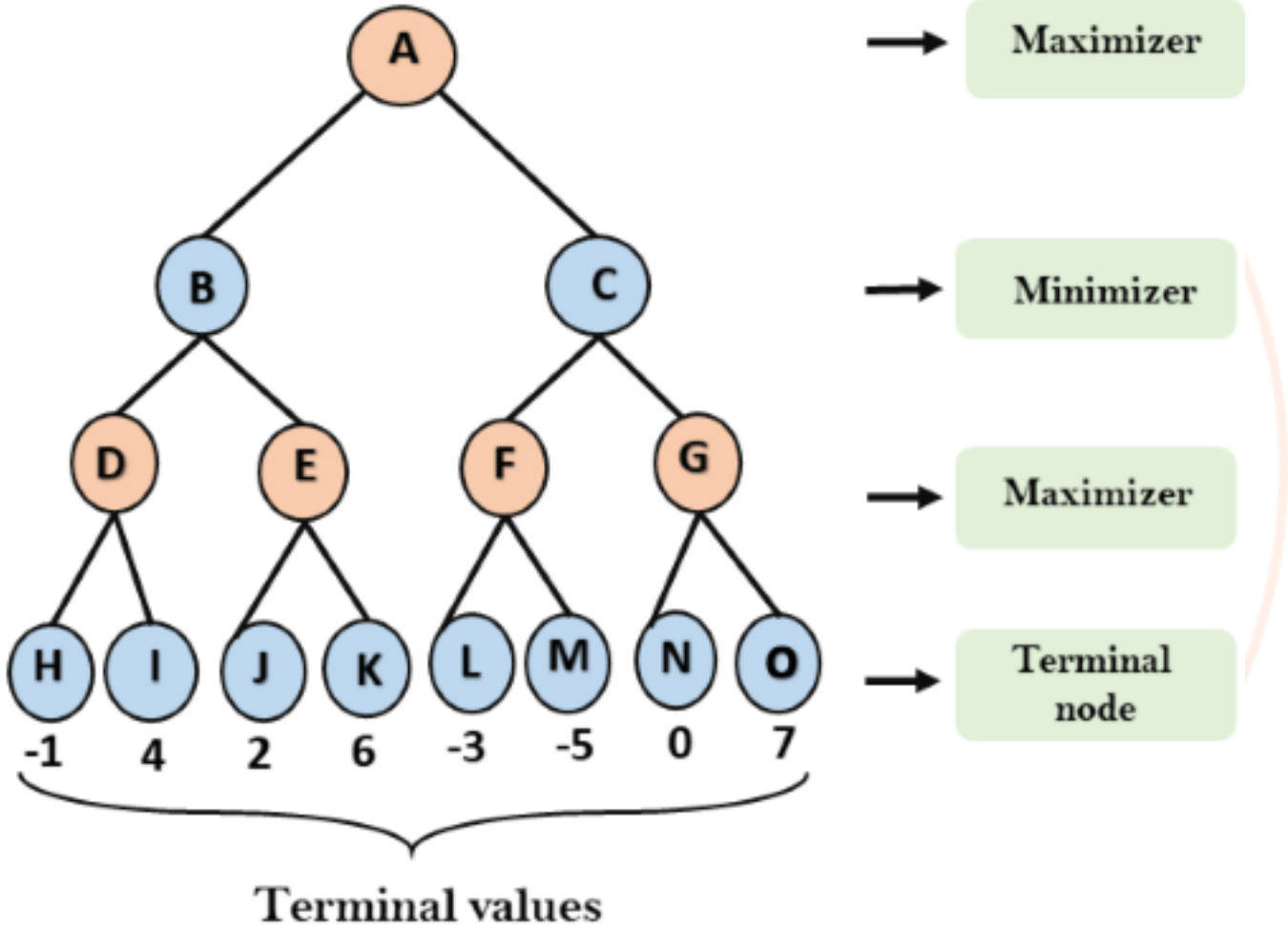
- A game tree is a tree where nodes of the tree are the game states and Edges of the tree are the moves by players. Game tree involves initial state, actions function, and result Function.

- Example: Tic-Tac-Toe game tree:

- The following figure is showing part of the game-tree for tic-tac-toe game. Following are some key points of the game:

✓ There are two players MAX and MIN.
✓ Players have an alternate turn and start with MAX.
✓ MAX maximizes the result of the game tree
✓ MIN minimizes the result.





Alpha-Beta Pruning

- Alpha-beta pruning is a modified version of the minimax algorithm. It is an optimization technique for the minimax algorithm.
- As we have seen in the minimax search algorithm that the number of game states it has to examine are exponential in depth of the tree. Since we cannot eliminate the exponent, but we can cut it to half. Hence there is a technique by which without checking each node of the game tree we can compute the correct minimax decision, and this technique is called pruning. This involves two threshold parameter Alpha and beta for future expansion, so it is called alpha-beta pruning. It is also called as Alpha-Beta Algorithm.

Alpha-Beta Pruning

- Alpha-beta pruning can be applied at any depth of a tree, and sometimes it not only prune the tree leaves but also entire sub-tree.

- The two-parameter can be defined as:
- Alpha: The best (highest-value) choice we have found so far at any point along the path of Maximizer. The initial value of alpha is -∞.
- Beta: The best (lowest-value) choice we have found so far at any point along the path of Minimizer. The initial value of beta is +∞.

❑ Knowledge-Based Agent in Artificial intelligence

- ❑ An intelligent agent needs knowledge about the real world for taking decisions and reasoning to act efficiently.

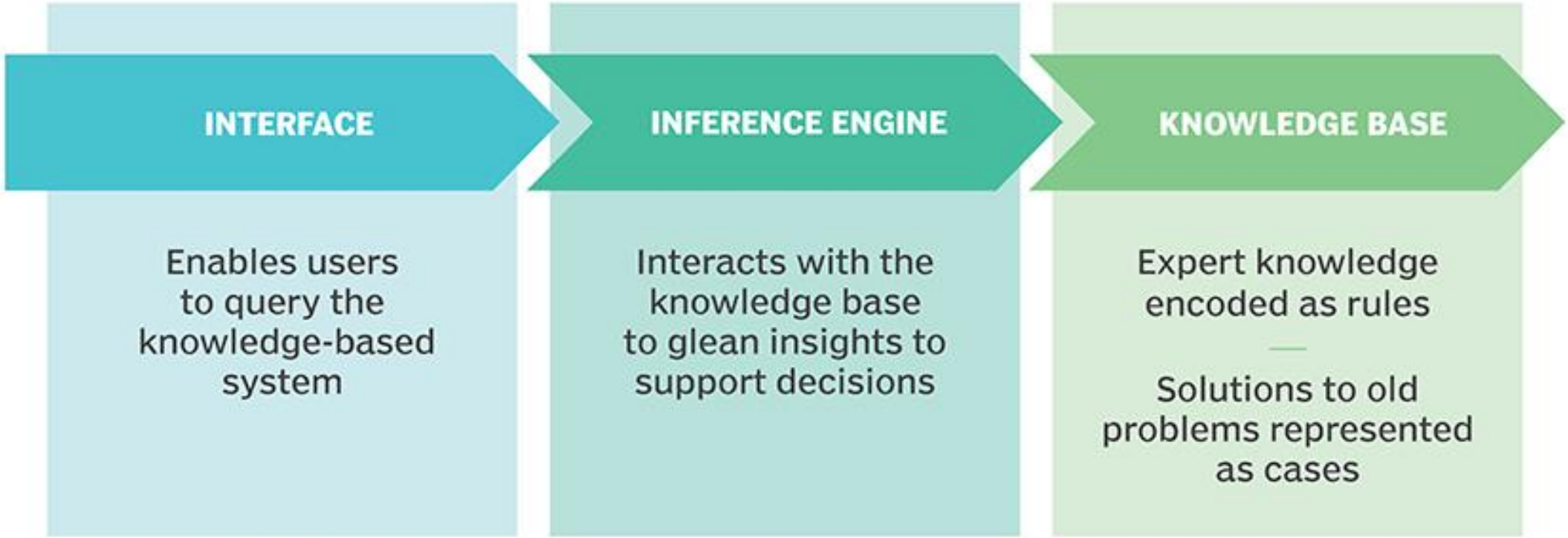
- ❑ Knowledge-based agents are those agents who have the capability of maintaining an internal state of knowledge, reason over that knowledge, update their knowledge after observations and take actions. These agents can represent the world with some formal representation and act intelligently.
- ❑ Knowledge-based agents are composed of two main parts:

1. Knowledge-base and
2. Inference system.

❑ Knowledge-Base

❑ Knowledge-based systems (KBSes) are computer programs that use a centralized repository of data known as a knowledge base to provide a method for problem-solving. Knowledge-based systems are a form of artificial intelligence (AI) designed to capture the knowledge of human experts to support decision-making

Knowledge-based systems architecture



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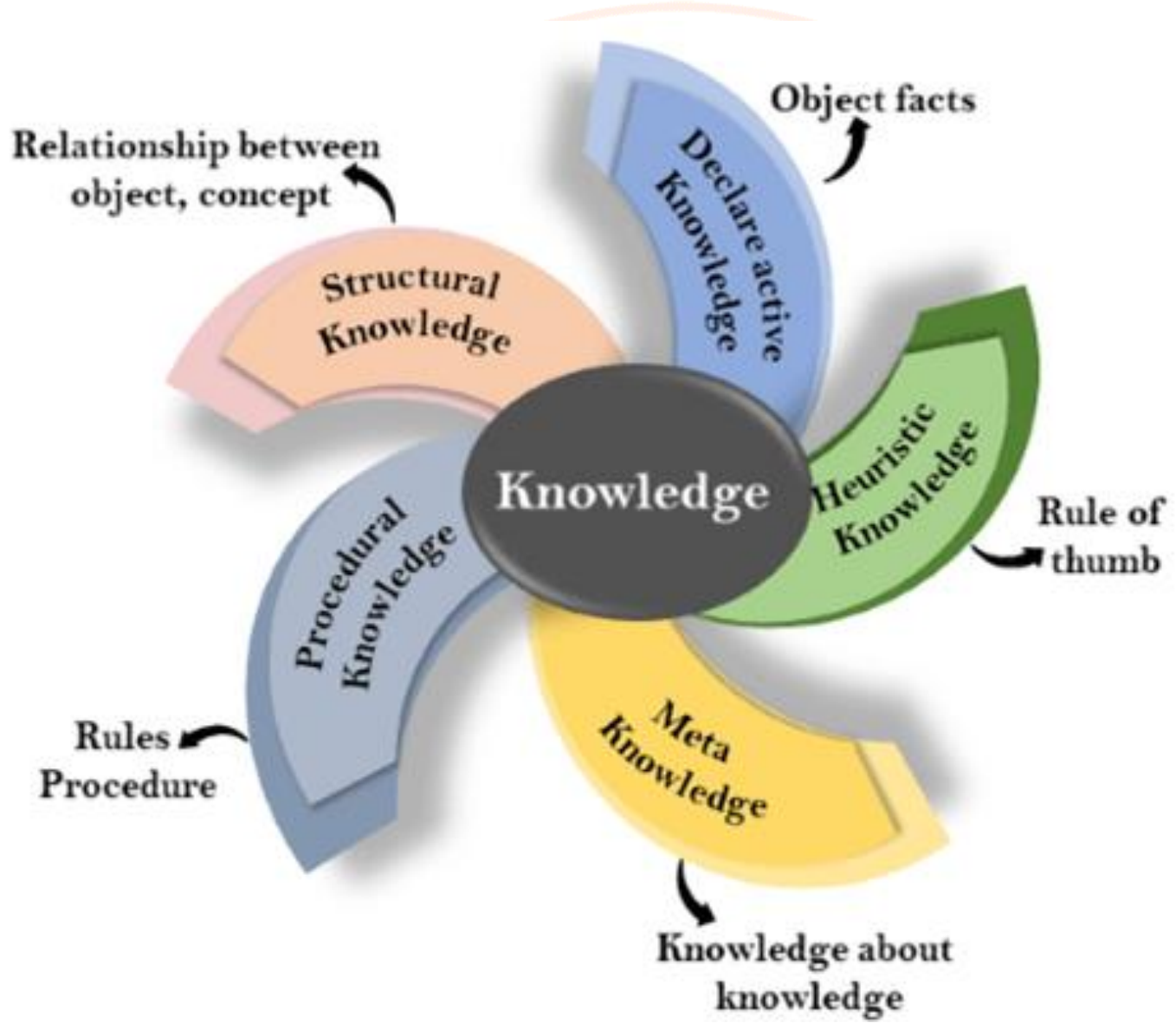
❑ Inference system:

❑ Inference means deriving new sentences from old. Inference system allows us to add a new sentence to the knowledge base. A sentence is a proposition about the world. Inference system applies logical rules to the KB to deduce new information.

❑ Inference system generates new facts so that an agent can update the KB. An inference system works mainly in two rules which are given as:

- ✓ Forward chaining
- ✓ Backward chaining

	Forward Chaining	Backward Chaining
1.	When based on available data a decision is taken then the process is called as Forward chaining.	Backward chaining starts from the goal and works backward to determine what facts must be asserted so that the goal can be achieved.
2.	Forward chaining is known as data-driven technique because we reaches to the goal using the available data.	Backward chaining is known as goal-driven technique because we start from the goal and reaches the initial state in order to extract the facts.
3.	It is a bottom-up approach.	It is a top-down approach.
4.	It applies the Breadth-First Strategy.	It applies the Depth-First Strategy.
5.	Its goal is to get the conclusion.	Its goal is to get the possible facts or the required data.
6.	Slow as it has to use all the rules.	Fast as it has to use only a few rules.
7.	It operates in forward direction i.e it works from initial state to final decision.	It operates in backward direction i.e it works from goal to reach initial state.
8.	Forward chaining is used for the planning, monitoring, control, and interpretation application.	It is used in automated inference engines, theorem proofs, proof assistants and other artificial intelligence applications.



1. Declarative Knowledge:

- ✓ Declarative knowledge is to know about something.
- ✓ It includes concepts, facts, and objects.
- ✓ It is also called descriptive knowledge and expressed in declarative sentences.
- ✓ It is simpler than procedural language.

2. Procedural Knowledge

- ✓ It is also known as imperative knowledge.
- ✓ Procedural knowledge is a type of knowledge which is responsible for knowing how to do something.
- ✓ It can be directly applied to any task.
- ✓ It includes rules, strategies, procedures, agendas, etc.
- ✓ Procedural knowledge depends on the task on which it can be applied.

3. Meta-knowledge:

- ✓ Knowledge about the other types of knowledge is called Meta-knowledge.

4. Heuristic knowledge:

- ✓ Heuristic knowledge is representing knowledge of some experts in a filed or subject.
- ✓ Heuristic knowledge is rules of thumb based on previous experiences, awareness of approaches, and which are good to work but not guaranteed.

5. Structural knowledge:

- ✓ Structural knowledge is basic knowledge to problem-solving.
- ✓ It describes relationships between various concepts such as kind of, part of, and grouping of something.
- ✓ It describes the relationship that exists between concepts or objects.

Propositional logic in Artificial intelligence

Propositional logic (PL) is the simplest form of logic where all the statements are made by propositions. A proposition is a declarative statement which is either true or false. It is a technique of knowledge representation in logical and mathematical form.

Example:
a) It is Sunday.
b) The Sun rises from West (False proposition)
c) 3+3= 7(False proposition)
d) 5 is a prime number.

Propositional logic in Artificial intelligence

- ✓ Propositional logic is also called Boolean logic as it works on 0 and 1.
- ✓ In propositional logic, we use symbolic variables to represent the logic, and we can use any symbol for a representing a proposition, such A, B, C, P, Q, R, etc.
- ✓ Propositions can be either true or false, but it cannot be both.
- ✓ Propositional logic consists of an object, relations or function, and logical connectives.
- ✓ These connectives are also called logical operators.
- ✓ The propositions and connectives are the basic elements of the propositional logic.

Propositional logic in Artificial intelligence

- ✓ Connectives can be said as a logical operator which connects two sentences.
- ✓ A proposition formula which is always true is called tautology, and it is also called a valid sentence.
- ✓ A proposition formula which is always false is called Contradiction.
- ✓ A proposition formula which has both true and false values is called
- ✓ Statements which are questions, commands, or opinions are not propositions such as "Where is Rohini", "How are you", "What is your name", are not propositions.

Connective symbols	Word	Technical term	Example
∧	AND	Conjunction	A ∧ B
∨	OR	Disjunction	A ∨ B
→	Implies	Implication	A → B
⇔	If and only if	Biconditional	A⇔ B
¬ or ~	Not	Negation	¬ A or ¬ B

For Negation:

P	¬ P
True	**False**
False	**True**

For Conjunction:

P	Q	P∧ Q
True	True	**True**
True	False	**False**
False	True	**False**
False	False	**False**

For disjunction:

P	Q	P ∨ Q.
True	True	**True**
False	True	**True**
True	False	**True**
False	False	**False**

For Implication:

P	Q	P→ Q
True	True	**True**
True	False	**False**
False	True	**True**
False	False	**True**

Precedence	Operators
First Precedence	Parenthesis
Second Precedence	Negation
Third Precedence	Conjunction(AND)
Fourth Precedence	Disjunction(OR)
Fifth Precedence	Implication
Six Precedence	Biconditional

First-Order Logic in Artificial intelligence

- ✓ "Some humans are intelligent", or "Sachin likes cricket.“
- ✓ To represent the above statements, PL logic is not sufficient, so we required some more powerful logic, such as first-order logic.

First-Order Logic in Artificial intelligence

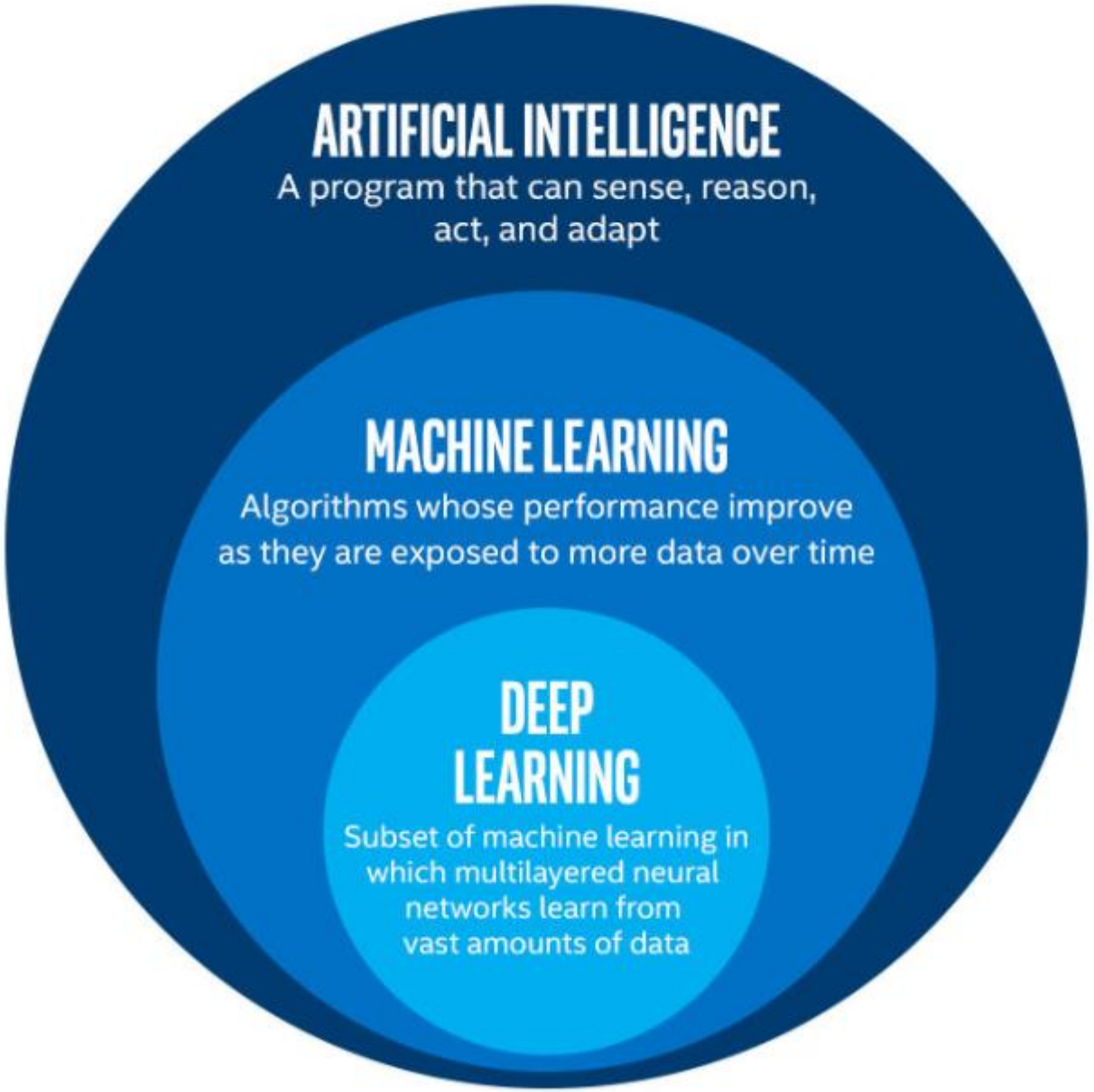
FOL is a mode of representation in Artificial Intelligence. It is an extension of PL.

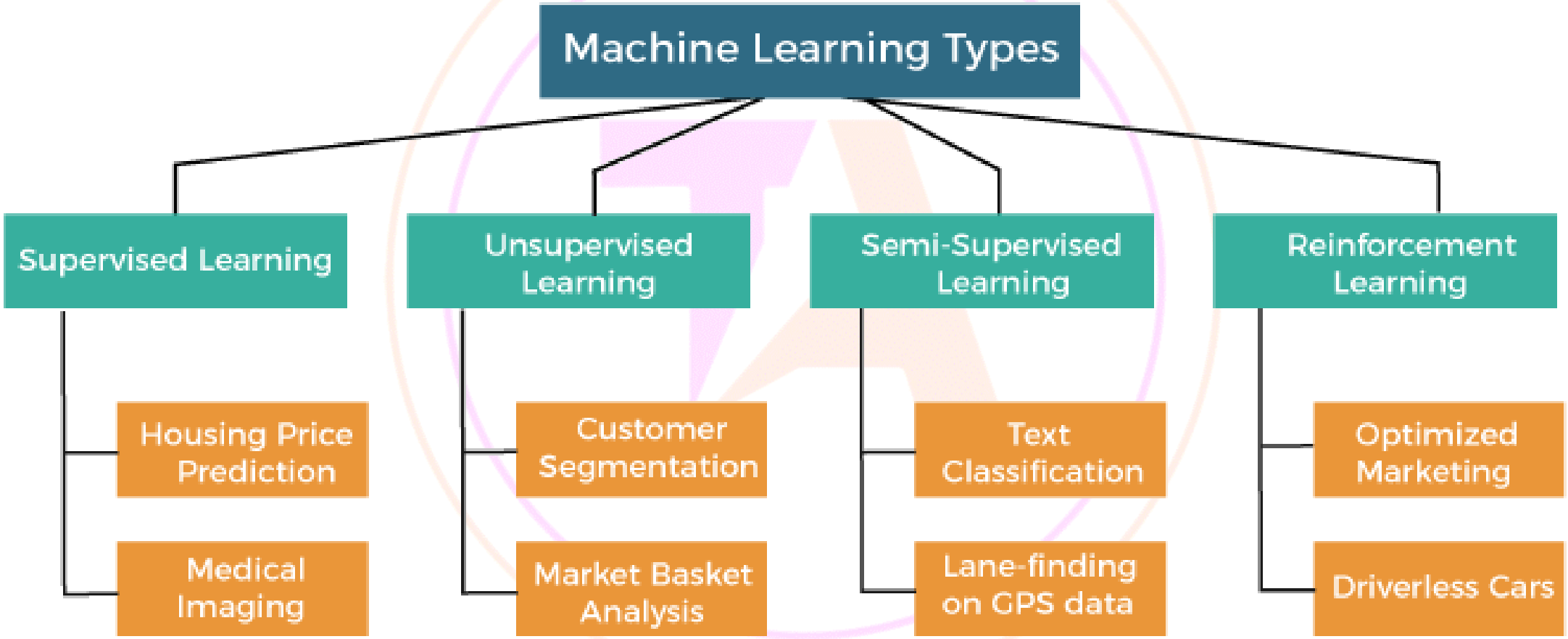
- ✓ FOL represents natural language statements in a concise way.
- ✓ FOL is also called predicate logic. It is a powerful language used to develop information about an object and express the relationship between objects.
- ✓ FOL not only assumes that does the world contains facts (like PL does), but it also assumes the following:
- ✓ Objects: A, B, people, numbers, colors, wars, theories, squares, pit, etc.
- ✓ Relations: It is unary relation such as red, round, sister of, brother of, etc.
- ✓ Function: father of, best friend, third inning of, end of, etc.

What is machine learning?

Machine learning is a subset of artificial intelligence that automatically enables a machine or system to learn and improve from experience. Instead of explicit programming, machine learning uses algorithms to analyze large amounts of data, learn from the insights, and then make informed decisions.

Machine learning algorithms improve performance over time as they are trained—exposed to more data. Machine learning models are the output, or what the program learns from running an algorithm on training data. The more data used, the better the model will get.





1. Supervised Machine Learning:

Supervised learning is defined as when a model gets trained on a “Labelled Dataset”. Labelled datasets have both input and output parameters. In Supervised Learning algorithms learn to map points between inputs and correct outputs. It has both training and validation datasets labelled.

Example: Consider a scenario where you have to build an image classifier to differentiate between cats and dogs. If you feed the datasets of dogs and cats labelled images to the algorithm, the machine will learn to classify between a dog or a cat from these labeled images. When we input new dog or cat images that it has never seen before, it will use the learned algorithms and predict whether it is a dog or a cat. This is how supervised learning works, and this is particularly an image classification.

2. Unsupervised Machine Learning

Unsupervised Learning Unsupervised learning is a type of machine learning technique in which an algorithm discovers patterns and relationships using unlabeled data. The primary goal of Unsupervised learning is often to discover hidden patterns, similarities, or clusters within the data, which can then be used for various purposes, such as data exploration, visualization, dimensionality reduction, and more

Example: Consider that you have a dataset that contains information about the purchases you made from the shop. Through clustering, the algorithm can group the same purchasing behavior among you and other customers, which reveals potential customers without predefined labels. This type of information can help businesses get target customers as well as identify outliers.

4. Reinforcement Machine Learning

Reinforcement machine learning algorithm is a learning method that interacts with the environment by producing actions and discovering errors. Trial, error, and delay are the most relevant characteristics of reinforcement learning. In this technique, the model keeps on increasing its performance using Reward Feedback to learn the behavior or pattern. These algorithms are specific to a particular problem e.g. Google Self Driving car, AlphaGo where a bot competes with humans and even itself to get better and better performers in Go Game. Each time we feed in data, they learn and add the data to their knowledge which is training data. So, the more it learns the better it gets trained and hence experienced.

4. Reinforcement Machine Learning

Example: Consider that you are training an AI agent to play a game like chess. The agent explores different moves and receives positive or negative feedback based on the outcome. Reinforcement Learning also finds applications in which they learn to perform tasks by interacting with their surroundings.