CONTENTS

ARTIFICIAL INTELLIGENCE

SYLLABUS

UNIT I : *[15 Hours]*

Introduction to AI: What is AI? Intelligent Agents: Agents and environment, the concept of Rationality, the nature of the environment, the structure of agents; Problem-solving: Problemsolving agents; Uninformed search strategies: DFS, BFS; Informed Search: Best First Search, A* search, AO* search, Means End Analysis. Adversarial Search & Games: Two player zero-sum games, Minimax Search, Alpha-Beta pruning.

UNIT - II *[15 Hours]*

Knowledge-based Agents, The Wumpus world as an example world, Logic, Propositional logic, First-order predicate logic, Propositional versus first-order inference, Unification and lifting, Forward chaining, Backward chaining, Resolution, Truth maintenance systems. Knowledge in Learning, What is learning? Types of Learning,: Rote Learning, Learning by Taking Advice, Learning in Problem Solving, Learning from Examples, Winston's Learning Program, Decision Trees.

UNIT - III *[15 Hours]*

Introduction to Planning: Blocks World problem, Strips; Handling Uncertainties: Nonmonotonic reasoning, Probabilistic reasoning, Fuzzy logic; Robotics: Fundamentals of Robotics, Robot Kinematics; Computer Vision: Introduction to image processing and classification, object detection.

UNIT - IV *[15 Hours]*

Natural Language Processing: Introduction, Syntactic Processing, Semantic Analysis, Discourse and Pragmatic Processing; Expert Systems: Architecture and role of expert systems, two case studies of Expert Systems; Introduction to Machine learning: Supervised learning, unsupervised learning, reinforcement learning; Neural Networks: Introduction, basics of ANN, Deep Learning with basics of CNN, RNN, LSTM and their applications.

INTRODUCTION TO AI

Unit - 1

SECTION A

Q.1 What is intelligence?

A system with intelligence is expected to behave as intelligent as a human. A system with intelligence is expected to behave in the best possible manner.

Q.2 What is Artificial Intelligence?

Artificial Intelligence is the branch of computer science concerned with the study of how to make computer do things which, at the moment people do better.

Q.3 Define problem space.

A problem space encompasses all valid states that can be generated by the application of any combination of operators on any combination of objects. The problem space may contain one or more solutions. A solution is a combination of operations and objects that achieve the goals.

Q.4 What is a Search?

Search proceeds with different types of 'search control strategies'. The depth-first search and breadth-first search are the two common search strategies.

Q.5 What are the AI Applications?

The AI applications are:

a) Understanding natural language

b) Expert System

c) Robotics

d) Computer Vision

Q.6 Define of Intelligent Agents.

Intelligent agents are autonomous entities that can observe their environment, reason about it, and take actions to achieve their predefined goals or tasks.

Q.7 What is Ideal Rational Agent?

An ideal rational agent is the one, which is capable of doing expected actions to maximize its performance measure, on the basis of "Its percept sequence and Its built-in knowledge base.

Q.8 What do you mean by Problem solving?

The term, Problem Solving relates to analysis in AI. Problem solving may be characterized as a systematic search through a range of possible actions to reach some predefined goal or solution. Problem-solving methods are categorized as special purpose and general purpose.

Q.9 What is Problem solving a special-purpose?

A special-purpose method is tailor-made for a particular problem, often exploits very specific features of the situation in which the problem is embedded.

Q.10 What is Problem solving a general-purpose?

A general-purpose method is applicable to a wide variety of problems. One General-purpose technique used in AI is 'means-end analysis': a step-by step, or incremental, reduction of the difference between current state and final goal

Q.11 What do you mean by Search tree?

A tree representation of search problem is called Search tree. The root of the search tree is the root node which is corresponding to the initial state.

Q.12 What is General Problem Solving?

Problem solving is a process of generating solutions from observed or given data. It is however not always possible to use direct methods (i.e. go directly from data to solution). Instead, problem solving often needs to use indirect or model based methods.

Q.13 What is General Problem Solver (GPS)?

General Problem Solver (GPS) was a computer program. GPS was based on Simon and Newell's theoretical work on logic machines. GPS in principle can solve any formalized symbolic problem, such as theorems proof and geometric problems and chess playing.

Q.14 Define Heuristic Search.

A Heuristic is a technique to solve a problem faster than classic methods, or to find an approximate solution when classic methods cannot. This is a kind of a shortcut as we often trade one of optimality, completeness, accuracy, or precision for speed.

Q.15 Why do we need heuristics?

One reason is to produce, in a reasonable amount of time, a solution that is good enough for the problem in question. It doesn't have to be the best approximate solution will do since this is fast enough.

Q.16 What is a Heuristic Function?

This is a function that maps from problem state descriptions to measures of desirability, usually represented as numbers.

Q.17 What is Best first search combines

It the advantages of both depth first search and breadth first search. One way to combine the two is to follow a single path at a time, but switch path whenever some competing path looks more promising than the current one.

Q.18 What is blind or uninformed search?

Uninformed search move through the space without worrying about what is coming next, but recognising the answer if we see it

Q.19 What is informed search?

Informed search guess what is ahead, and use that information to decide where to look next.

Q.20 What is AND-OR graph?

When a problem can be divided into a set of sub problems, where each sub problem can be solved separately and a combination of these will be a solution, AND-OR graphs or AND - OR trees are used for representing the solution.

Q.21 What is plausible move generator?

The generator which generates only some small number of promising moves.

Q.22 What is Completeness?

A search algorithm is said to be complete if it guarantees to return a solution if at least any solution exists for any random input.

Q.23 What is Optimality?

If a solution found for an algorithm is guaranteed to be the best solution (lowest path cost) among all other solutions, then such a solution for is said to be an optimal solution.

Q.24 What is Time Complexity?

Time complexity is a measure of time for an algorithm to complete its task.

Q.25 What is Space Complexity?

It is the maximum storage space required at any point during the search, as the complexity of the problem.

Q.26 What is rational agent?

A rational agent always performs right action, where the right action means the action that causes the agent to be most successful in the given percept sequence.

SECTION B

Q.1 Explain the basis concept of Artificial intelligence.

1. AI is the study of how to make computers do things which at the moment people do better.
2. AI is a field of study that encompasses computational techniques for performing tasks that apparently require intelligence when performed by humans.
3. AI is based upon the principles of computer science namely data structures used in knowledge representation, the algorithms needed to apply that knowledge and the languages and programming techniques used in their implementation.
4. AI is concerned with developing computer systems that can store knowledge and effectively use the knowledge to help solve problems

and accomplish tasks. This brief statement sounds a lot like one of the commonly accepted goals in the education of humans.

Q.2 Discuss the History of Artificial Intelligence.

1. **Classical Period:** It was started from 1950. In 1956, the concept of Artificial Intelligence came into existence. During this period, the main research work carried out includes game plying, theorem proving and concept of state space approach for solving a problem.
2. **Romantic Period:** It was started from the mid-1960 and continues until the mid-1970. During this period people were interested in making machine understand, that is usually mean the understanding of natural language. During this period the knowledge representation technique "semantic net" was developed.
3. **Modern Period:** It was started from 1970 and continues to the present day. This period was developed to solve more complex problems. This period includes the research on both theories and practical aspects of Artificial Intelligence. This period includes the birth of concepts like Expert system, Artificial Neurons, Pattern Recognition etc. The research of the various advanced concepts of Pattern Recognition and Neural Network are still going on.

Q.3 What are the Achievements of Artificial Intelligence?

1. ALVINN: Autonomous Land Vehicle In a Neural Network

The system drove a car from the East Coast of USA to the west coast, a total of about 2850 miles. Out of this about 50 miles were driven by a human, and the rest solely by the system.

2. Deep Blue: In 1997, the Deep Blue chess program created by IBM, beat the current world chess champion, Gary Kasparov.

3. Machine translation: A system capable of translations between people speaking different languages

4. Autonomous agents: In space exploration, robotic space probes autonomously monitor their surroundings, make decisions and act to achieve their goals.

5. Internet agents: The explosive growth of the internet has also led to growing interest in internet agents to monitor users' tasks, seek needed information, and to learn which information is most useful.

Q.4 Explain the any four applications of Artificial Intelligence.

a) Theorem Proving: Theorem proving has the property that people who do them well are considered to be displaying intelligence. There are two basics methods of theory proving.

Start with the given axioms, use the rules of inference and prove the theorem.

Prove that the negation of the result cannot be TRUE.

b) Natural Language Processing: The goal of natural language processing is to enable people and computer to communicate in a "natural "(human) language, such as English, rather than in a computer language. Natural language generation, which strives to have computers produce ordinary English language so that people can understand computers more easily.

c) Robotics: A robot is an electro-mechanical device that can be programmed to perform manual tasks. The Robotic Industries Association formally defines a robot as "a **reprogrammable multi-functional manipulator** designed to move material, parts, tools or specialized devices through variable programmed motions for the performance of a variety of tasks. An "intelligent" robot includes some kind of sensory apparatus, such as a camera, that allows it to respond to changes in its environment, rather than just to follow instructions "mindlessly."

d) Expert System: An expert system is a computer program designed to act as an expert in a particular domain (area of expertise). Also known as a knowledge-based system, an expert system typically includes a sizable knowledge base, consisting of facts about the domain and heuristics (rules) for applying those facts.

Q.5 Explain the various Components of an Intelligent Agent.

An intelligent agent typically consists of several key components

1) Sensors: These are responsible for perceiving the environment.

Sensors can include cameras, microphones, touch sensors, or any other sensory input devices.

2) **Actuators:** Actuators enable the agent to interact with the environment by taking actions. Examples include motors, speakers, and displays.

3) **Knowledge Base:** The agent maintains a knowledge base or internal representation of its environment and goals, which it uses for decision-making.

4) **Reasoning and Decision-Making Module:** This component processes information from the sensors and knowledge base to make informed decisions about what actions to take.

5) **Goal or Utility Function:** The agent has a set of goals or objectives it aims to achieve, and it evaluates potential actions based on how well they align with these goals.

Q.6 Discuss the various Types of Intelligent Agents.

1) Reactive Agents: These agents make decisions based solely on their current sensory input. They don't maintain an internal state or memory of past interactions.

2) Deliberative Agents: Deliberative agents plan their actions by considering their goals, the current state of the environment, and possible future states. They often use algorithms like search and optimization to make decisions.

3) Learning Agents: Learning agents can adapt and improve their behavior over time through machine learning techniques. They can acquire knowledge from data and past experiences.

4) Multi-Agent Systems: In some scenarios, multiple intelligent agents can collaborate or compete with each other to achieve individual or collective goals.

Q.7 Write note on Problems, Problem Spaces and Search.

Problems:

To solve the problem of building a system you should take the following steps:

1. Define the problem accurately including detailed specifications and what constitutes a suitable solution.

2. Scrutinize the problem carefully, for some features may have a central effect on the chosen method of solution.
3. Segregate and represent the background knowledge needed in the solution of the problem.
4. Choose the best solving techniques for the problem to solve a solution.

A 'problem space' is an abstract space.

1) A problem space encompasses all valid states that can be generated by the application of any combination of operators on any combination of objects.

2) The problem space may contain one or more solutions. A solution is a combination of operations and objects that achieve the goals.

A 'search' refers to the search for a solution in a problem space.

1) Search proceeds with different types of 'search control strategies'.

2) The depth-first search and breadth-first search are the two common search strategies.

Q.8 Write note on Advance search in AI.

AI programs is *searc,* Often there is no direct way to find a solution to some problem. However, you do know how to generate possibilities. For example, in solving a puzzle you might know all the possible moves, but not the sequence that would lead to a solution. When working out how to get somewhere you might know all the roads/buses/trains, just not the best route to get you to your destination quickly. Developing good ways to search through these possibilities for a good solution is therefore vital. *Brute force techniques, where you generate and try out every* possible solution may work, but are often very inefficient, as there are just too many possibilities to try. *Heuristic techniques are often better, where you only try* the options, which you think (based on your current best guess) are most likely to lead to a good solution.

Q.9 Explain the Properties of Search Algorithms.

Following are the four essential properties of search algorithms to compare the efficiency of these algorithms:

1) **Completeness:** A search algorithm is said to be complete if it guarantees to return a solution if at least any solution exists for any random input.
2) **Optimality:** If a solution found for an algorithm is guaranteed to be the best solution (lowest path cost) among all other solutions, then such a solution for is said to be an optimal solution.
3) **Time Complexity:** Time complexity is a measure of time for an algorithm to complete its task.
4) **Space Complexity:** It is the maximum storage space required at any point during the search, as the complexity of the problem.

Q.10 Discuss various types of search algorithms.

The types of search algorithms are:

1. Uninformed search

Uninformed search move through the space without worrying about what is coming next, but recognising the answer if we see it

Types of Uninformed search:

i. **Breadth First Search (BFS)**

Breadth first search is also like depth first search. Here searching progresses level by level. Unlike depth first search, which goes deep into the tree. An operator employed to generate all possible children of a node. Breadth first search being the brute force search generates all the nodes for identifying the goal.

ii. **Depth First Search (DFS)**

The searching process in AI can be broadly classified into two major types. Viz. Brute Force Search and Heuristics Search. Brute Force Search do not have any domain specific knowledge. All they need is initial state, the final. state and a set of legal operators. Depth-First Search is one the important technique of Brute Force Search.

In Depth-First Search, search begins by expanding the initial node, i.e., by using an operator, generate all successors of the initial node and test them.

2. Informed search

Informed search guess what is ahead, and use that information to decide where to look next. We may want to search for the first answer that satisfies our goal, or we may want to keep searching until we find the best answer.

Types of Informed search:

I. Best first search (BFS)

II. A* search

III. AO* search

i. **Best first search**

Best first search combines the advantages of both depth first search and breadth first search.

At each step, we select the most promising of the nodes we have generated so far. This is done by applying an appropriate heuristic function to each of them. We then expand the chosen node by using the rules to generate it successors.

ii. **A* ALGORITHM**

A * Algorithm is a searching algorithm that searches for the shortest path between the *initial and the final state.* It is used in various applications, such as *maps.* In *maps* the A* Algorithm is used to calculate the shortest distance between the source (initial state) and the destination (final state). A* Algorithm has 3 parameters:

- **g:** the **cost** of moving from the **initial cell to the current cell**. Basically, it is the sum of all the cells that have been visited since leaving the first cell.
- **h:** also known as the heuristic value, it is the **estimated cost** of moving from the current cell to the final cell. The actual cost cannot be calculated until the final cell is reached. Hence, h is the estimated cost. We must make sure that there is never an over estimation of the cost.

iii. Problem Reduction (AND - OR graphs - AO * Algorithm)

When a problem can be divided into a set of sub problems, where each sub problem can be solved separately and a combination of these will be a solution, AND-OR graphs or AND - OR trees are used for representing the solution.

Q.11 Explain the applications of Breadth first search.

The applications of Breadth first search are:

1. Shortest Path and Minimum Spanning Tree for unweighted graph In unweighted graph, the shortest path is the path with least number of edges. With Breadth First.
2. Peer to Peer Networks. In Peer to Peer Networks like BitTorrent, Breadth First Search is used to find all neighbor nodes.
3. Crawlers in Search Engines: Crawlers build index using Breadth First.
4. Social Networking Websites: In social networks, we can find people within a given distance 'k' from a person using Breadth First Search till 'k' levels.
5. GPS Navigation systems: Breadth First Search is used to find all neighboring locations.
6. Broadcasting in Network: In networks, a broadcasted packet follows Breadth First Search to reach all nodes.

Q.12 Write note on Means - Ends Analysis.

The means-ends analysis process centres around finding the difference between current state and goal state. The problem space of means - ends analysis has an initial state and one or more goal state, a set of operate with a set of preconditions their application and difference functions that computes the difference between two state a(i) and s(j). A problem is solved using means - ends analysis by

1. Computing the current state s1 to a goal state s2 and computing their difference D12.
2. Satisfy the preconditions for some recommended operator op is selected, then to reduce the difference D12.

3. The operator OP is applied if possible. If not the current state is solved a goal is created and means- ends analysis is applied recursively to reduce the sub goal.
4. If the sub goal is solved state is restored and work resumed on the original problem.

Q.14 Write note on Adversarial search and Game play.

Games have always been an important application area for heuristic algorithms. In playing games whose state space may be exhaustively delineated, the primary difficulty is in accounting for the actions of the opponent. This can be handled easily by assuming that the opponent uses the same knowledge of the state space as us and applies that knowledge in a consistent effort to win the game.

To improve the effectiveness, the following two things can be done: Improve the generate procedure so that only good paths are generated

Improve the test procedure so that the best moves will be recognized and explored first.

Q.15 Write note on MIN-MAX Search.

The min max search procedure is a depth first, depth limited search procedure. The idea is to start at the current position and use the plausible move generator to generate the set of possible successor positions.

To decide one move, it explores the possibilities of winning by looking ahead to more than one step. This is called a ply. Thus in a two ply search, to decide the current move, game tree would be explored two levels farther.

Consider the below example:

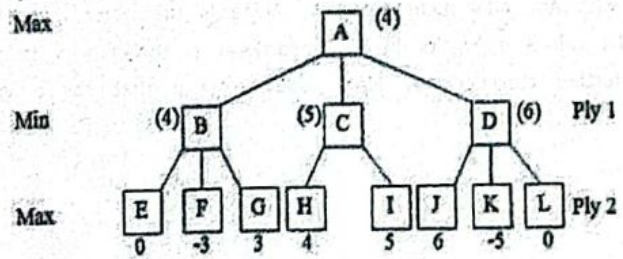


Figure Tree showing two ply search

In this tree, node A represents current state of any game and nodes B, C and D represent three possible valid moves from state A. similarly E, F, G represents possible moves from B, H, I from C and J, K, L, from D. to decide which move to be taken from A, the different possibilities are explored to two next steps. 0, -3, 3, 4, 5, 6, -5, 0 represent the utility values of respective move. They indicate goodness of a move. The utility value is back propagated to ancestor node, according to situation whether it is max ply or min ply.

Q.16 Write note on Alpha- Beta ( ) Pruning (Cut-off).

When a number of states of a game increase and it cannot be predicted about the states, then we can use the method pruning. **Pruning** is a method which is used to **reduce the number of states** in a game. Alpha- beta is one such pruning technique. The problem with minmax search is that the number of game states it has to examine is exponential in the number of moves. Unfortunately, we cannot eliminate the exponent, but we can effectively **cut it in half.** Alpha-beta pruning is one of the solutions to the problem of minmax search tree. When $\alpha - \beta$ pruning is applied to a standard minmax tree, it returns the same move as minmax would, but prunes away branches that cannot possibly influence the final decision.

The idea of alpha beta pruning is very simple. Alpha beta search proceeds in a depth first fashion rather than searching the entire space. Generally, two values, called **alpha and beta**, are created during the search.

The alpha value is associated with MAX nodes and the beta value is with MIN values. The value of alpha can never decrease; on the other hand, the value of beta never increases. Suppose the alpha value of a MAX node is 5. The MAX node then need not consider any transmitted value less than or equal to 5 which is associated with any MIN node below it. Alpha is the worst that MAX can score given that MIN will also do its best. Similarly, if a MIN has a beta value of 5, it need not further consider any MAX node below it that has a value of 6 or more.

KNOWLEDGE-BASED AGENTS — Unit - 2

SECTION A

Q.1 Write any four properties of Wumpus.

- **Partially observable:** The Wumpus world is partially observable because the agent can only perceive the close environment such as an adjacent room.
- **Deterministic:** It is deterministic, as the result and outcome of the world are already known.
- **Sequential:** The order is important, so it is sequential.
- **Static:** It is static as Wumpus and Pits are not moving.

Q.2 What is Propositional Logic?

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.

Q.3 What is predicate logic?

A predicate is an expression of one or more variables determined on some specific domain. A predicate with variables can be made a proposition by either authorizing a value to the variable or by quantifying the variable.

Q.4 What are the difference between PL and FOL?

Propositional Logic converts a complete sentence into a symbol and makes it logical whereas in First-Order Logic relation of a particular sentence will be made that involves relations, constants, functions, and constants.

PL does not signify or express the generalization, specialization or pattern for example 'QUANTIFIERS' cannot be used in PL but in FOL users can easily use quantifiers as it does express the generalization, specialization, and pattern.

Q.5 What is Unification?

Unification is a process of making two different logical atomic expressions identical by finding a substitution. Unification depends on the substitution process. It takes two literals as input and makes them identical using substitution.

Q.6 What is Forward Chaining?

Forward chaining is also known as a forward deduction or forward reasoning method when using an inference engine. Forward chaining is a form of reasoning which start with atomic sentences in the knowledge base and applies inference rules (Modus Ponens) in the forward direction to extract more data until a goal is reached.

Q.7 What are the Properties of Forward-Chaining?

- It is a down-up approach, as it moves from bottom to top.
- It is a process of making a conclusion based on known facts or data, by starting from the initial state and reaches the goal state.
- Forward-chaining approach is also called as data-driven as we reach to the goal using available data.

Q.8 What are the Properties of backward chaining?

- It is known as a top-down approach.
- Backward-chaining is based on modus ponens inference rule.
- In backward chaining, the goal is broken into sub-goal or sub-goals to prove the facts true.
- It is called a goal-driven approach, as a list of goals decides which rules are selected and used.

Q.9 What is Resolution?

- Resolution is a theorem proving technique that proceeds by building refutation proofs, i.e., proofs by contradictions. It was invented by a Mathematician John Alan Robinson in the year 1965.
- Resolution is used, if there are various statements are given, and we need to prove a conclusion of those statements.

Q.10 What is backward chaining?

Backward-chaining is also known as a backward deduction or backward reasoning method when using an inference engine. A backward chaining algorithm is a form of reasoning, which starts with the goal and works backward, chaining through rules to find known facts that support the goal.

Q.11 What is Inference engine?

The Inference engine is the component of the intelligent system in artificial intelligence, which applies logical rules to the knowledge base to infer new information from known facts. The first Inference engine was part of the expert system. Inference engine commonly proceeds in two modes, which are:

Q.12 What is Truth Maintenance Systems?

Truth Maintenance Systems (TMS), also called Reason Maintenance Systems, are used within Problem Solving Systems, in conjunction with Inference Engines (IE) such as rule-based Inference systems, to manage as a **Dependency Network.**

Q.13 What is learning?

Learning is the improvement of performance with experience over time. Learning element is the portion of a learning AI system that decides how to modify the performance element and implements those modifications.

Q.14 What is decision tree?

Decision Tree is a **supervised learning technique** that can be used for both classification and Regression problems, but mostly it is preferred for solving Classification problems.

Q.15 Why use Decision Trees?

There are various algorithms in Machine learning, so choosing the best algorithm for the given dataset and problem is the main point to remember while creating a machine learning model. Below are the two reasons for using the Decision tree:

- Decision Trees usually mimic human thinking ability while making a decision, so it is easy to understand.

- The logic behind the decision tree can be easily understood because it shows a tree-like structure.

Q.16 What is Gini Index?

- Gini index is a measure of impurity or purity used while creating a decision tree in the CART(Classification and Regression Tree) algorithm.

Q.17 What is information gain?

- Information gain is the measurement of changes in entropy after the segmentation of a dataset based on an attribute.
- It calculates how much information a feature provides us about a class.

Q.18 What is pruning?

Pruning is a process of deleting the unnecessary nodes from a tree in order to get the optimal decision tree.

Q.19 Give the meaning of Root Node.

Root node is from where the decision tree starts. It represents the entire dataset, which further gets divided into two or more homogeneous sets.

Q.20 Give the meaning of Leaf Node.

Leaf nodes are the final output node, and the tree cannot be segregated further after getting a leaf node.

Q.21 Give the meaning of Splitting.

Splitting is the process of dividing the decision node/root node into sub-nodes according to the given conditions.

SECTION B

Q.1 Write note on PEAS description of Wumpus world.

To explain the Wumpus world we have given PEAS description as below:

1. Performance measure:

a) +1000 reward points if the agent comes out of the cave with the gold.

b) -1000 points penalty for being eaten by the Wumpus or falling into the pit.

c) -1 for each action, and -10 for using an arrow.

d) The game ends if either agent dies or came out of the cave.

2. Environment:

a) A 4*4 grid of rooms.

b) The agent initially in room square [1, 1], facing toward the right.

c) Location of Wumpus and gold are chosen randomly except the first square [1,1].

d) Each square of the cave can be a pit with probability 0.2 except the first square.

3. Actuators:

- Left turn,
- Right turn
- Move forward
- Grab
- Release
- Shoot.

4. Sensors:

a) The agent will perceive the **stench** if he is in the room adjacent to the Wumpus. (Not diagonally).

b) The agent will perceive **breeze** if he is in the room directly adjacent to the Pit.

c) The agent will perceive the **glitter** in the room where the gold is present.

d) The agent will perceive the **bump** if he walks into a wall.

e) When the Wumpus is shot, it emits a horrible **scream** which can be perceived anywhere in the cave.

f) These percepts can be represented as five element list, in which we will have different indicators for each sensor.

Q.2 Explain the Wumpus world Properties.

a) **Partially observable:** The Wumpus world is partially observable because the agent can only perceive the close environment such as an adjacent room.

b) **Deterministic:** It is deterministic, as the result and outcome of the world are already known.

c) **Sequential:** The order is important, so it is sequential.

d) **Static:** It is static as Wumpus and Pits are not moving.

e) **Discrete:** The environment is discrete.

f) **One agent:** The environment is a single agent as we have one agent only and Wumpus is not considered as an agent.

Q.3 Explain the propositional logic.

Propositional logic, also known as sentential logic, is a branch of classical logic that deals with the logical relationships between propositions (statements that are either true or false). It provides a formal and systematic way to analyze and manipulate logical expressions. The basic building blocks of propositional logic are propositions, logical connectives, and truth values.

1. Propositions:

A proposition is a declarative statement that is either true or false but not both.

Examples of propositions:

"The sky is blue."

"2 + 2 = 5."

"It is raining."

2. Logical Connectives:

Logical connectives are used to combine or modify propositions to create more complex statements.

The main logical connectives are:

Negation (¬): Denotes the opposite of a proposition.

Example: If P is "It is raining," then ¬P is "It is not raining."

Conjunction (∧): Represents the logical AND, and it is true only if both propositions are true.

Example: $P \wedge Q$ is true if both P and Q are true.

Disjunction (∨): Represents the logical OR, and it is true if at least one of the propositions is true.

Example: $P \vee Q$ is true if either P or Q or both are true.

Implication (→): Represents the logical implication, and it is read as "if... then..."

Example: $P \rightarrow Q$ is true unless P is true and Q is false.

Biconditional (↔): Represents the logical equivalence, and it is true if both propositions have the same truth value.

Example: $P \leftrightarrow Q$ is true if both P and Q are true or both are false.

3. Truth Values:

Propositions can be either true (T) or false (F).

The truth value of compound propositions is determined by the truth values of their constituent propositions and the logical connectives used.

4. Logical Equivalences:

Logical equivalences are statements that express the same truth value, regardless of the truth values of their constituent propositions.

Example: $P \wedge Q$ is logically equivalent to $Q \wedge P$.

Q.4 Explain the First-order predicate logic.

First-order predicate logic (FOPL), also known as first-order logic (FOL) or predicate calculus, is an extension of propositional logic that allows for a more expressive and nuanced representation of logical relationships. While propositional logic deals with propositions as atomic units, first-order logic introduces variables, quantifiers, and predicates to represent more complex structures.

Here are the key components of first-order predicate logic:

1. Constants and Variables:

In FOPL, we can use constants and variables to represent objects or individuals in a domain.

Examples:

Constants: a, b, c

Variables: x, y, z

2. Predicates:

Predicates are expressions that involve variables and represent properties or relationships.

They can be unary (involving one variable), binary (involving two variables), and so on.

Examples:

P(x): "x is a person."

Q(x,y): "x is the parent of y."

3. Quantifiers:

FOPL introduces two quantifiers: universal quantifier ($\forall$) and existential quantifier ($\exists$).

$\forall x$ is read as "for all x" and indicates that a statement holds for every possible value of x in the domain.

$\exists x$ is read as "there exists x" and indicates that there is at least one value of x for which the statement is true.

4. Formulas:

FOPL formulas are constructed using predicates, variables, constants, and logical connectives.

For example,

$P(x) \wedge Q(y,z)$ represents the conjunction of the propositions "x is a person" and "y is the parent of z."

5. Quantified Formulas:

Formulas in FOPL can include quantifiers to express statements about all or some elements in the domain.

Example:

$\forall x(P(x) \rightarrow Q(x))$ can be read as "For all x, if x is a person, then x has the property Q."

6. Binding Variables:

The scope of a variable is determined by the quantifier that binds it.

For example, in

$\forall x P(x) \wedge Q(x)$, the scope of x is the entire conjunction.

First-order predicate logic is more expressive than propositional logic and allows for the representation of complex relationships and the formulation of statements about groups of objects. It is widely used in various fields, including mathematics, computer science, philosophy, linguistics, and artificial intelligence, to reason about structured information and relationships. The use of quantifiers adds a level of generality that enables the expression of statements applicable to entire classes of objects.

Q.5 What are symbols used in formalized symbolic logics.

Propositional Logic Symbols:

1. Propositional Variables:

P,Q,R,...: Represent propositions.

2. Logical Connectives:

$\neg$: Negation (NOT)

$\wedge$: Conjunction (AND)

$\vee$: Disjunction (OR)

$\rightarrow$: Implication (IF...THEN)

$\leftrightarrow$: Biconditional (IF AND ONLY IF)

3. Truth Values:

T: True

F: False

First-Order Predicate Logic Symbols:

1. Quantifiers:

∀ : Universal Quantifier (FOR ALL)

∃ : Existential Quantifier (THERE EXISTS)

2. Variables:

x,y,z,...: Represent variables that can take values from a specified domain.

4. Predicates:

P(x),Q(x,y),...: Represent properties or relationships involving variables.

5. Equality:

=: Represents equality between terms.

6. Logical Connectives (as in propositional logic):

¬, ∧,∨,→,↔

These symbols are used to formalize logical expressions and statements, making it easier to represent and analyze complex relationships and logical structures.

Q.6 Write note on FOPL - First-order predicate logic.

FOPL was developed to extend the expressiveness of PL. It is a generalization of the PL that permits reasoning about world objects as relational entities as well as classes or subclasses of objects. This generalization comes from the introduction of predicates in place of propositions, the use of functions and the use of variables together with quantifiers.

Syntax of FOPL:

The symbols and rules of combination permitted in FOPL are defined as follows.

Connections: 4└ , ┐,∩ ,!,!

Quantifiers: 2 (Existential Quantification)

┐ (For all) (Universal Quantification)

Constants: Fixed value terms that belong to a given domain, denoted

by numbers, words, E.g. Flight- 102, ak - 47, etc;

Variables: Terms that can assume different values over a given domain, denoted by words.

Functions: Function symbols denotes relations defined on a domain D. They map n elements (n >= 0) to a single element of the domain. Symbols f, g, h and words such as father- of, age- of represent functions.

E.g. f (t1, t2,.....,tn) where t, are terms (constants, variables or functions) defined over some domain, n>=0.

Q.7 Explain the difference between propositional logic and first-order logic.

Propositional logic and first-order logic differ in their expressive power and the complexity of the relationships they can represent. The distinction between propositional and first-order inference lies in the types of logical statements and reasoning they handle.

1. Propositional Inference:

Scope: Propositional logic deals with propositions as atomic units without internal structure. It does not have variables, quantifiers, or predicates.

Expressiveness: Limited expressiveness. Propositional logic is suitable for simple statements and relationships but lacks the ability to represent more complex structures.

Inference: Propositional inference involves determining the truth values of propositions based on given truth values using logical connectives. Inference is typically straightforward due to the simplicity of propositional statements.

Examples:

P∧Q: P AND Q

¬P: NOT P

P∨Q: P OR Q

2. First-Order Inference:

Scope: First-order logic extends propositional logic by introducing variables, quantifiers, and predicates. Variables can represent elements in a domain, quantifiers express generality, and predicates represent relationships.

Expressiveness: Higher expressiveness. First-order logic can represent complex relationships, properties, and statements involving variables and quantifiers.

Inference: First-order inference involves reasoning about more intricate relationships, including quantified statements.

The use of quantifiers ($\forall, \exists$) allows for reasoning about all elements or at least one element in a specified domain.

Examples:

$\forall x(P(x) \rightarrow Q(x)))$: For all x, if P(x), then Q(x)

$\exists y(R(y) \wedge S(y))$: There exists y such that R(y) and S(y)

Summary: Propositional Logic: Simple, deals with truth values of propositions, no variables or quantifiers, limited expressiveness. First-Order Logic: More complex, involves variables, quantifiers, and predicates, higher expressiveness, allows reasoning about general statements.

In summary, propositional logic is suitable for simple scenarios where propositions are atomic, while first-order logic provides a more expressive framework for dealing with relationships between variables, quantified statements, and complex structures. First-order inference involves reasoning about the relationships expressed in first-order logic, which includes both propositional-like aspects and additional features related to quantifiers and variables.

Q.8 Write the following sentences in symbolic form.

a. Some people who trust others one rewarded.

b. If anyone is good then Jhon is good.

c. He is ambitious or no one is ambitious.

d. Someone is teasing.

e. It is not true that all roads lead to Rome.

Solution:

Let P(x) : x is a person.

T(x) : x trusts others.

R(x) : x is rewarded.

G(x) : x is good.

A(x) : x is ambitious.

Q(x) : x is teasing.

S(x) : x is a road.

L(x) : x leads to Rome.

Then

a. Some People who trust others one rewarded.

Can be rephrased as

"There is one x such that x is a person, x trusts others and x is rewarded."

Symbolic form: (2 x) [P(x)¬T(x)¬R(x)]

b. If anyone is good, then Jhon is good, then Jhon is good can be worded as.

"If there is one x such that x is a person and x is good, then Jhon is good".

Symbolic form: (2x) [(P(x)¬G(x))] G (John).

c. 'He' represents a particular person. Let that person be y. so, that statement is 'Y' is ambitious or for all x, if x is a person then x is not ambitious.

Symbolic Form: (¬(for all) x): (2y): A(y)¬[P(x) 4└ A(x)]

d. 'Some one is teasing' can be written as "Then is one x such that x is a person and x is teasing".

Symbolic form: (2x) [P(x)¬Q(x)]

e. The statement can be written as 4└(¬(for all) x)[s(x) L(x)] or (2 (x))[s(x)¬4└L(x)]

Q.9 Explain the differences between PL and FOL.

a) Propositional Logic converts a complete sentence into a symbol and makes it logical whereas in First-Order Logic relation of a particular sentence will be made that involves relations, constants, functions, and constants.

b) The limitation of PL is that it does not represent any individual entities whereas FOL can easily represent the individual establishment that means if you are writing a single sentence then it can be easily represented in FOL.

c) PL does not signify or express the generalization, specialization or pattern for example 'QUANTIFIERS' cannot be used in PL but in FOL users can easily use quantifiers as it does express the generalization, specialization, and pattern.

Q.10 Write note on Unification.

a) Unification is a process of making two different logical atomic expressions identical by finding a substitution. Unification depends on the substitution process.

b) It takes two literals as input and makes them identical using substitution.

c) Let Ψ_1 and Ψ_2 be two atomic sentences and be a unifier such that, $\Psi_1 = \Psi_2$, then it can be expressed as **UNIFY**(Ψ_1, Ψ_2).

d) Example: Find the MGU for Unify{King(x), King(John)}

Let Ψ_1 = King(x), Ψ_2 = King(John),

Substitution θ = {John/x} is a unifier for these atoms and applying this substitution, and both expressions will be identical.

- The UNIFY algorithm is used for unification, which takes two atomic sentences and returns a unifier for those sentences (If any exist).
- Unification is a key component of all first-order inference algorithms.
- It returns fail if the expressions do not match with each other.
- The substitution variables are called Most General Unifier or MGU.

Q.11 What is Forward Chaining? Explain the Properties of Forward-Chaining.

Forward chaining is also known as a forward deduction or forward reasoning method when using an inference engine. Forward chaining is a form of reasoning which start with atomic sentences in the knowledge base and applies inference rules (Modus Ponens) in the forward direction to extract more data until a goal is reached.

Properties of Forward-Chaining:

1) It is a down-up approach, as it moves from bottom to top.
2) It is a process of making a conclusion based on known facts or data, by starting from the initial state and reaches the goal state.
3) Forward-chaining approach is also called as data-driven as we reach to the goal using available data.
4) Forward -chaining approach is commonly used in the expert system, such as CLIPS, business, and production rule systems.

Q.12 Write note on Truth Maintenance System (TMS).

Truth Maintenance Systems (TMS), also called Reason Maintenance Systems, are used within Problem Solving Systems, in conjunction with Inference Engines (IE) such as rule-based inference systems, to manage as a **Dependency Network.**

A TMS is intended to satisfy a number of goals:

1) Provide justifications for conclusions

When a problem solving system gives an answer to a user's query, an explanation of the answer is usually required. If the advice to a stockbroker is to invest millions of dollars, an explanation of the reasons for that advice can help the broker reach a reasonable decision.

2) Recognise inconsistencies

The IE may tell the TMS that some sentences are contradictory. Then, if on the basis of other IE commands and of inferences we find that all those sentences are believed true, then the TMS reports to the IE that a contradiction has arisen.

3) Support default reasoning

In many situations we want, in the absence of firmer knowledge, to reason from default assumptions. If Tweety is a bird, until told otherwise, we will assume that Tweety flies and use as justification the fact that Tweety is a bird and the assumption that birds fly.

4) Remember derivations computed previously

In the process of determining what is responsible for a network problem, we may have derived, while examining the performance of a name server, that Ms.Doe is an expert on e-mail systems.

5) Support dependency driven backtracking

The justification of a sentence, as maintained by the TMS, provides the natural indication of what assumptions need to be changed if we want to invalidate that sentence.

Q.13 What are the types of Truth Maintenance Systems?

a) Justification-Based Truth Maintenance System (JTMS)

It is a simple TMS where one can examine the consequences of the current set of assumptions. The meaning of sentences is not known.

b) Assumption-Based Truth Maintenance System (ATMS)

It allows to maintain and reason with a number of simultaneous, possibly incompatible, current sets of assumption. Otherwise it is similar to JTMS, i.e. it does not recognise the meaning of sentences.

c) Logical-Based Truth Maintenance System (LTMS)

Like JTMS it reasons with only one set of current assumptions at a time. More powerful than JTMS, it recognises the propositional semantics of sentences, i.e. understands the relations between p and ~p, p and q, and so on.

Q.14 Explain different types of learning.

There are five methods of learning. They are,

1. **Learning by memorization** is the simplest form of learning. It requires the least amount of inference and is accomplished by simply copying the knowledge in the same form that it will be used directly into the knowledge base.

   Example: Memorizing multiplication tables, formulating, etc.

2. **Direct instruction is a complex form of learning.** This type of learning requires more inference than role learning since the knowledge must be transformed into an operational form before learning when a teacher presents several facts directly to us in a well-organized manner.

3. **Analogical learning is the process of learning** a new concept or solution through the use of similar known concepts or solutions. We use this type of learning when solving problems on an exam where previously learned examples serve as a guide or when making frequent use of analogical learning.

4. **Learning by induction** is also one that is used frequently by humans. It is a powerful form of learning like analogical learning which also requires more inferring than the first two methods. This learning requires the use of inductive inference, a form of invalid but useful inference.

Q.15 Write note on Inductive learning.

Inductive learning is an inherently conjectural process because any knowledge created by generalization from specific facts cannot be proven true; it can only be proven false. Hence, inductive inference is falsity preserving, not truth preserving.

- To generalize beyond the specific training examples, we need constraints or biases on what f is best. That is, learning can be viewed as searching the Hypothesis Space H of possible f functions.
- A bias allows us to choose one f over another one
- A completely unbiased inductive algorithm could only memorize the training examples and could not say anything more about other unseen examples.
- Two types of biases are commonly used in machine learning:

- Restricted Hypothesis Space Bias Allow only certain types of f functions, not arbitrary ones
- Preference Bias Define a metric for comparing fs so as to determine whether one is better than another .

Inductive Learning Framework

- Raw input data from sensors are preprocessed to obtain a feature vector, x, that adequately describes all of the relevant features for classifying examples.
- Each x is a list of (attribute, value) pairs. For example,

  x = (Person = Sue, Eye-Color = Brown, Age = Young, Sex = Female)

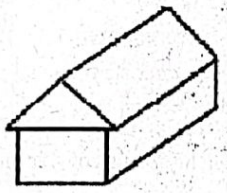
Q.16 Write note on Winston's learning.

Winston (1975) described a Blocks World Learning program. This program operated in a simple blocks domain. The goal is to construct representation of the definition of concepts in the blocks domain.

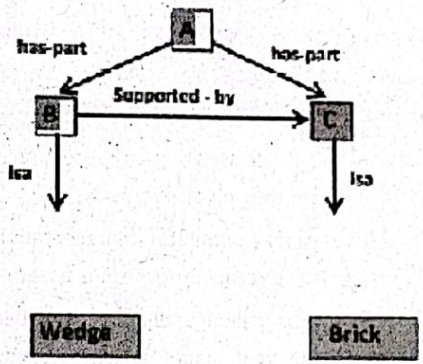
Example: Concepts such a "house".

- Start with input, a line drawing of a blocks world structure. It learned concepts House, Tent, Arch as: brick (rectangular block) with a wedge (triangular block) suitably placed on top of it, tent – as 2 wedges touching side by side, or an arch – as 2 non-touching bricks supporting a third wedge or brick.
- The program for Each concept is learned through near miss. A near miss is an object that is not an instance of the concept but a very similar to such instances.
- The program uses procedures to analyze the drawing and construct a semantic net representation.
- An example of such an structural for the house is shown below.

Object - house



Semantic net



- Node A represents entire structure, which is composed of two parts : node B, a Wedge Brick has-part A has-part B is a Supported - by C is a Wedge, and node C, a Brick.

Links in network include supported-by, has-part, and is a.

Winston's Program

Winston's program followed 3 basic steps in concept formulation:

1. Select one known instance of the concept. Call this the concept definition.
2. Examine definitions of other known instance of the concept. Generalize the definition to include them.
3. Examine descriptions of near misses. Restrict the definition to exclude these.

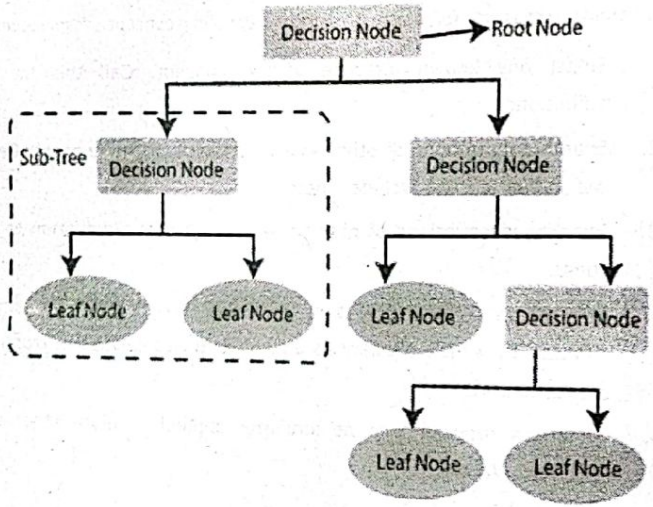
- Both steps 2 and 3 of this procedure rely heavily on comparison process by which similarities and differences between structures can be detected.
- Winston's program can be similarly applied to learn other concepts such as "ARCH"

Q.17 Write note on Decision Tree.

Decision Tree is a Supervised learning technique that can be used for both classification and Regression problems, but mostly it is preferred for solving Classification problems. It is a tree-structured classifier, where internal nodes represent the features of a dataset, branches represent the decision rules and each leaf node represents the outcome.

- The decisions or the test are performed on the basis of features of the given dataset.
- It is a graphical representation for getting all the possible solutions to a problem/decision based on given conditions.
- It is called a decision tree because, similar to a tree, it starts with the root node, which expands on further branches and constructs a tree-like structure.
- In order to build a tree, we use the CART algorithm, which stands for Classification and Regression Tree algorithm.
- A decision tree simply asks a question, and based on the answer (Yes/No), it further split the tree into subtrees.

o Below diagram explains the general structure of a decision tree:



Q.18 How does the Decision Tree algorithm work?

In a decision tree, for predicting the class of the given dataset, the algorithm starts from the root node of the tree. This algorithm compares the values of root attribute with the record (real dataset) attribute and, based on the comparison, follows the branch and jumps to the next node.

For the next node, the algorithm again compares the attribute value with the other sub-nodes and move further. It continues the process until it reaches the leaf node of the tree. The complete process can be better understood using the below algorithm:

Step-1: Begin the tree with the root node, says S, which contains the complete dataset.

Step-2: Find the best attribute in the dataset using **Attribute Selection Measure (ASM).**

Step-3: Divide the S into subsets that contains possible values for the best attributes.

Step-4: Generate the decision tree node, which contains the best attribute.

Step-5: Recursively make new decision trees using the subsets of the dataset created in step -3. Continue this process until a stage is reached where you cannot further classify the nodes and called the final node as a leaf node.

Q.19 What are the advantages and disadvantages of the Decision Tree?

Advantages

a) It is simple to understand as it follows the same process which a human follow while making any decision in real-life.

b) It can be very useful for solving decision-related problems.

c) It helps to think about all the possible outcomes for a problem.

d) There is less requirement of data cleaning compared to other algorithms.

Disadvantages

The decision tree contains lots of layers, which makes it complex.

a) It may have an overfitting issue, which can be resolved using the Random Forest algorithm.

b) For more class labels, the computational complexity of the decision tree may increase.

INTRODUCTION TO PLANNING

Unit - 3

SECTION A

Q.1 What is planning in AI?

The *planning* problem in Artificial Intelligence is about the decision making performed by intelligent creatures like robots, humans, or computer programs when trying to achieve some goal. It involves choosing a sequence of actions that will transform the state of the world, step by step, so that it will satisfy the goal.

Q.2 What are the basic components of a planning system?

a. States

b. Goal

c. Actions

d. Precondition

e. Effect

f. Finding a solution

g. Calculating the Dead State

Q.3 What is membership function?

Definition: A graph that defines how each point in the input space is mapped to membership value between 0 and 1.

Q.4 What is Fuzzy Control?

It is a technique to embody human-like thinking into a control system. It may not be designed to give accurate reasoning but it is designed to give acceptable reasoning.

Q.5 What are the Applications of fuzzy logic?

a) It is used in the aerospace field for altitude control of spacecraft and satellites.

b) It has been used in the automotive system for speed control, traffic control.

c) It is used for decision-making support systems and personal evaluation in the large company business.

Q.6 What is Fuzzification?

It is used to convert inputs i.e. crisp numbers into fuzzy sets. Crisp inputs are basically the exact inputs measured by sensors and passed into the control system for processing, such as temperature, pressure, rpm's, etc.

Q.7 What is a robot?

A robot is a machine that looks like a human, and is capable of performing out of box actions and replicating certain human movements automatically by means of commands given to it using programming.

Q.8 What are Digital Images?

Image processing deals with digital images, which are composed of a grid of discrete pixels. Each pixel represents a tiny portion of the image and contains information about color, intensity, and sometimes additional data (e.g., transparency or depth).

Q.9 What is Image Acquisition?

Images are typically obtained from various sources, such as digital cameras, scanners, or sensors. Image acquisition involves capturing real-world scenes and converting them into digital format.

Q.10 What is Image Enhancement?

Image enhancement techniques are used to improve the quality of images for better visualization or analysis. Common enhancement operations include adjusting brightness, contrast, and sharpness, as well as removing noise and artifacts.

Q.11 What is Image Restoration?

Image restoration focuses on the removal of degradation effects like blurring, noise, or distortion caused during image acquisition or transmission. Techniques include deconvolution and filtering.

Q.12 What is Image Compression?

Image compression reduces the size of digital images to save storage space or facilitate faster transmission over networks. Popular image compression standards include JPEG and PNG.

Q.13 What is Image Analysis?

Image analysis involves extracting meaningful information or features from images. This can include object recognition, object tracking, and measurement of various image characteristics.

Q.14 What is Image Segmentation?

Image segmentation divides an image into distinct regions or objects based on certain criteria. It is often used in computer vision for object detection and scene understanding.

Q.15 What is Computer Vision?

Image processing is a fundamental component of computer vision systems, enabling machines to "see" and understand their surroundings. Applications include facial recognition, autonomous vehicles, and robotics.

Q.16 What is Complexity?

Many real-world planning problems are highly complex, with numerous variables, constraints, and interdependencies. Handling this complexity efficiently remains a major challenge.

Q.17 What is Scalability?

As the problem size increases, traditional planning algorithms can become computationally infeasible. Scaling up planning algorithms to handle large, complex domains is a persistent challenge.

Q.18 What is Ethical and Fair Planning?

Ensuring that AI planning systems make ethical decisions and produce fair plans is a growing concern, especially in domains with potential societal impacts.

SECTION B

Q.1 Explain the different types of Planning?

1. **Classical Planning:** In classical planning, the environment is assumed to be deterministic, and actions have known effects. Classical planners often use symbolic representations like STRIPS (Stanford Research Institute Problem Solver) or PDDL (Planning Domain Definition Language).
2. **Probabilistic Planning:** In probabilistic planning, uncertainty is considered, and actions may have probabilistic outcomes. Bayesian networks and Markov decision processes are commonly used in this context.
3. **Hierarchical Planning:** In hierarchical planning, the problem is decomposed into smaller, more manageable sub-problems, allowing for more efficient planning and execution.
4. **Reactive Planning:** Reactive planners respond to the immediate environment without considering a long-term plan. They are often used in real-time, dynamic environments.

Q.2 Explain the Basic Components of a Planning System.

Various components of a planning system are described as follows.

(a) States: For a planning process, the planners decompose the world into some environments. Then environments are defined by some logical conditions and states. The problems can be viewed as the task of finding a path from a given starting state to some desirable goal state.

(b) Goal: A goal is a specified state. To find a solution to a problem using a search procedure is to generate moves through the problem space until a goal state is reached. In the context of game-playing programs, a goal state is one in which we win. Unfortunately, for interesting games like chess, it is not usually, possible, even with a good plausible move generator, to search until a goal state is found.

(c) Actions: An action is specified in terms of the pre-conditions that must be held before it can be executed and then the effects that ensue when it is executed. For example, an action for running a tiger from one location to another is:

Action (Run (T, from, to),

PRECONDITION: At (T, from) ^ Tiger (T) ^ Jungle (from) ^ Jungle (To)

EFFECT: ~ At (T, from) ^ At (T, to))

(d) Precondition: The precondition is a conjunction of function free positive literals stating what must be true in a state before the action can be executed.

(e) Effect: It is a conjunction of function free literals describing how the state changes when the action is executed.

(f) Finding a solution: A planning system has succeeded in finding a solution to a problem when it has found a sequence of operators that transforms the initial problem state into the goal state. The way it can be solved depends on the way that state descriptions are represented.

(g) Calculating the Dead State: As a planning system is searching for a sequence of operators to solve a particular problem, it must be able to detect when it is exploring a path that can never lead to a solution.

Q.3 What is Blocks World Planning?

a) A flat surface such as a table top

b) An adequate set of identical blocks which are identified by letters.

c) The blocks can be stacked one on one to form towers of apparently unlimited height.

d) The stacking is achieved using a robot arm which has fundamental operations and states which can be assessed using logic and combined using logical operations.

e) The robot can hold one block at a time and only one block can be moved at a time.

Q.4 Write note on GOAL STACK PLANNING.

Goal Stack Planning is one of the most important planning algorithms, which is specifically used by STRIPS.

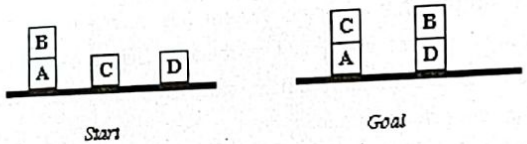
The stack is used in an algorithm to hold the action and satisfy the goal. A knowledge base is used to hold the current state, actions.

Goal stack is similar to a node in a search tree, where the branches are created if there is a choice of an action.

Basic Idea to handle interactive compound goals uses goal stacks, Here the stack contains:

goals, operators — ADD, DELETE and PREREQUISITE lists a database maintaining the current situation for each operator used.

Consider the following where wish to proceed from the *start* to *goal* state.



Start *Goal*

Q.5 What are the Challenges of planning in artificial intelligence?

While AI planning has made significant advancements, it still faces several challenges:

1. **Complexity:** Many real-world planning problems are highly complex, with numerous variables, constraints, and interdependencies. Handling this complexity efficiently remains a major challenge.
2. **Scalability:** As the problem size increases, traditional planning algorithms can become computationally infeasible. Scaling up planning algorithms to handle large, complex domains is a persistent challenge.
3. **Incomplete Information:** Many real-world scenarios involve uncertainty or incomplete information. AI planners must be able to handle situations where the full state of the world is not known.
4. **Continuous and Hybrid Domains:** Traditional planning models assume discrete actions and states, but many real-world problems involve continuous or hybrid domains (a mix of discrete and continuous variables), making planning more challenging.
5. **Temporal Reasoning:** Many tasks require reasoning about time, including scheduling and coordination. Incorporating temporal reasoning into planning models can be complex.
6. **Dynamic Environments:** Real-world environments are dynamic, and the state of the world can change unpredictably. Planning systems need to be able to adapt to these changes.

Q.6 Discuss the Monotonic Reasoning vs Non-monotonic Reasoning.

Monotonic Reasoning	Non-Monotonic Reasoning
1. Monotonic Reasoning is the process which does not change its direction or can say that it moves in the one direction.	Non-monotonic Reasoning is the process which changes its direction or values as the knowledge base increases.
2. Monotonic Reasoning deals with very specific type of models, which has valid proofs.	Non-monotonic reasoning deals with incomplete or not known facts.
3. The addition in knowledge won't change the result.	The addition in knowledge will invalidate the previous conclusions and change the result.
4. In monotonic reasoning, results are always true, therefore, set of prepositions will only increase.	In non-monotonic reasoning, results and set of prepositions will increase and decrease based on condition of added knowledge.
5 Monotonic Reasoning is based on true facts.	Non-monotonic Reasoning is based on assumptions.

Q.7 Write note on Probabilistic reasoning.

Probabilistic reasoning is a way of knowledge representation where we apply the concept of probability to indicate the uncertainty in knowledge. In

probabilistic reasoning, we combine probability theory with logic to handle the uncertainty.

Need of probabilistic reasoning in AI:

- When there are unpredictable outcomes.
- When specifications or possibilities of predicates becomes too large to handle.
- When an unknown error occurs during an experiment.

In probabilistic reasoning, there are two ways to solve problems with uncertain knowledge:

- Bayes' rule
- Bayesian Statistics

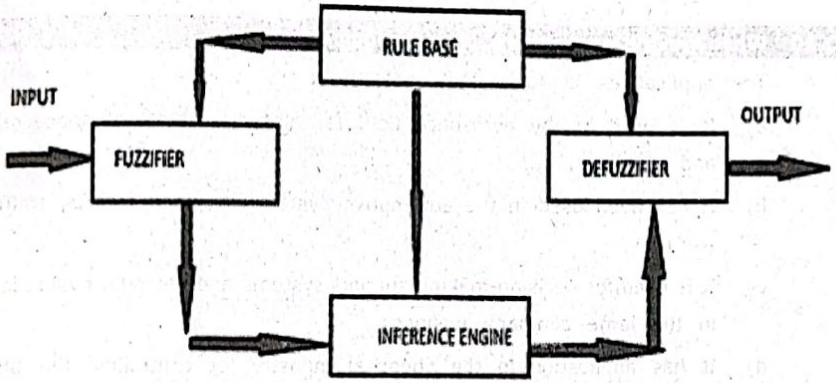
As probabilistic reasoning uses probability and related terms, so before understanding probabilistic reasoning, let's understand some common terms:

Q.8 Explain the FUZZY LOGIC ARCHITECTURE.

Its Architecture contains four parts:

1. **RULE BASE:** It contains the set of rules and the IF-THEN conditions provided by the experts to govern the decision-making system, based on linguistic information. Recent developments in fuzzy theory offer several effective methods for the design and tuning of fuzzy controllers. Most of these developments reduce the number of fuzzy rules.
2. **FUZZIFICATION:** It is used to convert inputs i.e. crisp numbers into fuzzy sets. Crisp inputs are the exact inputs measured by sensors and passed into the control system for processing, such as temperature, pressure, rpm, etc.
3. **INFERENCE ENGINE:** It determines the matching degree of the current fuzzy input with respect to each rule and decides which rules are to be fired according to the input field. Next, the fired rules are combined to form the control actions.

4. **DEFUZZIFICATION:** It is used to convert the fuzzy sets obtained by the inference engine into a crisp value. There are several defuzzification methods available and the best-suited one is used with a specific expert system to reduce the error.



FUZZY LOGIC ARCHITECTURE

Q.9 What are the advantages and disadvantages of Fuzzy Logic System?

Advantages of Fuzzy Logic System

a) This system can work with any type of inputs whether it is imprecise, distorted or noisy input information.

b) The construction of Fuzzy Logic Systems is easy and understandable.

c) Fuzzy logic comes with mathematical concepts of set theory and the reasoning of that is quite simple.

d) It provides a very efficient solution to complex problems in all fields of life as it resembles human reasoning and decision-making.

e) The algorithms can be described with little data, so little memory is required.

Disadvantages of Fuzzy Logic Systems

a) Many researchers proposed different ways to solve a given problem through fuzzy logic which leads to ambiguity. There is no systematic approach to solve a given problem through fuzzy logic.

b) Proof of its characteristics is difficult or impossible in most cases because every time we do not get a mathematical description of our approach.

c) As fuzzy logic works on precise as well as imprecise data so most of the time accuracy is compromised.

Q.10 What are the applications of fuzzy logic?

The applications of fuzzy logic are:

a) It is used in the aerospace field for altitude control of spacecraft and satellites.

b) It has been used in the automotive system for speed control, traffic control.

c) It is used for decision-making support systems and personal evaluation in the large company business.

d) It has application in the chemical industry for controlling the pH, drying, chemical distillation process.

e) Fuzzy logic is used in Natural language processing and various intensive applications in Artificial Intelligence.

f) Fuzzy logic is extensively used in modern control systems such as expert systems.

g) Fuzzy Logic is used with Neural Networks as it mimics how a person would make decisions, only much faster. It is done by Aggregation of data and changing it into more meaningful data by forming partial truths as Fuzzy sets.

Q.11 What is a robot? Explain the components of robots.

A robot is a machine that looks like a human and is capable of performing out-of-the-box actions and replicating certain human movements automatically using commands given to it using programming.

Examples: Drug Compounding Robots, Automotive Industry Robots, Order Picking Robots, Industrial Floor Scrubbers Sage Automation Gantry Robots, etc.

Components of robots:

1. **Actuators:** Actuators are the devices that are responsible for moving and controlling a system or machine. It helps to achieve physical movements by converting energy like electrical, hydraulic air, etc. Actuators can create linear as well as rotary motion.
2. **Power Supply:** It is an electrical device that supplies electrical power to an electrical load. The primary function of the power supply is to convert electrical current to power the load.
3. **Pneumatic Air Muscles:** Air Muscles are soft pneumatic devices that are ideally best fitted for robotics. They can contract extend and operate by pressurized air filling a pneumatic bladder. Whenever air is introduced, it can contract up to 40%.
4. **Muscles wire:** These are made up of nickel-titanium alloy called Nitinol and are very thin in shape. It can also extend and contract when a specific amount of heat and electric current is supplied to it.
5. **Piezo Motors and Ultrasonic Motors:** Piezoelectric motors or Piezo motors are electrical devices that receive an electric signal and apply a directional force to an opposing ceramic plate.
6. **Sensor:** They provide the ability like see, hear, touch and move like humans. Sensors are the devices or machines that help to detect events or changes in the environment and send data to the computer processor.

Q.12 What is Robot Kinematics?

Kinematics pertains to the motion of bodies in a robotic mechanism without regard to the forces/torques that cause the motion. Since robotic mechanisms are by their very essence designed for motion, kinematics is the most fundamental aspect of robot design, analysis, control, and simulation.

The robotics community has focused on efficiently applying different representations of position and orientation and their derivatives concerning time to solve foundational kinematics problems.

Forward Kinematics:

Forward kinematics is the process of calculating the frames of a robot's links, given a configuration and the robot's kinematic structure as input. The forward kinematics of a robot can be mathematically derived in closed form, which is useful for further analysis during mechanism design, or it can be computed in a software library in microseconds for tasks like motion prediction, collision detection, or rendering.

Q.13 Write note on Computer Vision.

Computer vision plays an important role in automated manufacturing industries, driverless car testing, medical diagnostics, monitoring crops and other real-time applications. Popular companies like Amazon, Google, Microsoft and Facebook are spending a lot on computer vision research.

Applications of Computer Vision

The usage of computer vision especially in retail, automotive, healthcare, agriculture, banking and industry. Amazon recently started the Amazon Go store where customers do need to wait in queue at the counter to pay their bills specialized cameras are fitted everywhere to monitor customer activities and these shops are located in Seattle, Washington. The technology called JustWalkOut is used in the Go store. Customers should activate the IOS or Android mobile phone app while entering the store gate. Cameras are fitted on the ceiling, over the passageways and on the shelves. In case the item is kept back on the shelf, then the system can remove that item from the customer's virtual basket.

The App can track people all the time inside the store with the help of a network of cameras. It makes sure that all the items are billed correctly as the customers walk out. As the name indicates the customers can walk freely out of the store after they have taken their products the app will send an online receipt to the customer which can be paid to their Amazon account.

Q.14 Write note on image processing.

This introduction provides an overview of image processing and its key concepts.

1. **Digital Images:** Image processing deals with digital images, which are composed of a grid of discrete pixels. Each pixel represents a tiny portion of the image and contains information about color, intensity, and sometimes additional data (e.g., transparency or depth).
2. **Image Acquisition:** Images are typically obtained from various sources, such as digital cameras, scanners, or sensors. Image acquisition involves capturing real-world scenes and converting them into digital format.
3. **Image Enhancement:** Image enhancement techniques are used to improve the quality of images for better visualization or analysis. Common enhancement operations include adjusting brightness, contrast, and sharpness, as well as removing noise and artifacts.
4. **Image Restoration:** Image restoration focuses on the removal of degradation effects like blurring, noise, or distortion caused during image acquisition or transmission. Techniques include deconvolution and filtering.
5. **Image Compression:** Image compression reduces the size of digital images to save storage space or facilitate faster transmission over networks. Popular image compression standards include JPEG and PNG.
6. **Image Analysis:** Image analysis involves extracting meaningful information or features from images. This can include object recognition, object tracking, and measurement of various image characteristics.
7. **Image Segmentation:** Image segmentation divides an image into distinct regions or objects based on certain criteria. It is often used in computer vision for object detection and scene understanding.
8. **Morphological Operations:** Morphological operations are used to process images based on the shape and structure of objects within them. These operations are useful for tasks like image filtering, edge detection, and image recognition.

Q.15 Explain the different types of image classification.

Depending on the problem at hand, there are different types of image classification methodologies to be employed. These are binary, multiclass, multilabel, and hierarchical.

1. **Binary:** Binary classification takes an either-or logic to label images, and classifies unknown data points into two categories. When your task is to categorize benign or malignant tumors, analyze product quality to find out whether it has defects or not, and many other problems that require yes/no answers are solved with binary classification.
2. **Multiclass:** While binary classification is used to distinguish between two classes of objects, multiclass, as the name suggests, categorizes items into three or more classes. It's very useful in many domains like NLP (sentiment analysis where more than two emotions are present), medical diagnosis(classifying diseases into different categories), etc.
3. **Multilabel:** Unlike multiclass classification, where each image is assigned to exactly one class, multilabel classification allows the item to be assigned to multiple labels. For example, you may need to classify image colors and there are several colors.
4. **Hierarchical:** Hierarchical classification is the task of organizing classes into a hierarchical structure based on their similarities, where a higher-level class represents broader categories and a lower-level class is more concrete and specific.

Q.16 How image classification works?

It's a known fact that the image we see as a whole is made up of hundreds to thousands of tiny pixels. Before computer vision can determine and label the image as a whole, it needs to analyze the individual components of the image to make an educated assumption. That is why image classification techniques analyze a given image in the form of pixels and accomplish this by treating the picture as an array of matrices, the size of which is determined by the image resolution. The pixels of the digital image are taken and grouped into what we know as "classes."

From here, the process will differ based on the algorithm but before observing the various machine learning algorithms, let's take a more generalized look at how it works. The chosen algorithm will transform the image into a series of key attributes to ensure it is not left solely on the final classifier. Those attributes help the classifier determine what the image is about and which class it belongs to.

Q.17 What is Object Detection? Explain the concepts and methods in object detection.

Object detection is a computer vision task that involves identifying and locating objects of interest within an image or video frame. Unlike image classification, where the goal is to assign a single label to an entire image, object detection aims to not only classify objects but also provide their precise spatial locations through bounding boxes.

Here's an overview of key concepts and methods in object detection:

1. **Dataset Preparation:** Object detection typically requires a labeled dataset with images and bounding boxes around the objects of interest. Each bounding box is associated with a class label that identifies the type of object.
2. **Convolutional Neural Networks (CNNs):** CNNs are the backbone of most modern object detection models. These neural networks are used for feature extraction from input images. They consist of convolutional layers, pooling layers, and fully connected layers.
3. **Region Proposal Networks (RPN):** Many object detection frameworks incorporate Region Proposal Networks (RPNs) to generate candidate object regions (bounding boxes) within an image. These regions are scored for likelihood of containing objects.
4. **Anchor Boxes:** Anchor boxes are pre-defined bounding box shapes with different aspect ratios and scales. They are used by RPNs to propose potential object locations. The model adjusts these anchor boxes to tightly fit the detected objects.
5. **Two-Stage and Single-Stage Detectors:** Object detection models can be categorized into two-stage and single-stage detectors. Two-

stage detectors (e.g., Faster R-CNN) first propose regions of interest and then classify and refine those regions. They are often more accurate but slower.

6. **Non-Maximum Suppression (NMS):** After object regions are detected, NMS is applied to remove redundant bounding boxes with overlapping regions. This step helps eliminate duplicate detections.
7. **Training and Loss Functions:** During training, object detection models are optimized to minimize a combination of classification and localization loss. Common loss functions include cross-entropy loss for classification and smooth L1 loss for bounding box regression.
8. **Evaluation Metrics:** Object detection models are evaluated using metrics such as mean Average Precision (mAP), Intersection over Union (IoU), and precision-recall curves.
9. **Transfer Learning:** Transfer learning is often used to fine-tune pretrained object detection models on specific datasets or tasks. This helps in cases where labeled data is limited.

Q.18 Write note on image classification vs. object detection.

Image classification, object detection, object localization — all of these may be a tangled mess in your mind, and that's completely fine if you are new to these concepts. In reality, they are essential components of computer vision and image annotation, each with its distinct nuances. Let's untangle the intricacies right away.

Object detection on the other hand is the method of locating items within an and image assigning labels to them, as opposed to image classification, which assigns a label to the entire picture. As the name implies, object detection recognizes the target items inside an image, labels them, and specifies their position. One of the most prominent tools to perform object detection is the "bounding box" which is used to indicate where a particular object is located on an image and what the label of that object is. Essentially, object detection combines image classification and object localization.

NATURAL LANGUAGE PROCESSING

Unit - 4

SECTION A

Q.1 What is Natural Language Processing?

Natural Language Processing is a branch of AI that helps computers to understand, interpret and manipulate human languages like English or Hindi to analyse and derive it's meaning.

Q.2 What is Phonological Analysis?

This level is applied only if the text origin is a speech. It deals with the interpretation of speech sounds within and across words. Speech sound might give a big hint about the meaning of a word or a sentence.

Q.3 What is Morphological Analysis?

Deals with understanding distinct words according to their morphemes (the smallest units of meanings).

Q.4 What is Lexical Analysis?

It involves identifying and analysing the structure of words. Lexicon of a language means the collection of words and phrases in a language. Lexical analysis is dividing the whole chunk of txt into paragraphs, sentences, and words.

Q.5 What is Syntactic Analysis?

Deals with analysing the words of a sentence so as to uncover the grammatical structure of the sentence.

Q.6 What is Semantic Analysis?

Determines the possible meanings of a sentence by focusing on the interactions among word-level meanings in the sentence.

Q.7 What is Discourse Integration?

Focuses on the properties of the text as a whole that convey meaning by making connections between component sentences. It means a sense of the context. The meaning of any single sentence which depends upon that sentences.

Q.8 What is Pragmatic Analysis?

Explains how extra meaning is read into texts without actually being encoded in them. This requires much world knowledge, including the understanding of intentions, plans, and goals.

Q.9 What is an Expert System?

An expert system is a computer program that is designed to solve complex problems and to provide decision-making ability like a human expert. It performs this by extracting knowledge from its knowledge base using the reasoning and inference rules according to the user queries.

Q.10 What is Expert System Shell?

Expert System Shell is a problem-independent component housing facilities for creating, editing, and executing rules.

Q.11 What is Knowledge Acquisitions?

It is the process of extracting, organizing, and structuring the domain knowledge, specifying the rules to acquire the knowledge from various experts, and store that knowledge into the knowledge base

Q.12 What is Knowledge Base?

The knowledgebase is a type of storage that stores knowledge acquired from the different experts of the particular domain. It is considered as big storage of knowledge. The more the knowledge base, the more precise will be the Expert System.

Q.13 What is Inference Engine?

The inference engine is known as the brain of the expert system as it is the main processing unit of the system. It applies inference rules to the knowledge base to derive a conclusion or deduce new information. It helps in deriving an error-free solution of queries asked by the user.

Q.14 What is learning?

Learning is the improvement of performance with experience over time. Learning element is the portion of a learning AI system that decides how to modify the performance element and implements those modifications.

Q.15 What is Artificial Neural Network?

The term "Artificial Neural Network" is derived from Biological neural networks that develop the structure of a human brain. Similar to the human brain that has neurons interconnected to one another, artificial neural networks also have neurons that are interconnected to one another in various layers of the networks. These neurons are known as nodes.

Q.16 What is Feedback ANN?

In this type of ANN, the output returns into the network to accomplish the best-evolved results internally.

Q.17 What is Feed-Forward ANN?

A feed-forward network is a basic neural network comprising of an input layer, an output layer, and at least one layer of a neuron.

Q.18 What is Machine learning?

Machine learning is a method of teaching computers to learn and make predictions or decisions without being explicitly programmed for each task.

Q.19 What is deep learning?

Deep learning is a subset of machine learning and artificial intelligence (AI) that focuses on training artificial neural networks to perform tasks that typically require human intelligence.

Q.20 What is pattern recognition?

Pattern recognition is a cognitive process and a field of study in computer science and artificial intelligence that involves identifying and classifying patterns or regularities within data or information. It is a fundamental aspect of human intelligence and is also widely applied in machine learning and data analysis.

SECTION B

Q.1 What is Natural language processing? Explain the history.

Natural Language Processing (NLP) is a branch of AI that helps computers to understand, interpret and manipulate human languages like English or Hindi to

analyse and derive it's meaning. NLP helps developers to organize and structure knowledge to perform tasks like translation, summarization, named entity recognition, relationship extraction, speech recognition, topic segmentation, etc.

History of NLP?

1950- NLP started when Alan Turing published an article called "Machine and Intelligence."

1950- Attempts to automate translation between Russian and English

1960- The work of Chomsky and others on formal language theory and generative syntax

1990- Probabilistic and data-driven models had become quite standard

2000- A Large amount of spoken and textual data become available

Q.2 Explain the components of NLP/steps in Natural Language Processing.

Five main Component of Natural Language processing in AI are:

1. **Morphological and Lexical Analysis**

   Lexical analysis is a vocabulary that includes its words and expressions. It depicts analysing, identifying and description of the structure of words. It includes dividing a text into paragraphs, words and the sentences. Individual words are analysed into their components, and non-word tokens such as punctuations are separated from the words.

2. **Semantic Analysis**

   Semantic Analysis is a structure created by the syntactic analyser which assigns meanings. This component transfers linear sequences of words into structures. It shows how the words are associated with each other. Semantics focuses only on the literal meaning of words, phrases, and sentences.

3. **Pragmatic Analysis**

   Pragmatic Analysis deals with the overall communicative and social content and its effect on interpretation. It means abstracting or deriving the meaningful use of language in situations. In this analysis, the main focus always on what was said in reinterpreted on what is meant.

Q.3 Discuss the Natural Language vs Computer Language.

Below are the main differences between Natural Language and Computer Language:

Parameter	Natural Language	Computer Language
Ambiguous	They are ambiguous in nature.	They are designed to unambiguous.
Redundancy	Natural languages employ lots of redundancy.	Formal languages are less redundant.
Literalness	Natural languages are made of idiom & metaphor	Formal languages mean exactly what they want to say.

Q.4 What are the advantages of NLP?

1. Users can ask questions about any subject and get a direct response within seconds.
2. NLP system provides answers to the questions in natural language
3. NLP system offers exact answers to the questions, no unnecessary or unwanted information
4. The accuracy of the answers increases with the amount of relevant information provided in the question.
5. NLP process helps computers communicate with humans in their language and scales other language-related tasks
6. Allows you to perform more language-based data compares to a human being without fatigue and in an unbiased and consistent way.
7. Structuring a highly unstructured data source

Q.5 Write note on Part-of-Speech (POS) Tagging.

Each word has a part-of-speech tag to describe its category.

Part-of-speech tag of a word is one of major word groups (or its subgroups).

open classes — noun, verb, adjective, adverb

closed classes — prepositions, determiners, conjuctions, pronouns, particples

POS Taggers try to find POS tags for the words.

duck is a verb or noun? (morphological analyzer cannot make decision).

A POS tagger may make that decision by looking the surrounding words.

Duck! (verb)

Duck is delicious for dinner. (noun)

Q.6 Write note on Parsing.

It is the process of analysing a continuous stream of input in order to determine its grammatical structure with respect to a given formal grammar.

Parse tree:

Graphical representation of a derivation or deduction is called a parse tree. Each interior node of the parse tree is a non-terminal; the children of the node can be terminals or non-terminals.

Types of parsing:

1. Top down parsing
2. Bottom up parsing

Top-down parsing: A parser can start with the start symbol and try to transform it to the input string. Example: LL Parsers.

Bottom-up parsing: A parser can start with input and attempt to rewrite it into the start symbol. Example: LR Parsers.

Q.7 Write note on Augmented Transition Network (ATN).

A transition network is a network consisting of nodes and labelled arcs. The nodes represent different states of a process and the arcs represent the transitions from state to state, with labels referring to word categories in NLP. A Recursive Transition Network (RTN) is a transition network which allows arc labels to refer to both word categories as well as other networks. It has the same descriptive power as context-free grammars. In order to extend the power of RTN

and Transformational Grammar, Augmented Transition Network was developed as a method of expressing syntactic grammar that was computationally tractable and could capture linguistic generalizations in a concise way. Basically, ATN consists of an RTN augmented by a set of tests to be satisfied before an arc was traversed and a set of registers that could be used to save intermediate results or global states.

ATN, let us consider the same example from article 1, but in passive form in which the CFG is unable to resolve.

Q.8 What are the characteristics of Expert System?

The characteristics of Expert System are:

a) **High Performance:** The expert system provides high performance for solving any type of complex problem of a specific domain with high efficiency and accuracy.

b) **Understandable:** It responds in a way that can be easily understandable by the user. It can take input in human language and provides the output in the same way.

c) **Reliable:** It is much reliable for generating an efficient and accurate output.

d) **Highly responsive:** ES provides the result for any complex query within a very short period of time.

Q.9 What are the advantages and limitations of Expert System?

Advantages

a) These systems are highly reproducible.

b) They can be used for risky places where the human presence is not safe.

c) Error possibilities are less if the KB contains correct knowledge.

d) The performance of these systems remains steady as it is not affected by emotions, tension, or fatigue.

e) They provide a very high speed to respond to a particular query.

Limitations

a) The response of the expert system may get wrong if the knowledge base contains the wrong information.

b) Like a human being, it cannot produce a creative output for different scenarios.

c) Its maintenance and development costs are very high.

d) Knowledge acquisition for designing is much difficult.

Q.10 Explain the applications of Expert System.

The applications of expert system:

a) **In designing and manufacturing domain:** It can be broadly used for designing and manufacturing physical devices such as camera lenses and automobiles.

b) **In the knowledge domain:** These systems are primarily used for publishing the relevant knowledge to the users. The two popular ES used for this domain is an advisor and a tax advisor.

c) **In the finance domain:** In the finance industries, it is used to detect any type of possible fraud, suspicious activity, and advise bankers that if they should provide loans for business or not.

d) **In the diagnosis and troubleshooting of devices:** In medical diagnosis, the ES system is used, and it was the first area where these systems were used.

e) **Planning and Scheduling:** The expert systems can also be used for planning and scheduling some particular tasks for achieving the goal of that task.

Q.11 Write short note on Expert System Architecture.

The Expert System Shell is a problem-independent component housing facilities for creating, editing, and executing rules. A software architecture for an expert system is illustrated in the following Figure.

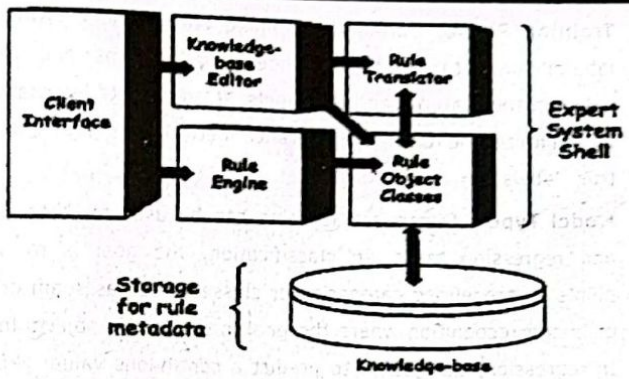


Figure: Expert System Architecture

The shell portion includes software modules whose purpose it is to,

- Process requests for service from system users and application layer modules
- Support the creation and modification of business rules by subject matter experts
- Translate business rules, created by a subject matter expert, into machine-readable forms
- Execute business rules and
- Provide low-level support to expert system components (e.g., retrieve metadata from and save metadata to knowledge base, build Abstract Syntax Trees during rule translation of business rules, etc.).

Q.12 Write short note on Supervised learning.

Supervised learning is the types of machine learning in which machines are trained using well "labelled" training data, and on basis of that data, machines predict the output.

Some key aspects of supervised learning:

1. **Labeled Data:** In supervised learning, you have a dataset consisting of input-output pairs, where the input is often referred to as features, and the output is the target or label. For example, in a spam email classifier, the features might be the words in an email, and the labels are binary (spam or not spam).

2. **Training Phase:** During the training phase, the algorithm uses the labeled data to learn the underlying patterns and relationships between the features and the labels. It adjusts its internal parameters to minimize the error or difference between its predictions and the true labels.
3. **Model Types:** Supervised learning can be used for both classification and regression tasks. In classification, the goal is to assign data points to predefined categories or classes, such as spam or not spam, or image recognition where the goal is to identify objects in an image. In regression, the goal is to predict a continuous value, like predicting house prices based on features like size, location, and number of bedrooms.

Q.13 Write note on unsupervised learning.

Unsupervised learning is a machine learning paradigm where the algorithm learns patterns and structures in data without explicit supervision or labelled training examples.

The two common types of unsupervised learning techniques:

1. **Clustering:** Clustering algorithms group data points into clusters based on similarities or patterns within the data. The goal is to find natural groupings or clusters of data points without any prior knowledge of what those groups represent. Examples of clustering algorithms include K-Means, Hierarchical Clustering, and DBSCAN.
2. **Dimensionality Reduction:** Dimensionality reduction techniques aim to reduce the number of features (or dimensions) in a dataset while preserving as much relevant information as possible. This is useful for visualizing data, removing noise, and simplifying complex datasets. Principal Component Analysis (PCA) and t-Distributed Stochastic Neighbor Embedding (t-SNE) are common dimensionality reduction methods.

Unsupervised learning has several applications across various domains, including:

- **Customer Segmentation:** Businesses can use clustering to segment their customer base into groups with similar purchasing behaviors.
- **Anomaly Detection:** Unsupervised learning can be used to identify unusual or anomalous data points in applications like fraud detection or network security.
- **Image and Text Analysis:** Dimensionality reduction techniques can help visualize high-dimensional data, and clustering can be used to group similar images or texts together.
- **Recommendation Systems:** Collaborative filtering algorithms often use unsupervised techniques to recommend products or content to users based on their preferences and behaviours.

Q.14 Explain the components of Reinforcement learning.

The components of reinforcement learning include:

1. **Agent:** The learner or decision-maker that interacts with the environment. It takes actions based on its policy.
2. **Environment:** The external system with which the agent interacts. The environment is dynamic and responds to the agent's actions, providing feedback in the form of rewards and new states.
3. **State (s):** A representation of the current situation or configuration of the environment. The state is essential because it determines the available actions and the consequences of those actions.
4. **Action (a):** The choices made by the agent to influence the environment. The set of possible actions is defined by the environment.
5. **Reward (r):** A numerical signal provided by the environment after each action taken by the agent. It indicates how good or bad the action was with respect to the agent's objective.
6. **Policy (δ):** A strategy or mapping from states to actions that defines the agent's behavior. The policy can be deterministic or stochastic.
7. **Value Function (V):** It estimates the expected cumulative reward an agent can obtain starting from a particular state and following a particular policy. It helps the agent evaluate how good a state or state-action pair is.

8. **Q-Value Function (Q):** This function estimates the expected cumulative reward of taking a specific action in a given state and then following a policy. It's used in algorithms like Q-learning and Deep Q-Networks (DQN).

Q.15 What are the characteristics Recurrent Neural Network (Top of Form RNN)?

The characteristics and components of RNNs:

1. **Recurrent Connections:** The defining feature of an RNN is its recurrent connections. These connections allow information to flow not only from the input to the output but also through a hidden state or memory cell, which can store information about previous time steps.
2. **Time Steps:** RNNs process data one time step at a time, where each time step corresponds to a specific element in the input sequence. This allows them to handle sequences of arbitrary length.
3. **Hidden State:** At each time step, an RNN computes an output and updates its hidden state based on the current input and the previous hidden state. This hidden state serves as a kind of memory that can store information from past time steps and influence the current output.
4. **Parameter Sharing:** RNNs share the same set of weights and biases across all time steps, which allows them to learn and generalize patterns within sequences.
5. **Architectural Variations:** There are several architectural variations of RNNs, including vanilla RNNs, Long Short-Term Memory (LSTM) networks, and Gated Recurrent Unit (GRU) networks.

Q.16 Write note on Long Short-Term Memory.

Long Short-Term Memory (LSTM) is a type of recurrent neural network (RNN) architecture that was designed to overcome some of the limitations of traditional RNNs when dealing with long sequences of data.

The key components of an LSTM network are as follows:

1. **Cell State (Ct)**

   The cell state is a linear memory that runs through the entire sequence, allowing information to flow unchanged when necessary. It can be thought of as a conveyor belt that carries information across time steps. LSTMs use a set of gates to control the flow of information into and out of the cell state.

2. **Hidden State (ht)**

   The hidden state is a function of the cell state and the current input. It carries information from previous time steps and is used to make predictions or generate output.

3. **Input Gate (it)**

   The input gate determines which information from the current time step should be stored in the cell state. It takes the current input and the previous hidden state as inputs and produces a vector of values between 0 and 1 to control this.

4. **Forget Gate (ft)**

   The forget gate decides what information from the cell state should be discarded or forgotten. It considers the current input and the previous hidden state to produce a forget gate vector.

5. **Output Gate (ot)**

   The output gate determines what information from the cell state should be used to make predictions or generate the current output. It combines information from the current input and the previous hidden state to produce an output gate vector.

Q.17 What are the Advantages of Artificial Neural Network (ANN)?

The following are the some of the advantages of Artificial Neural Network

1. **Parallel processing capability**

   Artificial neural networks have a numerical value that can perform more than one task simultaneously.

2. **Storing data on the entire network**

   Data that is used in traditional programming is stored on the whole

network, not on a database. The disappearance of a couple of pieces of data in one place doesn't prevent the network from working.

3. **Capability to work with incomplete knowledge**

After ANN training, the information may produce output even with inadequate data. The loss of performance here relies upon the significance of missing data.

4. **Having a memory distribution**

For ANN is to be able to adapt, it is important to determine the examples and to encourage the network according to the desired output by demonstrating these examples to the network.

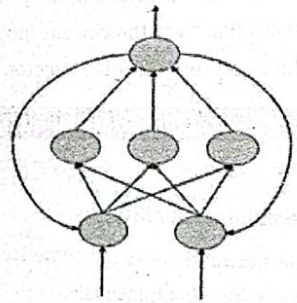
5. **Having fault tolerance**

Extortion of one or more cells of ANN does not prohibit it from generating output, and this feature makes the network fault-tolerance.

Q.18 Explain the Types of Artificial Neural Network.

1. Feedback ANN:

In this type of ANN, the output returns into the network to accomplish the best-evolved results internally. As per the **University of Massachusetts,** Lowell Centre for Atmospheric Research. The feedback networks feed information back into itself and are well suited to solve optimization issues. The Internal system error corrections utilize feedback ANNs.



2. Feed-Forward ANN:

A feed-forward network is a basic neural network comprising of an input layer, an output layer, and at least one layer of a neuron. Through assessment of its output by reviewing its input, the intensity of the network can be noticed based on group behaviour of the associated neurons, and the output is decided. The primary advantage of this network is that it figures out how to evaluate and recognize input patterns.