Q.1) Write & explain various AI problem characteristics.

AI problem characteristics refer to the features or attributes that define the complexity and difficulty of an AI problem. Here are some common AI problem characteristics:

1. Complexity: The problem may involve a large number of variables, constraints, or possibilities, making it difficult to solve using traditional methods.
2. Uncertainty: The problem may involve incomplete, ambiguous, or conflicting information, making it difficult to make accurate predictions or decisions.
3. Dynamic environments: The problem may involve a changing or unpredictable environment, requiring the AI system to adapt and respond in real-time.
4. Multiple objectives: The problem may involve multiple conflicting goals or objectives, requiring the AI system to trade-off between them.
5. Scalability: The problem may involve a large amount of data or a high number of potential solutions, requiring the AI system to be able to handle large volumes of information efficiently.

Examples of AI problems with these characteristics include self-driving cars, medical diagnosis, and financial market prediction. In each of these cases, the AI system must be able to deal with complex and uncertain environments, make decisions based on multiple conflicting objectives, and adapt to changing conditions.

OR

To choose an appropriate method for a particular problem first we need to categorize the problem based on the following characteristics.

1. Is the problem decomposable into small sub-problems which are easy to solve?
2. Can solution steps be ignored or undone?
3. Is the universe of the problem being predictable?
4. Is a good solution to the problem is absolute or relative?
5. Is the solution to the problem a state or a path?
6. What is the role of knowledge in solving a problem using artificial intelligence?
7. Does the task of solving a problem require human interaction?

Q.2) What do you mean by control strategies? Explain request of good control strategies.

Control Strategy in Artificial Intelligence scenario is a technique or strategy, tells us about which rule has to be applied next while searching for the solution of a problem within problem space. It helps us to decide which rule has to apply next without getting stuck at any point. These rules decide the way we approach the problem and how quickly it is solved and even whether a problem is finally solved.

A good Control strategy has two main characteristics:

1. **Control Strategy should cause Motion**
2. **Control strategy should be Systematic**

Finally, it must be efficient in order to find a good answer

Q.3) List various task domains of AI.

Artificial Intelligence tasks are divided into three groups, Mundane Tasks, Formal Tasks and Expert Tasks.

1. **Mundane Tasks:**
   a) Perception
   b) Vision
   c) Speech
   d) Natural Languages
   e) Understanding
   f) Generation
   g) Translation
   h) Common sense reasoning
   i) Robot Control

2. **Formal Tasks**
   a) Games: chess, checkers, etc
   b) Mathematics: Geometry, logic, Proving properties of programs

3. **Expert Tasks:**
   a) Engineering (Design, Fault finding, Manufacturing planning)
   b) Scientific Analysis
   c) Medical Diagnosis
   d) Financial Analysis

Q.4) Give production system rules or water jug problem. Also give the sequence of rules to solve water jug problem

The water jug problem is a classic problem in artificial intelligence that involves finding a sequence of actions to reach a desired state. Here is an example of a set of rules for a production system to solve the water jug problem:

There are two jugs of volume A litre and B litre. Neither has any measuring mark on it. There is a pump that can be used to fill the jugs with water. How can you get exactly x litre of water into the A litre jug? Assuming that we have unlimited supply of water. Note: Let's assume we have A=4 litre and B= 3 litre jugs. And we want exactly 2 Litre water into jug A (i.e., 4 litre jug) how we will do this.

The state space for this problem can be described as the set of ordered pairs of integers **(x,y)** Where,
x represents the quantity of water in the **4-gallon jug x= 0,1,2,3,4**
y represents the quantity of water in **3-gallon jug y=0,1,2,3**
Start State: (0,0)
Goal State: (2,0)
Generate production rules for the water jug problem.

We basically perform three operations to achieve the goal.

1. Fill water jug.
2. Empty water jug
3. and Transfer water jug

Rule 1: If you have a jug of size A and a jug of size B, and the jug of size A is empty, fill it up.

Rule 2: If you have a jug of size A and a jug of size B, and the jug of size B is empty, fill it up.

Rule 3: If you have a jug of size A and a jug of size B, and the jug of size A is full, pour it into the jug of size B until the jug of size B is full or the jug of size A is empty.

Rule 4: If you have a jug of size A and a jug of size B, and the jug of size B is full, pour it into the jug of size A until the jug of size A is full or the jug of size B is empty.

Production Rules:

Rule	State	Process
1	(X,Y | X<4)	(4,Y) {Fill 4-gallon jug}
2	(X,Y |Y<3)	(X,3) {Fill 3-gallon jug}
3	(X,Y |X>0)	(0,Y) {Empty 4-gallon jug}
4	(X,Y | Y>0)	(X,0) {Empty 3-gallon jug}
5	(X,Y | X+Y>=4 ^ Y>0)	(4,Y-(4-X)) {Pour water from 3-gallon jug into 4-gallon jug until 4-gallon jug is full}
6	(X,Y | X+Y>=3 ^X>0)	(X-(3-Y),3) {Pour water from 4-gallon jug into 3-gallon jug until 3-gallon jug is full}
7	(X,Y | X+Y<=4 ^Y>0)	(X+Y,0) {Pour all water from 3-gallon jug into 4-gallon jug}
8	(X,Y | X+Y <=3^ X>0)	(0,X+Y) {Pour all water from 4-gallon jug into 3-gallon jug}
9	(0,2)	(2,0) {Pour 2-gallon water from 3-gallon jug into 4-gallon jug}

Steps or Sequence

Initialization: Start State: (0,0)

1. Fill 3-gallon jug (x,3)
2. Pour all water from 3-gallon jug into 4-gallon jug (3,0)
3. Fill 3-gallon jug (3,3)
4. Pour water from 3-gallon jug into 4-gallon jug until 4-gallon jug is full (4,2
5. Empty 4-gallon jug (0,2)
6. Pour 2 gallon water from 3 gallon jug into 4 gallon jug (2,0)

Goal State: (2,0) Achieved.

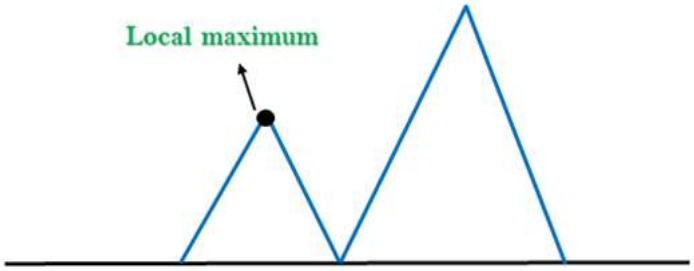
Water Jug Solution using DFS (Depth First Search)

Q.5) What do you mean by control strategies? Explain request of good control strategies.

Problems in Hill Climbing Algorithm:

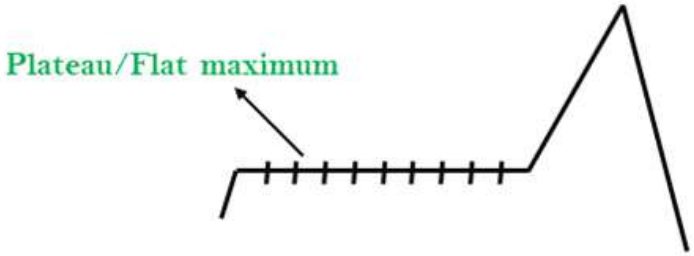
1. Local Maximum: A local maximum is a peak state in the landscape which is better than each of its neighbouring states, but there is another state also present which is higher than the local maximum.

Solution: Backtracking technique can be a solution of the local maximum in state space landscape. Create a list of the promising path so that the algorithm can backtrack the search space and explore other paths as well.



2. Plateau: A plateau is the flat area of the search space in which all the neighbor states of the current state contains the same value, because of this algorithm does not find any best direction to move. A hill-climbing search might be lost in the plateau area.

Solution: The solution for the plateau is to take big steps or very little steps while searching, to solve the problem. Randomly select a state which is far away from the current state so it is possible that the algorithm could find non-plateau region.



3. Ridges: A ridge is a special form of the local maximum. It has an area which is higher than its surrounding areas, but itself has a slope, and cannot be reached in a single move.

Solution: With the use of bidirectional search, or by moving in different directions, we can improve this problem.

Q.6) Write the difference between: -

i) **Procedural and declarative knowledge**
ii) **Predicate logic and propositional logic**
iii) **Forward and Backward reasoning.**

i) Difference the Procedural and Declarative Knowledge

S.NO	Procedural Knowledge	Declarative Knowledge
1.	It is also known as Interpretive knowledge.	It is also known as Descriptive knowledge.
2.	Procedural Knowledge means how a particular thing can be accomplished.	While Declarative Knowledge means basic knowledge about something.
3.	Procedural Knowledge is generally not used means it is not more popular.	Declarative Knowledge is more popular.
4.	Procedural Knowledge can't be easily communicated.	Declarative Knowledge can be easily communicated.
5.	Procedural Knowledge is generally process oriented in nature.	Declarative Knowledge is data oriented in nature.
6.	In Procedural Knowledge debugging and validation is not easy.	In Declarative Knowledge debugging and validation is easy.
7.	Procedural Knowledge is less effective in competitive programming.	Declarative Knowledge is more effective in competitive programming.

ii) Difference between Backward and Forward chaining

Forward Chaining	Backward chaining
Forward chaining suitable for breadth first search.	Backward chaining is suitable for depth search.
It begins with initial facts.	It begins with some hypothesis goal.
It may slow, because in which we tested all the rules.	It may fast as compared to Forward chaining because it test fewer rules.
It provides small amount of data in which we use to store large amount of information.	It provides small amount of data in which we store small information.
It is basically on primarily data driven.	It is basically on goal driven.
It follows Bottom-up reasoning.	It follows Top-down reasoning.
It contains small number of initial states but large number of conclusions.	It contains small number of initial goals and large number of rules.
It is suitable for data collection problem like planning monitoring.	It is suitable for hypothesis problem like diagnosis.
In which all data is available.	In which data must be acquired.

iii) Difference between Propositional Logic and Predicate Logic

	Propositional Logic	Predicate Logic
1	Propositional logic is the logic that deals with a collection of declarative statements which have a truth value, true or false.	Predicate logic is an expression consisting of variables with a specified domain. It consists of objects, relations and functions between the objects.
2	It is the basic and most widely used logic. Also known as Boolean logic.	It is an extension of propositional logic covering predicates and quantification.
3	A proposition has a specific truth value, either true or false.	A predicate's truth value depends on the variables' value.
4	Scope analysis is not done in propositional logic.	Predicate logic helps analyze the scope of the subject over the predicate. There are three quantifiers : Universal Quantifier (∀) depicts for all, Existential Quantifier (∃) depicting there exists some and Uniqueness Quantifier (∃!) depicting exactly one.
5	Propositions are combined with Logical Operators or Logical Connectives like Negation(¬), Disjunction(∨), Conjunction(∧), Exclusive OR(⊕), Implication(⇒), Bi-Conditional or Double Implication(⇔).	Predicate Logic adds by introducing quantifiers to the existing proposition.
6	It is a more generalized representation.	It is a more specialized representation.
7	It cannot deal with sets of entities.	It can deal with set of entities with the help of quantifiers.

Q.7) Explain the following: Scripts, Frames, Genes, Chromosomes

1. **Scripts** are a type of knowledge representation in artificial intelligence that describe the typical sequence of events in a specific situation. For example, a script for going to a restaurant might include steps such as deciding where to go, making a reservation, traveling to the restaurant, and ordering food. Scripts can be used to help an AI system understand and respond appropriately to familiar situations.

2.**Frames** are another type of knowledge representation that are used to organize and structure information about a specific concept or object. A frame consists of a set of slots, which are like fields that contain specific pieces of information, and a set of rules that describe the relationships between the slots. For example, a frame for a person might include slots for the person's name, age, and occupation, as well as rules that describe how these slots are related to each other.

3.**Genes** are the units of heredity that are passed down from parent to offspring. Genes contain the instructions for building and maintaining an organism's cells and traits, and are made up of DNA molecules

A gene is one element position of a chromosome.

4.**Chromosomes** are long, linear strands of DNA that are found in the nucleus of cells. Chromosomes are made up of genes, and they are responsible for passing genetic information from one generation to the next. Humans have 23 pairs of chromosomes, for a total of 46 chromosomes.

In genetic algorithms, a chromosome (also sometimes called a genotype) is **a set of parameters** which **define a proposed solution to the problem that the genetic algorithm is trying to solve. The set of all solutions** is known as **the population**.
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Q.8) What are semantic networks?

Semantic networks are a type of knowledge representation that are used to represent the meaning of words and concepts in a way that is easy for computers to understand. They consist of nodes, which represent concepts or words, and edges, which represent the relationships between the concepts or words.

Semantic networks can be used to represent a wide range of knowledge, including concepts, relationships, and categories. They are a useful tool for helping AI systems understand and reason about complex concepts and relationships.
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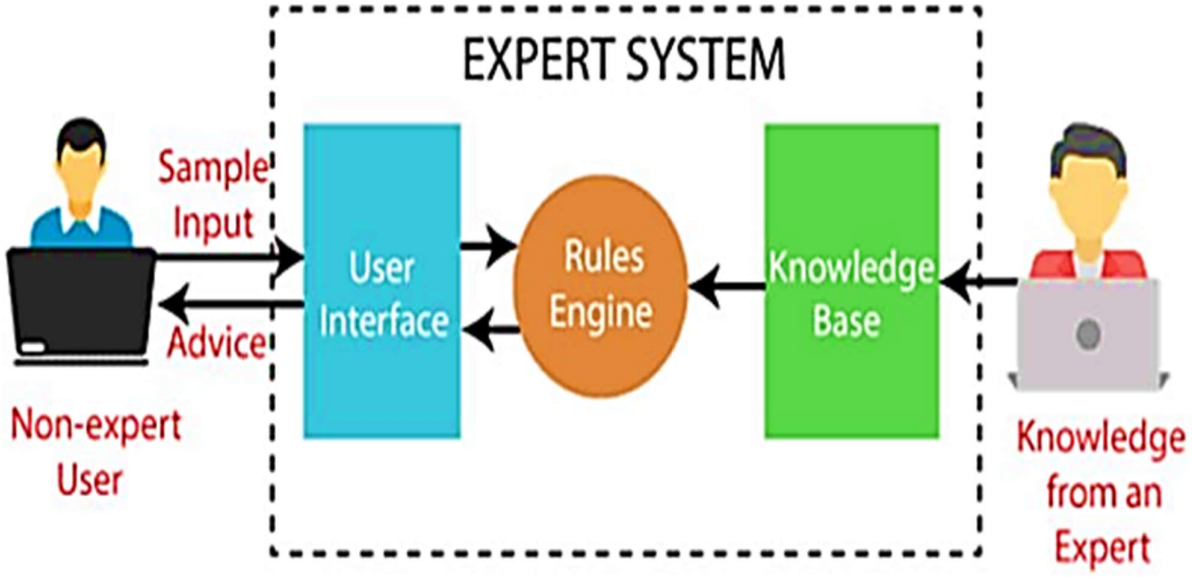
For example, a semantic network for the concept of **"animals"** might include **nodes** for specific animals, such as **"dog," "cat," and "bird,"** as well as **edges that represent the relationships *between the animals***. For example, there might be **an edge between "dog" and "cat"** that represents the relationship "**predator-prey**," and an **edge between "bird" and "cat"** that represents the relationship "**food**."

Q.9) Define expert system shell. Explain architecture of 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.

The performance of an expert system is based on the expert's knowledge stored in its knowledge base.



The architecture of an expert system typically consists of the following components:

1. **Knowledge base:** This is a **database of knowledge and information** about the **domain** that the **expert system is designed to operate in**. The knowledge base is usually composed of a set of rules or facts that the expert system can use to make decisions.
2. **Reasoning engine:** This is the component of the expert system that is **responsible for using the knowledge in the knowledge base to make decisions and solve problems**. The reasoning engine may use techniques such as forward chaining or backward chaining to process the knowledge in the knowledge base and generate conclusions.
3. **User interface:** This is the component of the expert system that **allows users to interact** with the **system and ask questions or provide input**. The user interface may be a command-line interface, a graphical user interface, or a web-based interface, depending on the needs of the expert system.

Q.10) List the levels of NLP and explain each with suitable examples.

Natural language processing (NLP) is the field of artificial intelligence that deals with the interaction between computers and human languages. There are several levels of NLP, including:

1. Lexical analysis: This is the **process of breaking down a piece of text into its individual words and symbol**s.

   For example, a lexical analyser might break the sentence "The cat sat on the mat" into the individual tokens "The", "cat", "sat", "on", "the", "mat".

2. Syntactic analysis: This is the **process of analysing the structure of a sentence in order to understand the relationships between the words and symbols.**

   For example, a syntactic analyser might determine that the subject of the sentence "The cat sat on the mat" is "The cat" and the object is "the mat".

3. Semantic analysis: This is the **process of analysing the meaning of a sentence in order to understand the intended message**.

   For example, a semantic analyser might determine that the sentence "The cat sat on the mat" means that a cat was physically located on top of a mat.

4. Pragmatic analysis: This is the **process of analysing the context and purpose of a piece of language in order to understand its intended meaning**.

   For example, a pragmatic analyser might determine that the phrase "I'm hungry" means that the speaker is requesting food, based on the context of the conversation and the speaker's previous statements.

Q.11) Define
i) Artificial Neural Network
ii) Genetic algorithm

i) Artificial Neural Network

An artificial neural network (ANN) is a type of machine learning algorithm that is inspired by the structure and function of the human brain. It consists of a large number of interconnected processing units called "neurons," which are organized into layers. The input layer receives data, and the output layer produces the final output of the network. The layers in between the input and output layers are called "hidden layers," and they process the data to produce the final output.

Each neuron in an ANN receives input from other neurons and processes it using an activation function, which determines whether the neuron should "fire" and transmit its output to other neurons. The weights of the connections between neurons can be adjusted during training, allowing the network to learn patterns in the data and make predictions or decisions based on those patterns.

ANNs are widely used in a variety of applications, including image and speech recognition, natural language processing, and decision making. They are particularly useful for handling complex, nonlinear relationships in data and can be trained to make accurate predictions or decisions based on large amounts of data.

ii) Genetic algorithm

A genetic algorithm is a type of optimization algorithm that is inspired by the process of natural evolution. It is used to find the optimal solution to a problem by simulating the process of natural selection, in which the fittest individuals are more likely to survive and reproduce.

In a genetic algorithm, a set of potential solutions to a problem, called "individuals," are represented as a string of genes, which are encoded as a series of bits or numbers. The fitness of each individual is evaluated using a fitness function, which measures how well the individual solves the problem.

The genetic algorithm then uses a set of rules, called "operators," to generate a new population of individuals by combining the genes of the fittest individuals from the previous generation. This process is repeated iteratively until the optimal solution is found or a stopping criteria is met.

Genetic algorithms are useful for solving complex optimization problems that may have many local maxima or minima, as they are able to escape from these local optima and search the entire space of possible solutions. They are also useful for problems where the solution space is large and it is not possible to exhaustively search all possible solutions.

Q.12) Explain various applications of ANN.

1. Image and speech recognition: ANNs can be trained to recognize patterns in images and audio data, enabling applications such as facial recognition, object recognition, and speech-to-text translation.
2. Natural language processing: ANNs can be used to process and understand human language, enabling applications such as language translation, text classification, and sentiment analysis.
3. Decision making: ANNs can be used to make decisions based on data and analysis, enabling applications such as fraud detection, credit risk assessment, and recommendation systems.
4. Predictive modelling: ANNs can be used to analyse data and make predictions about future outcomes, enabling applications such as weather forecasting, stock market analysis, and disease prediction.
5. Control systems: ANNs can be used to control systems and processes, enabling applications such as autonomous vehicles and power grid management.
6. Healthcare: ANNs can be used to analyse medical data and assist with diagnosis, treatment planning, and patient monitoring.

Q.13) Difference between Breadth first and depth first search.

Important Differences Between BFS And DFS.

Sr. No.	Key	BFS	DFS
1	Definition	BFS, stands for Breadth First Search.	DFS, stands for Depth First Search.
2	Data structure	BFS uses Queue to find the shortest path.	DFS uses Stack to find the shortest path.
3	Source	BFS is better when target is closer to Source.	DFS is better when target is far from source.
4	Suitability for decision tree	As BFS considers all neighbour so it is not suitable for decision tree used in puzzle games.	DFS is more suitable for decision tree. As with one decision, we need to traverse further to augment the decision. If we reach the conclusion, we won.
5	Speed	BFS is slower than DFS.	DFS is faster than BFS.
6	Time Complexity	Time Complexity of BFS = O(V+E) where V is vertices and E is edges.	Time Complexity of DFS is also O(V+E) where V is vertices and E is edges.

Q.14) Explain Expert System. Define its characteristics.

An expert system is a type of artificial intelligence (AI) that is designed to mimic the decision-making abilities of a human expert in a particular domain. Expert systems are used to solve complex problems that require specialized knowledge and expertise, and they are often used in situations where it is difficult or impractical to rely on a human expert.
There are several characteristics that define expert systems:

1. Domain-specific knowledge: Expert systems are built to operate in a specific domain, such as medicine, finance, or engineering. They are designed to store and use a large amount of domain-specific knowledge in order to make decisions and solve problems.
2. Reasoning: Expert systems use logical reasoning to process the knowledge in their knowledge base and generate conclusions or recommendations. They may use techniques such as forward chaining or backward chaining to process the knowledge and reach a decision.
3. Explanation: Expert systems are able to explain the reasoning behind their decisions, allowing users to understand how the system arrived at its conclusions.
4. Interactivity: Expert systems are typically designed to interact with users, allowing them to ask questions and provide input to the system.
5. Autonomy: Expert systems are able to operate independently and make decisions without the need for human intervention.

Q.15) Explain Bayes Theorem and describe Bayesian Network.

Bayes' theorem is a mathematical formula that is used to **calculate the probability of an event based on prior knowledge or evidence.** It is named after the mathematician Thomas Bayes, who first developed the theorem in the 18th century. The theorem is written as follows:
P(A|B) = P(B|A) * P(A) / P(B)
where:

- P(A|B) is the probability of event A occurring given that event B has occurred
- P(B|A) is the probability of event B occurring given that event A has occurred
- P(A) is the probability of event A occurring
- P(B) is the probability of event B occurring

Bayes' theorem allows us to update our belief about the probability of an event based on new evidence or information. It is widely used in machine learning and statistical analysis to make predictions and make decisions based on data.

A **Bayesian network** is a **graphical model that represents the probabilistic relationships between a set of variables**. It is used to represent and reason about uncertain knowledge, and it can be used to make predictions about the likelihood of different events based on the evidence available.

A Bayesian network consists of a **set of nodes**, which **represent variables**, and **a set of edges**, which **represent the relationships between the variables**. The **probabilities of the variables** are **encoded** in the **network using conditional probability tables**, which specify the probability of each variable given the values of its parent variables.
Bayesian networks are widely used in a variety of applications, including **decision making, risk assessment, and predictive modelling**. They are particularly useful for **handling complex, uncertain systems** and can be used to **represent and reason about large amounts of data.**