IT8601 COMPUTATIONAL INTELLIGENCE

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OBJECTIVES:

- To provide a strong foundation on fundamental concepts in Computational Intelligence.
- To enable Problem-solving through various searching techniques.
- To apply these techniques in applications which involve perception, reasoning and learning. To apply Computational Intelligence techniques for information retrieval
- To apply Computational Intelligence techniques primarily for machine learning.

UNIT I INTRODUCTION **9**

Introduction to Artificial Intelligence-Search-Heuristic Search-A* algorithm-Game Playing- Alpha-Beta Pruning-Expert systems-Inference-Rules-Forward Chaining and Backward Chaining- Genetic Algorithms.

UNIT II KNOWLEDGE REPRESENTATION AND REASONING **9**

Proposition Logic - First Order Predicate Logic – Unification – Forward Chaining - Backward Chaining - Resolution – Knowledge Representation - Ontological Engineering - Categories and Objects – Events - Mental Events and Mental Objects - Reasoning Systems for Categories - Reasoning with Default Information - Prolog Programming.

UNIT III UNCERTAINTY **9**

Non monotonic reasoning-Fuzzy Logic-Fuzzy rules-fuzzy inference-Temporal LogicTemporal Reasoning-Neural Networks-Neuro-fuzzy Inference.

UNIT IV LEARNING **9**

Probability basics - Bayes Rule and its Applications - Bayesian Networks – Exact and Approximate Inference in Bayesian Networks - Hidden Markov Models - Forms of Learning - Supervised Learning - Learning Decision Trees – Regression and Classification with Linear Models - Artificial Neural Networks – Nonparametric Models - Support Vector Machines - Statistical Learning - Learning with Complete Data - Learning with Hidden
Variables- The EM Algorithm Reinforcement Learning

UNIT V INTELLIGENCE AND APPLICATIONS 9

Natural language processing-Morphological Analysis-Syntax analysis-Semantic Analysis-
AIl applications – Language Models - Information Retrieval – Information
Extraction – Machine Translation – Machine Learning - Symbol-Based – Machine Learning: Connectionist – Machine Learning.

TOTAL: 45

PERIODS OUTCOMES:

Upon completion of the course, the students will be able to

- Provide a basic exposition to the goals and methods of Computational Intelligence.
- Study of the design of intelligent computational techniques.
- Apply the Intelligent techniques for problem solving
- Improve problem solving skills using the acquired knowledge in the areas of, reasoning, natural language understanding, computer vision, automatic programming and machine learning.

TEXT BOOKS:

1. Stuart Russell, Peter Norvig, ―Artificial Intelligence: A Modern Approach‖, Third Edition, Pearson Education / Prentice Hall of India, 2010.

2. Elaine Rich and Kevin Knight, ―Artificial Intelligence‖, Third Edition, Tata McGraw- Hill, 2010.

REFERENCES:

1. Patrick H. Winston. "Artificial Intelligence", Third edition, Pearson Edition, 2006.

2. Dan W.Patterson, ―Introduction to Artificial Intelligence and Expert Systems‖, PHI, 2006.

3. Nils J. Nilsson, ―Artificial Intelligence: A new Synthesis‖, Harcourt Asia Pvt. Ltd., 2000.

UNIT 1 INTRODUCTION

Introduction to Artificial Intelligence - Search-Heuristic Search-A*algorithm-Game Playing- Alpha-Beta Pruning-Expert systems-Inference-Rules-Forward Chaining and Backward Chaining- Genetic Algorithms.

COURSE OBJECTIVE: To provide a strong foundation on fundamental concepts in Computational Intelligence.

PART – A

1. What is AI? (R)

Artificial Intelligence is composed of two words **Artificial** and **Intelligence**, where Artificial defines *"man-made,"* and intelligence defines *"thinking power"*, hence AI means *"a man-made thinking power."* Systems that think like humans

- Systems that act like humans
- Systems that think rationally
- Systems that act rationally
-

2. Why Artificial Intelligence? (U)

Before Learning about Artificial Intelligence, we should know that what is the importance of AI and why should we learn it. Following are some main reasons to learn about AI:

- With the help of AI, you can create such software or devices which can solve real-world problems very easily and with accuracy such as health issues, marketing, traffic issues, etc.
- With the help of AI, you can create your personal virtual Assistant, such as Cortana, Google Assistant, Siri, etc.
- With the help of AI, you can build such Robots which can work in an environment where survival of humans can be at risk.
- AI opens a path for other new technologies, new devices, and new Opportunities.

3. Goals of Artificial Intelligence (R)

Following are the main goals of Artificial Intelligence:

- Replicate human intelligence
- Solve Knowledge-intensive tasks
- An intelligent connection of perception and action
- Building a machine which can perform tasks that requires human intelligence such as:
  - Proving a theorem
  - Playing chess
  - Plan some surgical operation
  - Driving a car in traffic
- Creating some system which can exhibit intelligent behavior, learn new things by itself, demonstrate, explain, and can advise to its user.

4. What is a heuristic function? (U) (Nov/Dec 2016)

A **heuristic function** or simply a heuristic is a function that ranks alternatives in various search algorithms at each branching step basing on available information in order to make a decision which branch is to be followed during a search.

For example, for shortest path problems, a *heuristic* is a function, *h* (*n*) defined on the nodes of a search tree, which serves as an estimate of the cost of the cheapest path from that node to the goal node. Heuristics are used by informed search algorithms such as Greedy best-first search and A* to choose the best node to explore.

5. What is A^* search? (R)

A^* search is the most widely-known form of best-first search. It evaluates the nodes by combining g(n),the cost to reach the node, and h(n),the cost to get from the node to the goal:

f (n) = g(n) + h(n) Where f (n) = estimated cost of the cheapest solution through n.

g (n) is the path cost from the start node to node n. h (n) = heuristic function

A^* search is both complete and optimal.

6. What is Recursive best-first search? (R)

Recursive best-first search is a simple recursive algorithm that attempts to mimic the operation of

standard best-first search, but using only linear space.

7. Define constraint satisfaction problem. (NOV/DEC 2015-REG 2008) (R)

A **Constraint Satisfaction problem** (or CSP) is defined by a set of **variables** X1, X2,…..,Xn, and a set of **constraints,** C1,C2,…..,Cm. Each variable Xi has a nonempty **domain** Di of possible **values.** Each constraint Ci involves some subset of the variables and specifies the allowable combinations of values for that subset. A **state** of the problem is defined by an assignment of values to some or all of the variables,{Xi = vi,Xj=vj,…} A **solution** to a CSP is a complete assignment that satisfies all the constraints.

8. Define a game. (R) Formal Definition of Game

We will consider games with two players, whom we will call **MAX** and **MIN**. MAX moves first, and then they take turns moving until the game is over. At the end of the game, points are awarded to the winning player and penalties are given to the loser. A **game** can be formally defined as a **search problem** with the following components:

- The **initial state**, which includes the board position and identifies the player to move.
- A **successor function**, which returns a list of (*move, state*) pairs, each indicating a legal move and the resulting state.
- A **terminal test**, which describes when the game is over. States where the game has ended are called **terminal states**.
- A **utility function** (also called an objective function or payoff function), which give a numeric value for the terminal states. In chess, the outcome is a win, loss, or draw,with values +1,-1,or 0. he payoffs in backgammon range from +192 to -192.

9. List the various AI Application Areas (R)

- natural language processing - understanding,
- generating, translating;
- planning;
- vision - scene recognition, object recognition,
- face recognition; robotics; theorem proving;
- speech recognition; game playing; problem
- solving;
- expert systems etc

10. What is heuristic search strategy? (Nov/Dec 2014) (R)

Heuristic search is an Ai search technique employs heuristics for its move. Heuristic is a rule of thumb probably leads to solution. It play a major role in search strategies because of exponential nature of the most problems. It is also helps to reduce the number of alternatives from an exponential number to a polynomial number.

11. Advantages of Artificial Intelligence (U) Following are some main advantages of Artificial Intelligence:

- **High Accuracy with less error:** AI machines or systems are prone to less errors and high accuracy as it takes decisions as per pre-experience or information.
- **High-Speed:** AI systems can be of very high-speed and fast-decision making; because of that AI systems can beat a chess champion in the Chess game.
- **High reliability:** AI machines are highly reliable and can perform the same action multiple times with high accuracy.
- **Useful for risky areas:** AI machines can be helpful in situations such as defusing a bomb, exploring the ocean floor, where to employ a human can be risky.
- **Digital Assistant:** AI can be very useful to provide digital assistant to the users such as AI technology is currently used by various E-commerce websites to show the products as per customer requirement.
- **Useful as a public utility:** AI can be very useful for public utilities such as a selfdriving car which can make our journey safer and hassle-free, facial recognition for security purpose, Natural language processing to communicate with the human in human-language, etc.

12. Explain Best-first Search Algorithm (Greedy Search) (R)

Greedy best-first search algorithm always selects the path which appears best at that moment. It is the combination of depth-first search and breadth-first search algorithms. It uses the heuristic function and search. Best-first search allows us to take the advantages of both algorithms. With the help of best-first search, at each step, we can choose the most promising node. In the best first search algorithm, we expand the node which is closest to the goal node and the closest cost is estimated by heuristic function, i.e. f(n)= g(n).

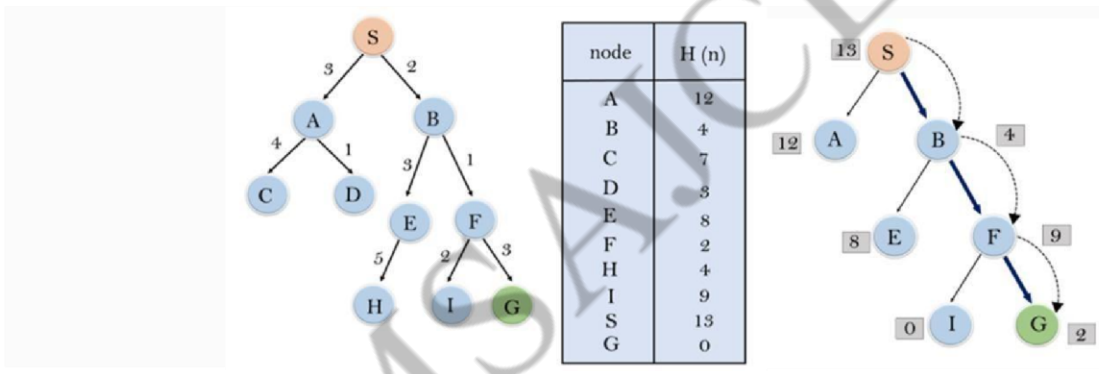
Were, h(n)= estimated cost from node n to the goal.

The greedy best first algorithm is implemented by the priority queue. Best first search algorithm:

Step 1: Place the starting node into the OPEN list.

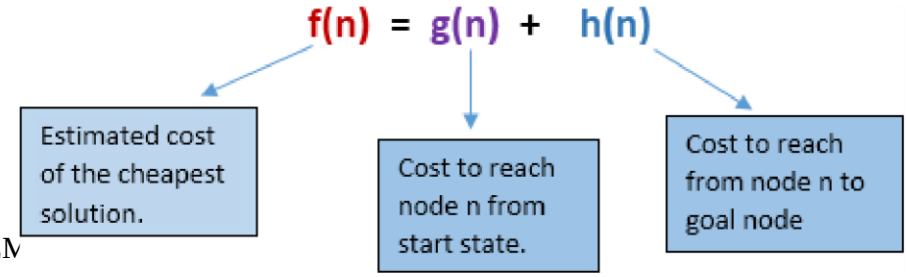
Step 2: If the OPEN list is empty, Stop and return failure.
Step 3: Remove the node n, from the OPEN list which has the lowest value of h(n), and places it in the CLOSED list.
Step 4: Expand the node n, and generate the successors of node n.

Step 5: Check each successor of node n, and find whether any node is a goal node or not. If any successor node is goal node, then return success and terminate the search, else proceed to Step 6. **Step 6:** For each successor node, algorithm checks for evaluation function f(n), and then check if the node has been in either OPEN or CLOSED list. If the node has not been in both list, then add it to the OPEN list.
Step 7: Return to Step 2.



13. Explain A* Search Algorithm (U)

A* search is the most commonly known form of best-first search. It uses heuristic function h(n), and cost to reach the node n from the start state g(n). It has combined features of UCS and greedy best-first search, by which it solve the problem efficiently. A* search algorithm finds the shortest path through the search space using the heuristic function. This search algorithm expands less search tree and provides optimal result faster. A* algorithm is similar to UCS except that it uses g(n)+h(n) instead of g(n).
In A* search algorithm, we use search heuristic as well as the cost to reach the node. Hence we can combine both costs as following, and this sum is called as a **fitness number**.



Practical Applications of A*

A* is the most popular choice for path finding, because it's fairly flexible and can be used in a wide range of contexts such as games (8-puzzle and a path finder). Variations of A*

- Bidirectional search
- Iterative deepening
- Beam search
- Dynamic weighting
- Bandwidth search
-
- Dynamic A* and Lifelong Planning A*

14. What is the Minimax algorithm? (R)

- Minimax is a recursive algorithm which is used to choose an optimal move for a player assuming that the other player is also playing optimally.
- It is used in games such as tic-tac-toe, go, chess, Isola, checkers, and many other two-player games.
- Such games are called games of perfect information because it is possible to see all the possible moves of a particular game.
- There can be two-player games which are not of perfect information such as Scrabble because the opponent‘s move cannot be predicted.
- It is similar to how we think when we play a game: ―if I make this move, then my opponent can only make only these moves,‖ and so on.
- Minimax is called so because it helps in minimizing the loss when the other player chooses the strategy having the maximum loss.

15. Define Alpha-Beta Pruning (U)

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

and beta for future expansion, so it is called **alpha-beta pruning**. It is also called as **Alpha-Beta Algorithm**.

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

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

- The Alpha-beta pruning to a standard minimax algorithm returns the same move as the standard algorithm does, but it removes all the nodes which are not really affecting the final decision but making algorithm slow. Hence by pruning these nodes, it makes the algorithm fast.

16. What are Expert Systems?(U)

The expert systems are the computer applications developed to solve complex problems in a particular domain, at the level of extra-ordinary human intelligence and expertise.

Characteristics of Expert Systems

- High performance
- Understandable
- Reliable

Highly responsive

17. What are the Capabilities of Expert Systems (U)

The expert systems are capable of −

- Advising
- Instructing and assisting human in decision making
- Demonstrating
- Deriving a solution
- Diagnosing
- Explaining
- Interpreting input
- Predicting results
- Justifying the conclusion
- Suggesting alternative options to a problem

18. Rules of Inference in Artificial intelligence

Inference:

In artificial intelligence, we need intelligent computers which can create new logic from old logic or by evidence, **so generating the conclusions from evidence and facts is termed as Inference**.

Inference rules:

Inference rules are the templates for generating valid arguments. Inference rules are applied to derive proofs in artificial intelligence, and the proof is a sequence of the conclusion that leads to the desired goal.

In inference rules, the implication among all the connectives plays an important role. Following are some terminologies related to inference rules:

- **Implication:** It is one of the logical connectives which can be represented as P → Q. It is a Boolean expression.
- **Converse:** The converse of implication, which means the right-hand side proposition goes to the left-hand side and vice-versa. It can be written as Q → P.
- **Contrapositive:** The negation of converse is termed as contrapositive, and it can be represented as ¬ Q → ¬ P.

 Inverse: The negation of implication is called inverse. It can be represented as ¬ P → ¬ Q.

19. Types of Inference rules: Modus Ponens:

 The Modus Ponens rule is one of the most important rules of inference, and it states that if P and

P → Q is true, then we can infer that Q will be true. It can be represented as:

Notation for Modus ponens: $\frac{P \rightarrow Q, \quad P}{\therefore Q}$

Modus Tollens:

 The Modus Tollens rule state that if P→ Q is true and **¬ Q is true, then ¬ P** will also true. It can be represented as:

Notation for Modus Tollens: $\frac{P \rightarrow Q, \quad \sim Q}{\sim P}$

 Statement-1: "If I am sleepy then I go to bed" ==> P→ Q

Statement-2: "I do not go to the bed."==> ~Q

Statement-3: Which infers that "**I am not sleepy**" => ~P

Hypothetical Syllogism:

 The Hypothetical Syllogism rule state that if P→R is true whenever P→Q is true, and Q→R is

true. It can be represented as the following notation: Disjunctive Syllogism:

 The Disjunctive syllogism rule state that if P∨Q is true, and ¬P is true, then Q will be true. It can

be represented as:

Notation of Disjunctive syllogism: $\frac{P \vee Q, \quad \neg P}{Q}$

Addition:

The Addition rule is one the common inference rule, and it states that If P is true, then PVQ will be true.

Notation of Addition: $\frac{P}{P \vee Q}$

Simplification:

The simplification rule state that if **P**A **Q** is true, then **Q or P** will also be true. It can be represented as:

Notation of Simplification rule: $\frac{P \wedge Q}{Q}$ Or $\frac{P \wedge Q}{P}$

20. List out the Properties of Forward-Chaining(U)

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. Forward -chaining approach is commonly used in the expert system, such as CLIPS, business, and production rule systems.

21. List out the Properties of backward chaining(U)

- 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.

- Backward -chaining algorithm is used in game theory, automated theorem proving tools, inference engines, proof assistants, and various AI applications.
- The backward-chaining method mostly used a **depth-first search** strategy for proof.

22. Difference between the forward chaining and backward chaining:

S. No.	Forward Chaining	Backward Chaining
1.	Forward chaining starts from known facts and applies inference rule to extract more data unit it reaches to the goal.	Backward chaining starts from the goal and works backward through inference rules to find the required facts that suppor the goal.
2.	It is a bottom-up approach	It is a top-down approach
3.	Forward chaining is known as datadriven inference technique as we reach to the goal using the available data.	Backward chaining is known as goal-driven technique as we start from the goal and divide into sub-goal to extract the facts.
4.	Forward chaining reasoning applies a breadth- first search strategy.	Backward chaining reasoning applies a depth-first search strategy.
5.	Forward chaining tests for all	Backward chaining only tests for few required rules.
6.	Forward chaining is suitable for the planning, monitoring, control, and interpretation application.	Backward chaining is suitable for diagnostic, prescription, and debugging application.
7.	Forward chaining can generate	Backward chaining generates a finite number of possible conclusions.
8.	It operates in the forward direction.	It operates in the backward direction.
9.	Forward chaining is aimed for any conclusion.	Backward chaining is only aimed for the required data.

What is genetic algorithm ? (U)

A genetic algorithm is a search heuristic that is inspired by Charles Darwin‘s theory of natural evolution. This algorithm reflects the process of natural selection where the fittest individuals are selected for reproduction in order to produce offspring of the next generation. Five phases are considered in a genetic algorithm.

1. Initial population
2. Fitness function
3. Selection
4. Crossover
5. Mutation

24. List the criteria to measure the performance of different search strategies. APRIL / MAY 2021

• Performance criteria for strategies

a. Time complexity - how long will it take

b. Space complexity - how much memory is used

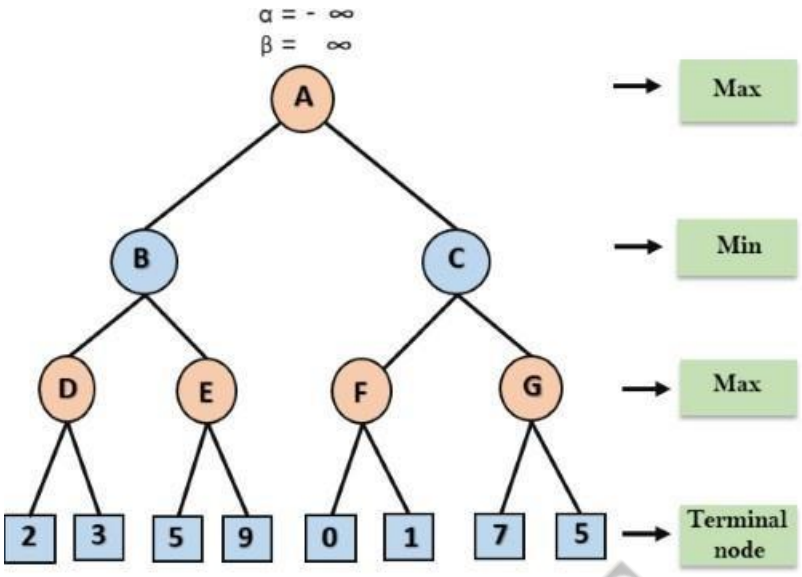
c. Completeness - the search will find an answer if one exists.

d. Optimality - quality of solution, where cost is the number of transformations, or sum of transformation costs. These are computed below for the worst case.

25. State the Point of view of alpha-beta pruning. APRIL / MAY 2021 o Alpha-beta pruning can be applied at any depth of a tree, and sometimes it not only prune the tree leaves but also entire sub-tree. o The two-parameter can be defined as:

a. Alpha: The best (highest-value) choice we have found so far at any point along the path of Maximizer. The initial value of alpha is -∞.

b. Beta: The best (lowest-value) choice we have found so far at any point along the path of Minimizer. The initial value of beta is +∞.



PART- B

1. Explain in details about Artificial Intelligence**(U)**

2. Explain in details about Heuristic Search and A*algorithm**(U)**

3. Explain in details about Game Playing**(U)**

4. Explain in details about Alpha-Beta Pruning**(U)**

5. Explain in details about Expert systems**(U)**
6. Explain in details about Inference-Rules**(U)**
7. Explain in details about Forward Chaining and Backward Chaining**(U)**

8. Explain in details about Genetic Algorithms. **(U)**

9. What is depth limited search? Give the recursive implementation of depth limited search **(U) (Nov/Dec 2014)**

10. Discuss recursive best first search algorithm **(U) (Nov/Dec 2014) (Nov/Dec 2015)**

11. Explain AO* algorithm with an example. **(Ap) (Nov/Dec 2012) (Nov/Dec 2015)**

12. What are the five uninformed search strategies? Explain any two in detail with example. **(Ap) (Nov/Dec 2013)**

13. Explain the approach of formulation for constraint satisfaction problems with example. (Ap)

(Nov/Dec 2013)

14. Explain any two informed search strategies. **(R)** (**April/May 2015)**

15. Discuss about constraint satisfaction problem. **(R)**(**April/May 2015)**

16. Explain the following uninformed search strategies. (**April/May 2015) (NOV/DEC 2015)**

17. Depth first search **(U)**

18. Iterative Deepening Depth First Search **(U)**

19. Explain the Heuristic functions with examples. **(Ap)** (**May/June 2016)**

20. Write the algorithm for Generate and Test and Simple Hill Climbing. **(U) (May/June 2016)**

21. Solve the given problem. Describe the operators involved in it.

22. Consider a water jug problem: you are given two jugs, a 4 gallon one and a 3-gallon one. Neither has ant measuring markers on it.There is a pump that can be used to fill the jugs with water. How can you get exactly 2 gallons of water into the 4-gallon jug? Explicit Assumptions: A jug can be filled from the pump, water can be poured out of a jug onto the ground, water can be poured from one jug to another and that there are no other measuring devices available **(Ap & E) (May/June 2016)**

23. Exemplify the necessary components to define an AI problem with an example. **(Ap) (Nov/Dec 2016)**

24. Consider a water jug problem. You are given 2 jugs: a 4- gallon and a 3- gallon jugs.

Neither has any measuring mark in it. There is a pump that can be used to fill the jugs with water. How can you get exactly 2-gallon of water into a 4- gallon jugs? State the production rules for the water jug problem. **(An)(Nov/Dec 2016)**

25. Explain DFS algorithm with an example. (**Ap)** (**Nov/Dec 2016)**

26. State the characteristics of an AI problem. **(R) (Nov/Dec 2016)**

27. Explain informed search strategies with an example. **(U) (April/May 2017)**

28. Explain the process of simulated annealing with example.**(U)(April / May 2017)**

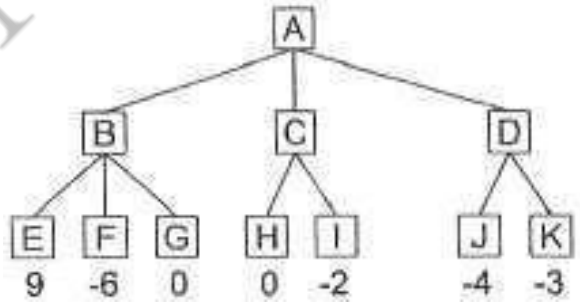
29. Illustrate the role of knowledge engineer, domain expert and an end user in an expert system. **APRIL / MAY 2021**

30. Explain the difficulties involved in developing an expert system. **APRIL / MAY 2021**

31. Define A* search algorithm. Discuss the admissibility of A* algorithm. **APRIL / MAY**
2021

32. Explain MINIMAX search technique / algorithm with an example. **APRIL / MAY 2021**

33. Consider a two player game in which the minimax search procedure is used to compute the best moves for the first player. Assume a static evaluation function that returns values ranging from -10 to 10, with 10 indicating a win for the first player and -10 a win for the second player. Assume the following game tree in which the static scores are from the first player's point of view. Suppose the first player is the maximizing player and needs to make the next move. What move should be chosen at this point? Can the search be optimized? Refer figure-1. **APRIL / MAY 2021**



COURSE OUTCOME: Provide a basic exposition to the goals and methods of Computational

Intelligence.

UNIT II KNOWLEDGE REPRESENTATION AND REASONING

Proposition Logic - First Order Predicate Logic – Unification – Forward Chaining - Backward Chaining - Resolution – Knowledge Representation - Ontological Engineering - Categories and Objects – Events - Mental Events and Mental Objects - Reasoning Systems for Categories - Reasoning with Default Information - Prolog Programming.

COURSE OBJECTIVE: To enable Problem-solving through various searching techniques.

PART – A

1. What isPropositional logic in Artificial intelligence (R)

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

Example:

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

2. What is First-Order Logic in Artificial intelligence (U)

In the topic of Propositional logic, we have seen that how to represent statements using propositional logic. But unfortunately, in propositional logic, we can only represent the facts, which are either true or false. PL is not sufficient to represent the complex sentences or natural language statements. The propositional logic has very limited expressive power. Consider the following sentence, which we cannot represent using PL logic.

- **"Some humans are intelligent", or**
- **"Sachin likes cricket."**

3. What is Knowledge representation (U)

Humans are best at understanding, reasoning, and interpreting knowledge. Human knows things, which is knowledge and as per their knowledge they perform various actions in the real world. **But how machines do all these things comes under knowledge representation and reasoning**. Hence we can describe Knowledge representation as following:

- Knowledge representation and reasoning (KR, KRR) is the part of Artificial intelligence which concerned with AI agents thinking and how thinking contributes to intelligent behavior of agents.
- It is responsible for representing information about the real world so that a computer can understand and can utilize this knowledge to solve the complex real world problems such as diagnosis a medical condition or communicating with humans in natural language.
- It is also a way which describes how we can represent knowledge in artificial intelligence.

  Knowledge representation is not just storing data into some database, but it also enables an intelligent machine to learn from that knowledge and experiences so that it can behave intelligently like a human.

4. List out the Properties for knowledge Representation (R)

The following properties should be possessed by a knowledge representation system.

a. **Representational Adequacy:** It is the ability to represent the required knowledge.

b. **Inferential Adequacy:** It is the ability to manipulate the knowledge represented to produce new knowledge corresponding to that inferred from the original.

c. **Inferential Efficiency:** The ability to direct the inferential mechanisms into the most productive directions by storing appropriate guides.

d. **Acquisition Efficiency:** The ability to acquire new knowledge using automatic methods wherever possible rather than reliance on human intervention.

5. What is Simple relational knowledge (R)

- It is the simplest way of storing facts which uses the relational method, and each fact about a set of the object is set out systematically in columns.
- This approach of knowledge representation is famous in database systems where the relationship between different entities is represented.
- This approach has little opportunity for inference.

Example: The following is the simple relational knowledge representation.

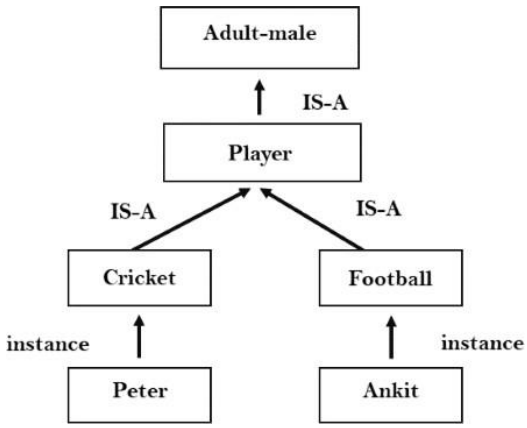
Player	Weight	Age
Player1	65	23
Player2	58	18
Player3	75	24

6. What is Inheritable knowledge (R)

o In the inheritable knowledge approach, all data must be stored into a hierarchy of classes. o All classes should be arranged in a generalized form or a hierarchal manner. o In this approach, we apply inheritance property. o Elements inherit values from other members of a class.

o This approach contains inheritable knowledge which shows a relation between instance and class, and it is called instance relation.

o Every individual frame can represent the collection of attributes and its value. o In this approach, objects and values are represented in Boxed nodes. o We use Arrows which point from objects to their values. o **Example:**



7. What is Inferential knowledge(R)

o Inferential knowledge approach represents knowledge in the form of formal logics. o This approach can be used to derive more facts. o It guaranteed correctness.

o **Example:** Let's suppose there are two statements:

- Marcus is a man
- All men are mortal

Then it can represent as;

man(Marcus) ∀x = man (x)---------- > mortal (x)s

8. What is Procedural knowledge(R)

- o Procedural knowledge approach uses small programs and codes which describes how to do specific things, and how to proceed.
- o In this approach, one important rule is used which is **If-Then rule**.
- o In this knowledge, we can use various coding languages such as **LISP language** and **Prolog language**.
- o We can easily represent heuristic or domain-specific knowledge using this approach. o But it is not necessary that we can represent all cases in this approach.

9. What is Logical Representation (R)

Logical representation is a language with some concrete rules which deals with propositions and has no ambiguity in representation. Logical representation means drawing a conclusion based on various conditions. This representation lays down some

important communication rules. It consists of precisely defined syntax and semantics which supports the sound inference. Each sentence can be translated into logics using syntax and semantics.

Syntax:

- Syntaxes are the rules which decide how we can construct legal sentences in the logic. o It determines which symbol we can use in knowledge representation.
- How to write those symbols. Semantics:
- Semantics are the rules by which we can interpret the sentence in the logic. o Semantic also involves assigning a meaning to each sentence.

10. Define Semantic Network Representation (U)

Semantic networks are alternative of predicate logic for knowledge representation. In Semantic networks, we can represent our knowledge in the form of graphical networks. This network consists of nodes representing objects and arcs which describe the relationship between those objects. Semantic networks can categorize the object in different forms and can also link those objects. Semantic networks are easy to understand and can be easily extended.

This representation consist of mainly two types of relations:

1. IS-A relation (Inheritance)
2. Kind-of-relation

11. Frame Representation (U)

A frame is a record like structure which consists of a collection of attributes and its values to describe an entity in the world. Frames are the AI data structure which divides knowledge into substructures by representing stereotypes situations. It consists of a collection of slots and slot values. These slots may be of any type and sizes. Slots have names and values which are called facets.

12. Define Facets(U)

The various aspects of a slot is known as **Facets**. Facets are features of frames which enable us to put constraints on the frames. Example: IF-NEEDED facts are called when data of any particular slot is needed. A frame may consist of any number of slots, and a

slot may include any number of facets and facets may have any number of values. A frame is also known as **slot-filter knowledge representation** in artificial intelligence.

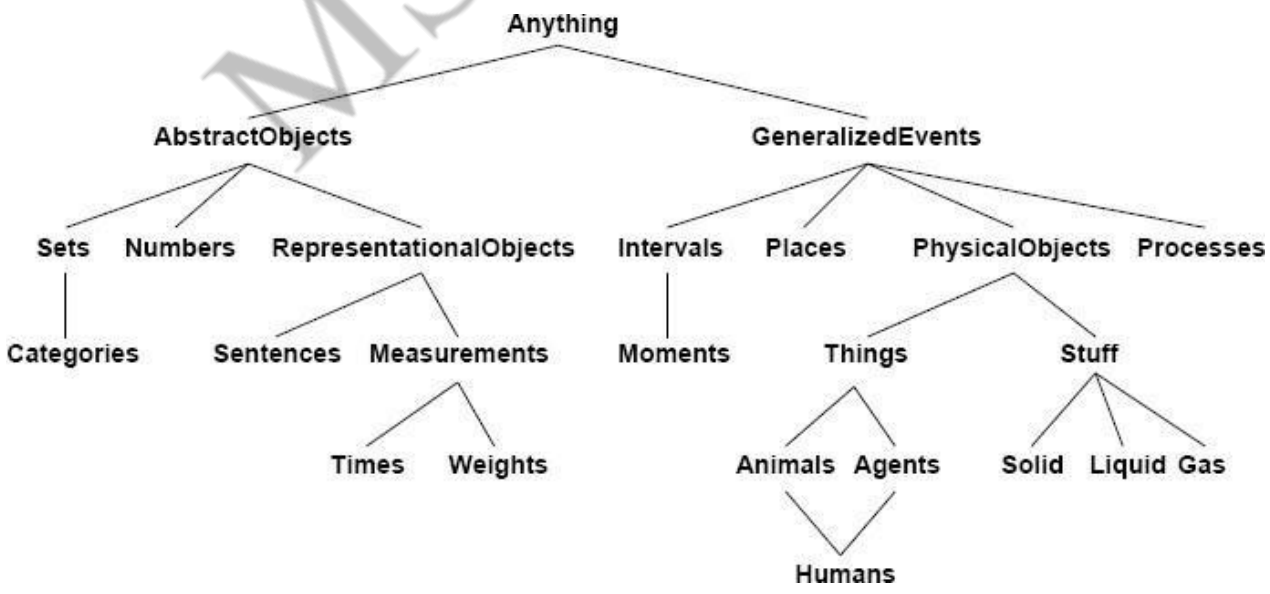
13. Advantages of frame representation:

- The frame knowledge representation makes the programming easier by grouping the related data.
- The frame representation is comparably flexible and used by many applications in AI.
- It is very easy to add slots for new attribute and relations.
- It is easy to include default data and to search for missing values.
- Frame representation is easy to understand and visualize.

14. Explain Ontology engineering(R)

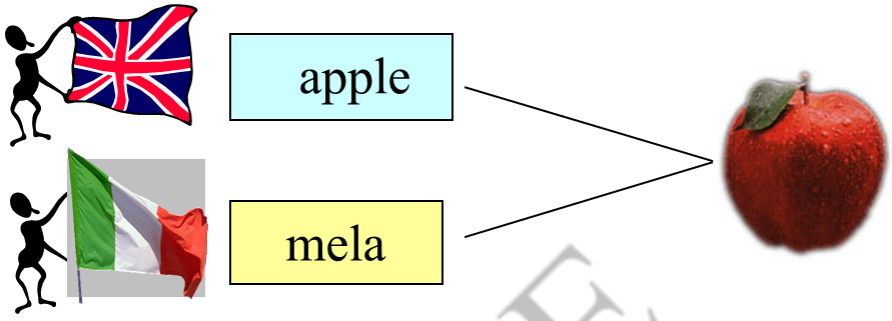
In philosophy, ontology is the study of what exists. In AI, ontology is a specification of the meanings of the symbols in an information system. That is, it is a specification of a conceptualization. It is a specification of what individuals and relationships are assumed to exist and what terminology is used for them. Typically, it specifies what types of individuals will be modeled, specifies what properties will be used, and gives some axioms that restrict the use of that vocabulary.

15. Draw the upper ontology of the world (AN)



16. What is a conceptualization? (R)

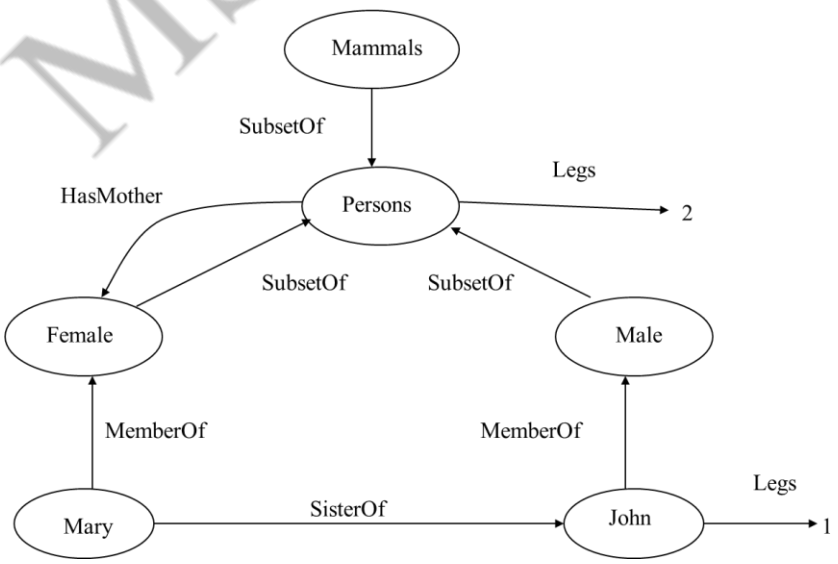
- Conceptualization: the formal structure of reality as perceived and organized by an agent, independently of:
  - the vocabulary used (i.e., the *language* used)
  - the actual occurrence of a specific *situation*
- Different situations involving the same objects, described by different vocabularies, may share the same conceptualization.



17. Defines a taxonomy (U)

Taxonomies and ontologies provide machines powerful tools to make sense of data. What is a

Taxonomy vs. Ontology? Taxonomies provide machines ordered representations. According to Bowles, Taxonomy represents the formal structure of classes or types of objects within a domain.



18. Explain Categories and Objects (U)

The organization of objects into **categories** is a vital part of knowledge representation. Al- though interaction with the world takes place at the level of individual objects, *much reasoning takes place at the level of categories.* For example, a shopper might have the goal of buying a basketball, rather than a *particular* basketball such as *BB9.* Categories also serve to make predictions about objects once they are classified. One infers the presence of certain objects from perceptual input, infers category membership from the perceived properties of the objects, and then uses category information to make predictions about the objects.

19. Define Mental Events (U)

The agents we have constructed so far have beliefs and can deduce new beliefs. 'let none of them has any knowledge about beliefs or about deduction. For single-agent domams, knowledge about one's own knowledge and reasoning processes is useful for controlling inference. For example, if one knows that one does not know anything about Romanian geography, then one need not expend enormous computational effort trying to calculate the shortest path from Arad to Bucharest. One can also reason about one's own knowledge in order to construct plans that will change it-for example by buying a map of Romania.

20. Define Mental Objects (U)

In multiagent domains, it becomes important for an agent to reason about the mental states of the other agents. For example, a Romanian police officer might well know the best way to get to Bucharest, so the agent might ask for help. In essence, what we need is a model of the mental objects that are in someone's head (or something's knowledge base) and of the mental processes that manipulate those mental objects.

21. What is Prolog? (R)

- traditional programming languages are said to be **procedural**
- procedural programmer must specify in detail how to solve a problem:

```
mix ingredients;
beat until
smooth;
bake for 20 minutes in a moderate oven;
remove tin from oven;
put on bench; close oven; turn off oven;
```

- in purely declarative languages, the programmer only states what the problem is and leaves the rest to the language system

- We'll see specific, simple examples of cases where Prolog fits really well shortly

22. Applications of Prolog (U)

Some applications of Prolog are:

- intelligent data base retrieval
- natural language understanding
- expert systems
- specification language
- machine learning robot
- planning automated reasoning

23. Difference between Propositional Logic and Predicate Logic APRIL / MAY 2021

	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.

24. Assess the chances for representing categories in first-order logic APRIL / MAY 2021 ○ First-order logic is another way of knowledge representation in artificial intelligence. It is an extension to propositional logic.

- FOL is sufficiently expressive to represent the natural language statements in a concise way.
- First-order logic is also known as **Predicate logic or First-order predicate logic**. First- order logic is a powerful language that develops information about the objects in a more easy way and can also express the relationship between those objects.
- First-order logic (like natural language) does not only assume that the world contains facts like propositional logic but also assumes the following things in the world:
- **Objects:** A, B, people, numbers, colors, wars, theories, squares, pits, wumpus, ...
- **Relations: It can be unary relation such as:** red, round, is adjacent, **or n-any relation such as:** the sister of, brother of, has color, comes between

- **Function:** Father of, best friend, third inning of, end of, ...
- As a natural language, first-order logic also has two main parts:

  a. Syntax b. Semantics

PART- B

1. Proposition Logic - First Order Predicate Logic – Unification – Forward Chaining - Backward Chaining - Resolution – Knowledge Representation - Ontological Engineering - Categories and Objects – Events - Mental Events and Mental Objects - Reasoning Systems for Categories - Reasoning with Default Information - Prolog Programming**.(R)**
2. Explain the resolution for first order logic and inference rule (**R)**
3. Illustrate the use of first-order-logic to represent the knowledge **(Ap).**
4. Explain the unification algorithm with an example. **(U)**
5. Explain standard quantifiers of first order login with example **(U**) **(Nov/Dec 2014)**
6. Explain the forward chaining algorithm with the help of the pseudo –code **(Ap) (Nov/Dec 2014)**
7. Give the completeness proof of resolution **(An) (Nov/Dec 2014)**
8. Consider the following facts and represent them in predicate form**(Ap&E)(Nov/Dec 2012) (Nov/Dec 2015)**
   - F1 There are 500 employees in ABC Company
   - F2 Employees earning more than Rs.5000 pay tax
   - F3 John is a manager in ABC Company
   - F4 Manager earns Rs 10,000
9. Convert the facts in predicate form to clauses and then prove by resolution ―John pays tax‖ Explain

with an example the use of unification algorithm to prove the concept of resolution **(U) (Nov/Dec 2012)**

9. Explain the forward chaining process and efficient forward chaining with example. State its usage

(U) (Nov/Dec 2013)

10. State and explain the various steps in knowledge engineering process **(An)** (**Nov/Dec 2013)**

11. Explain forward chaining and backward chaining algorithm with an example **(U)** (**April/May 2015) (November/December 2015)**

12. Illustrate the use of first order logic to represent knowledge **(Ap)** (**April/May 2015)**

13. Explain the backward chaining algorithm**.(R) (May/June 2016)**

14. Convert the following well-formed formula into clause form with sequence of steps

∀x:[Roman(x) A Know(x,Marcus)]->[hate(x,Caesar) ∨(∀y: ∃z:hate(y,z)->thinkcrazy(x,y))] **(E)**

15. (i) Write the resolution procedure for prepositional logic. **(Ap)(May/June 2016)**

(ii) Explain the iterative Deepening Algorithm. **(U) May/June 2016) (Nov/Dec 2015)**

16. Explain resolution in predicate logic with suitable example. **(U) (Nov/Dec 2016)**

17. Consider the following sentences: **(An)**

- John like all kinds of food
- Apples are food
- Chicken is food

- Anything any one eats and isn‘t killed by is food
- Bill eats peanuts and is still alive
- Sue eats everything Bill eats

Translate these sentences into formulate in predicate logic.

18. Convert the above FOL into clause form **(E) (Nov/Dec 2016).**

19. Explain Minmax algorithm in detail. **(April/May 2017) (U).**

20. Explain Alpha-beta pruning and alpha beta algorithm.**(April/May 2017) (U)**

21. Consider a two player game in which the min-max search procedure is used to compute the best moves for the first player. Assume a static evaluation function that returns values ranging from -10 to 10,with 10 indicating a win for the first player and - 10 a win for the second player. Assume the following game tree in which the static scores are from the first player‘s point of view. Suppose the first player is the maximizing player and needs to make the next move. What move should be chosen at this point? Can the search be optimized?**(An)**

22. Explain Backward and forward Chaining, with example in logic representation. Mention advantages and disadvantages of both the algorithms.

APRIL / MAY 2021

23. Describe the Reasoning system for categories and Reasoning with Default information in detail with suitable illustrations. **APRIL / MAY 2021**

COURSE OUTCOME: Study of the design of intelligent computational techniques.

UNIT III UNCERTAINTY

Non monotonic reasoning-Fuzzy Logic-Fuzzy rules-fuzzy inference-Temporal Logic- Temporal Reasoning-Neural Networks-Neuro-fuzzy Inference..

COURSE OBJECTIVE: To apply these techniques in applications which involve perception, reasoning.

PART – A

1. What is Non-monotonic Reasoning (R)

The definite clause logic is **monotonic** in the sense that anything that could be concluded before a clause is added can still be concluded after it is added; adding knowledge does not reduce the set of propositions that can be derived.

A logic is **non-monotonic** if some conclusions can be invalidated by adding more knowledge. The logic of definite clauses with negation as failure is non-monotonic. Non-monotonic reasoning is useful for representing defaults. A **default** is a rule that can be used unless it overridden by an exception.
For example, to say that *b* is normally true if *c* is true, a knowledge base designer can write a rule of the form b ←c A ∼ aba.

where *aba* is an atom that means abnormal with respect to some aspect *a*. Given *c*, the agent can infer *b* unless it is told *aba*. Adding *aba* to the knowledge base can prevent the conclusion of *b*. Rules that imply *aba* can be used to prevent the default under the conditions of the body of the rule. **2. What is Fuzzy Logic Systems (U)**

Fuzzy Logic Systems (FLS) produce acceptable but definite output in response to incomplete, ambiguous, distorted, or inaccurate (fuzzy) input.

Fuzzy logic is a form of many-valued logic in which the truth values of variables may be any real number between 0 and 1 both inclusive. It is employed to handle the concept of partial truth, where the truth value may range between completely true and completely false. By contrast, in Boolean logic, the truth values of variables may only be the integer values 0 or 1.

Fuzzy logic is based on the observation that people make decisions based on imprecise and non- numerical information. Fuzzy models or sets are mathematical means of representing vagueness and imprecise information (hence the term fuzzy). These models have the capability of recognizing, representing, manipulating, interpreting, and utilizing data and information that are vague and lack certainty.

3. Define Fuzzification Module (U)

It transforms the system inputs, which are crisp numbers, into fuzzy sets. It splits the input signal

into five steps such as −

LP	x is Large Positive
MP	x is Medium Positive
S	x is Small
MN	x is Medium Negative
LN	x is Large Negative

4. What is Propositional fuzzy logics (R)

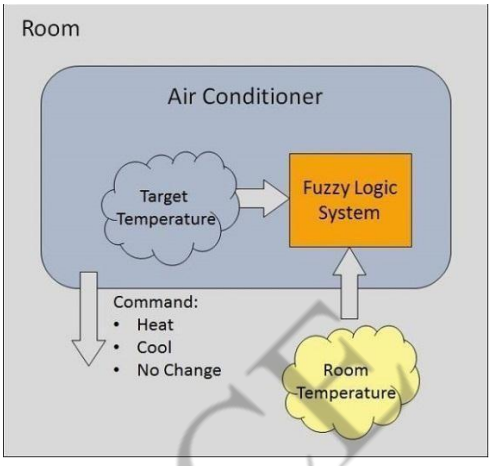
The most important propositional fuzzy logics are:

- Monoidal t-norm-based propositional fuzzy logic MTL is an axiomatization of logic where conjunction is defined by a left continuous t- norm and implication is defined as the residuum of the t-norm. Its models correspond to MTL-algebras that are pre-linear commutative bounded integral residuated lattices.
- Basic propositional fuzzy logic BL is an extension of MTL logic where conjunction is defined by a continuous t-norm, and implication is also defined as the residuum of the t-norm. Its models correspond to BL-algebras.
- Łukasiewicz fuzzy logic is the extension of basic fuzzy logic BL where standard conjunction is the Łukasiewicz t-norm. It has the axioms of basic fuzzy logic plus an axiom of double negation, and its models correspond to MV-algebras.
- Gödel fuzzy logic is the extension of basic fuzzy logic BL where conjunction is Gödel t-norm. It has the axioms of BL plus an axiom of idempotence of conjunction, and its models are called G- algebras.
- Product fuzzy logic is the extension of basic fuzzy logic BL where conjunction is product t- norm. It has the axioms of BL plus another axiom for cancellativity of conjunction, and its models are called product algebras.
- Fuzzy logic with evaluated syntax (sometimes also called Pavelka's logic), denoted by EVŁ, is a further generalization of mathematical fuzzy logic. While the above kinds of fuzzy logic have traditional syntax and many-valued semantics, in EVŁ is evaluated also syntax. This means that each formula has an evaluation.

  Axiomatization of EVŁ stems from Łukasziewicz fuzzy logic. A generalization of classical Gödel completeness theorem is provable in EVŁ.

5. What is example of a Fuzzy Logic System (R)

Let us consider an air conditioning system with 5-level fuzzy logic system. This system adjusts the temperature of air conditioner by comparing the room temperature and the target temperature value.



Algorithm

- Define linguistic Variables and terms (start)
- Construct membership functions for them. (start)
- Construct knowledge base of rules (start)
- Convert crisp data into fuzzy data sets using membership functions. (fuzzification)
- Evaluate rules in the rule base. (Inference Engine)
- Combine results from each rule. (Inference Engine)
- Convert output data into non-fuzzy values. (defuzzification)

6. List out the Advantages of Fuzzy Logic System(U)

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

- The construction of Fuzzy Logic Systems is easy and understandable.
- Fuzzy logic comes with mathematical concepts of set theory and the reasoning of that is quite simple.
- It provides a very efficient solution to complex problems in all fields of life as it resembles human reasoning and decision making.
- The algorithms can be described with little data, so little memory is required.

7. Application of Fuzzy Logic System(U)

- It is used in the aerospace field for altitude control of spacecraft and satellite.
- It has used in the automotive system for speed control, traffic control.
- It is used for decision making support systems and personal evaluation in the large company business.
- It has application in chemical industry for controlling the pH, drying, chemical distillation process.
- Fuzzy logic are used in Natural language processing and various intensive applications in

  Artificial Intelligence.
- Fuzzy logic are extensively used in modern control systems such as expert
- systems.

  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 into more meaningful data by forming partial truths as Fuzzy sets.

8. Explain Fuzzy set (R)

- **Fuzzy set** is a set having **degrees of membership** between 1 and 0. Fuzzy sets are represented with tilde character(~). For example, Number of cars following traffic signals at a particular time out of all cars present will have membership value between [0,1].
- Partial membership exists when member of one fuzzy set can also be a part of other fuzzy sets in the same universe.
- The degree of membership or truth is not same as probability, fuzzy truth represents membership in vaguely defined sets.
- A fuzzy set A~ in the universe of discourse, U, can be defined as a set of ordered pairs and it is given by

{(( )|

- When the universe of discourse, U, is **discrete and finite**, fuzzy set A~ is given by

$$\tilde{A} = \sum_{i=1}^{n} \frac{\mu_{\tilde{A}}(x_i)}{x_i} = \frac{\mu_{\tilde{A}}(x_1)}{x_1} + \frac{\mu_{\tilde{A}}(x_2)}{x_2} + \ldots + \frac{\mu_{\tilde{A}}(x_n)}{x_n}$$

$$\tilde{A} = \int \frac{\mu_{\tilde{A}}(x)}{x}$$

9. Define Inference Engine: (R)

- As inputs are received by the system, inference engine evaluates all IF THEN rules and determines their truth values. If a given input does not precisely correspond to an IF THEN rule, then partial matching of the input data is used to interpolate an answer.
- For example, suppose that the air conditioning system has measured temperature and moisture levels and mapped them to the fuzzy values of 0.7 and 0.1 respectively. The system now needs to infer the truth of each fuzzy rule presented above. In this example we use the simplest method, MAX-MIN. Basically, this method sets the fuzzy value of the THEN clause (or conclusion) to the fuzzy value of the IF clause. Thus, the method infers fuzzy values of 0.7, 0.1 and 0.1 for rules 1, 2 and 3 respectively.

10. Composition: (R)

- Combines all fuzzy conclusions obtained by inference into a single conclusion. Different fuzzy rules might have different conclusions, so it is necessary to consider

  all rules.
- For example, each inference conclusion about the air conditioning system suggests a different action; rule 1 suggests a _high‘ circulation level, rule 2 suggests turning off air circulation, and rule 3 suggests a _low‘ circulation level. The max-min method uses the maximum fuzzy value of the inference conclusions as the final conclusion (In particular, composition selects a fuzzy value of 0.7 since this was the highest fuzzy value associated with the inference conclusions).

11. Define Defuzzification (R)

Defuzzification is a process, which maps from a space defined over an fuzzy input universe of discourse into a space of non-fuzzy (crisp) number., it Is intuitive that fuzzification and Defuzzification should be reversible. If we are going to use fuzzy sets to make decisions, then ultimately getting fuzzy answer is no help to us. We need to convert from a fuzzy answer to an actual number.

12. Explain Temporal logic (R)

In logic, **temporal logic** is any system of rules and symbolism for representing, and reasoning about, propositions qualified in terms of time (for example, "I am *always* hungry", "I will *eventually* be hungry", or "I will be hungry *until* I eat something"). It is sometimes also used to refer to **tense logic**, a modal logic-based system of temporal logic introduced by Arthur Prior in the late 1950s, with important contributions by Hans Kamp. It has been further developed by computer scientists, notably Amir Pnueli, and logicians.

13. Define Prior's tense logic (TL)

(U)

The sentential tense logic introduced in *Time and Modality* has four (non-truth-functional) modal operators (in addition to all usual truth-functional operators in first-order propositional logic.

- *P*: "It was the case that..." (P stands for "past")
- *F*: "It will be the case that..." (F stands for "future")
- *G*: "It always will be the case that..." *H*: "It always was the case that..."

From *P* and *F* one can define *G* and *H*, and vice versa: F ≡ ¬ G ¬ P ≡ ¬ H ¬

14. What is Artificial Neural Network (U)

Neural networks are parallel computing devices, which are basically an attempt to make a computer model of the brain. The main objective is to develop a system to perform various computational tasks faster than the traditional systems.

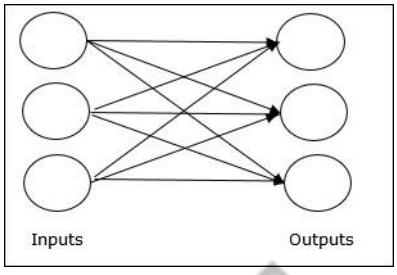
Neural networks are parallel computing devices, which is basically an attempt to make a computer model of the brain. The main objective is to develop a system to perform various computational tasks faster than the traditional systems. These tasks include pattern recognition and classification, approximation, optimization, and data clustering.

15. What is Feedforward Network (R)

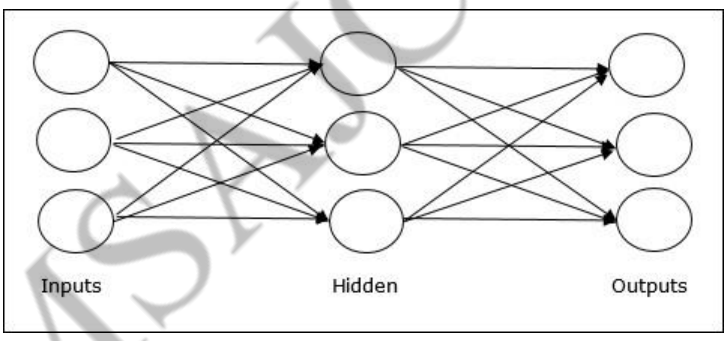
It is a non-recurrent network having processing units/nodes in layers and all the nodes in a layer are connected with the nodes of the previous layers. The connection has different

weights upon them. There is no feedback loop means the signal can only flow in one direction, from input to output. It may be divided into the following two types −

- **Single layer Feedforward network** − the concept is of Feedforward ANN having only one weighted layer. In other words, we can say the input layer is fully connected to the output layer.



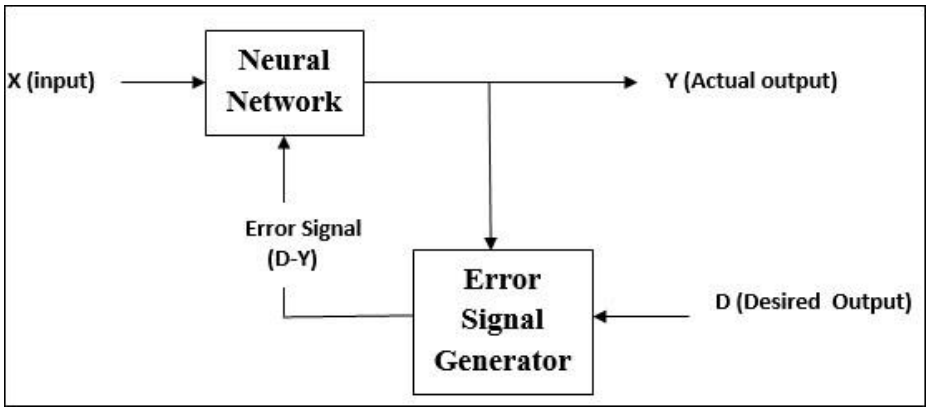
- **Multilayer Feedforward network** − the concept is of Feedforward ANN having more than one weighted layer. As this network has one or more layers between the input and the output layer, it is called hidden layers.



16. What is Supervised Learning (R)

As the name suggests, this type of learning is done under the supervision of a teacher. This learning process is dependent.

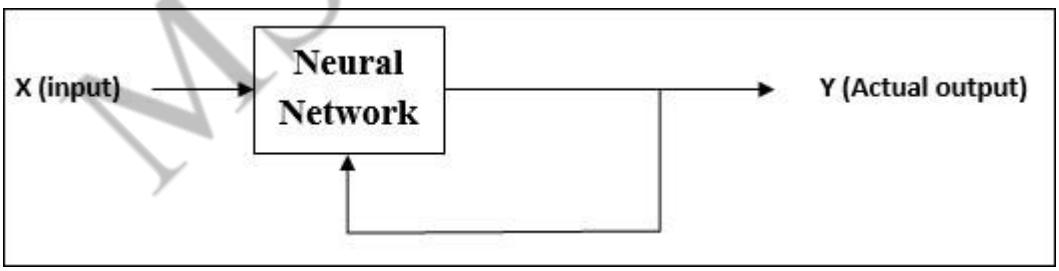
During the training of ANN under supervised learning, the input vector is presented to the network, which will give an output vector. This output vector is compared with the desired output vector. An error signal is generated, if there is a difference between the actual output and the desired output vector. On the basis of this error signal, the weights are adjusted until the actual output is matched with the desired output.



17. What is Unsupervised Learning (R)

As the name suggests, this type of learning is done without the supervision of a teacher. This learning process is independent.

During the training of ANN under unsupervised learning, the input vectors of similar type are combined to form clusters. When a new input pattern is applied, then the neural network gives an output response indicating the class to which the input pattern belongs. There is no feedback from the environment as to what should be the desired output and if it is correct or incorrect. Hence, in this type of learning, the network itself must discover the patterns and features from the input data, and the relation for the input data over the output.

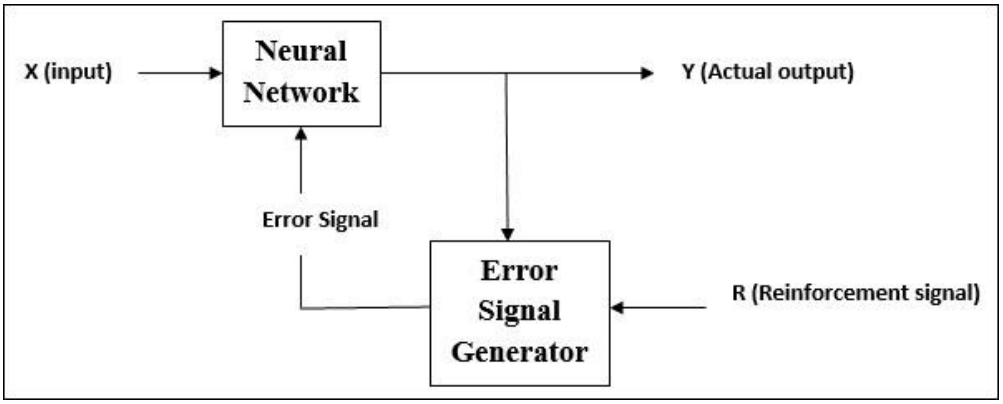


18. What is Reinforcement Learning(R)

As the name suggests, this type of learning is used to reinforce or strengthen the network over some critic information. This learning process is similar to supervised learning, however we might have very less information.

During the training of network under reinforcement learning, the network receives some feedback from the environment. This makes it somewhat similar to supervised learning. However, the feedback obtained here is evaluative not instructive, which means there is

no teacher as in supervised learning. After receiving the feedback, the network performs adjustments of the weights to get better critic information in future.



19. List out the Applications of Neural Networks(R)

They can perform tasks that are easy for a human but difficult for a machine −

- **Aerospace** − Autopilot aircrafts, aircraft fault detection.
- **Automotive** − Automobile guidance systems.
- **Military** − Weapon orientation and steering, target tracking, object discrimination, facial recognition, signal/image identification.
- **Electronics** − Code sequence prediction, IC chip layout, chip failure analysis, machine vision, voice synthesis.
- **Financial** − Real estate appraisal, loan advisor, mortgage screening, corporate bond rating, portfolio trading program, corporate financial analysis, currency value prediction, document readers, credit application evaluators.
- **Industrial** − Manufacturing process control, product design and analysis, quality inspection systems, welding quality analysis, paper quality prediction, chemical product design analysis, dynamic modeling of chemical process systems, machine maintenance analysis, project bidding, planning, and management.
- **Medical** − Cancer cell analysis, EEG and ECG analysis, prosthetic design, transplant time optimizer.
- **Speech** − Speech recognition, speech classification, text to speech conversion.
- **Telecommunications** − Image and data compression, automated information services, real-time spoken language translation.
- **Transportation** − Truck Brake system diagnosis, vehicle scheduling, routing systems.
- **Software** − Pattern Recognition in facial recognition, optical character recognition, etc.

20. What is Neuro-Fuzzy Systems (R)

A Neuro-fuzzy system is a fuzzy system that uses a learning algorithm derived from or inspired by neural network theory to determine its parameters (fuzzy sets and fuzzy rules) by processing data samples.

Modern Neuro-fuzzy systems are usually represented as special multilayer Feedforward neural networks. However, fuzzification of other neural network architectures is also considered, for example self-organizing feature maps. In those Neuro--fuzzy networks, connection weights and propagation and activation functions differ from common neural networks.

21. Difference between Neural Networks and Fuzzy Systems(R)

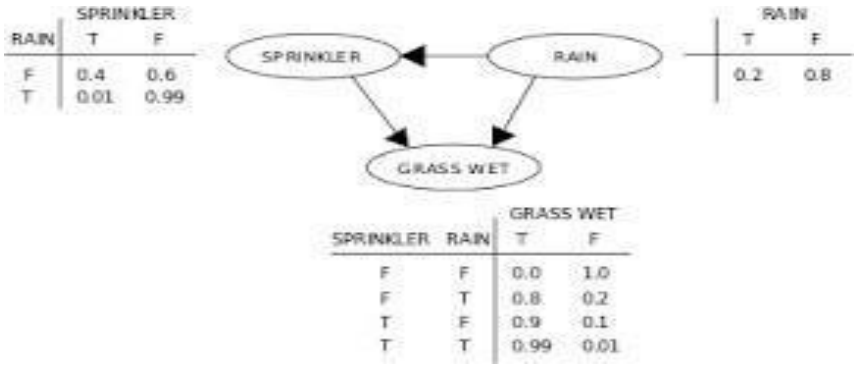
Neural Networks	**Fuzzy Systems**
no mathematical model necessary	no mathematical model necessary
learning from scratch	apriori knowledge essential
several learning algorithms	not capable to learn
black-box behavior	simple interpretation and implementation
Table 1: Comparison of neural control and fuzzy control	

22. Define knowledge acquisition. (April/May 2015) (R)

The knowledge engineer might already be an expert in the domain, ***or*** might need to work with real experts to extract what they know-a process called **knowledge acquisition.**

23. What is Bayesian Network? (May /June 2016) (U)

A Bayesian network, Bayes network, belief network, Bayes model or probabilistic directed acyclic graphical model is a probabilistic graphical model (a type of statistical model) that represents a set of random variables and their conditional dependencies via a directed acyclic graph (DAG).



24. What are Fuzzy sets?(Nov/Dec 2016) (U)

A fuzzy set **A** in **X** is characterized by a membership function **fA(*x*)** which associates with each

point in **X** a real number in the interval **[0,1]**, with the values of **fA(*x*)** at **x** representing the "grade of membership" of **x** in **A**. Thus, the nearer the value of **fA(*x*)** to unity, the higher the grade of membership of *x* in **A**.

Let **X** be a space of points, with a generic element of **X** denoted by **x**. Thus **X** = {**x**}.

25. Write the properties of fuzzy sets. (May/June 2016, Nov/Dec 2016) (R)

- Complementation
- Intersection
- Union

Give the Baye's Rule equation (Apr/ May 2017) (R)

$P(h \mid e \wedge k) = P(e \mid h \wedge k) \times P(h \mid k) / P(e \mid k)$.

27. Define Fuzzy reasoning (Nov/Dec 2017) (R)

- Fuzzy reasoning models are relevant to a wide variety of subject areas such as engineering, economics, psychology, sociology, finance, and education.
- In the literatures various fuzzy reasoning methods are purposed to process uncertain information and increase the efficiency of the designed systems.
- These fuzzy reasoning methods are mainly based on compositional rule, analogy and similarity, interpolation, and the concept of distance.

PART- B

1. Explain about Non monotonic reasoning **(R)**
2. Explain about Fuzzy Logic **(R)**
3. Explain about Fuzzy rules **(R)**

4. Explain about fuzzy inference **(R)**
5. Explain about Temporal Logic **(R)**
6. Explain about Temporal Reasoning **(R)**
7. Explain about Neural Networks **(R)**
8. Explain about Neuro-fuzzy Inference. **(R)**
9. Explain the need of fuzzy set and fuzzy logic with example. (An) (Nov/Dec 2013)
10. Demonstrate fuzzy inferences from imprecise data. **PRIL / MAY 2021**
11. Classify and explain the fuzzy rules with examples. **PRIL / MAY 2021**
12. Explain the neuro fuzzy architecture and outline the applications. **PRIL / MAY 2021**
13. Illustrate the Temporal Logic with Reasoning. **PRIL / MAY 2021**

COURSE OUTCOME: Apply the Intelligent techniques for problem solving

UNIT-IV LEARNING

Probability basics - Bayes Rule and its Applications - Bayesian Networks – Exact and Approximate Inference in Bayesian Networks - Hidden Markov Models - Forms of Learning - Supervised Learning - Learning Decision Trees – Regression and

Classification with Linear Models - Artificial Neural Networks – Nonparametric Models - Support Vector Machines - Statistical Learning - Learning with Complete Data - Learning with Hidden Variables- The EM Algorithm – Reinforcement Learning

COURSE OBJECTIVE: To apply these techniques in applications which involve learning.

1. What is meant by learning?

(U)

Learning is a goal-directed process of a system that improves the knowledge or the knowledge representation of the system by exploring experience and prior knowledge. **2. Define informational equivalence. (R)**

A transformation from on representation to another causes no loss of information; they can be constructed from each other.

3. Define computational equivalence. (R)

The same information and the same inferences are achieved with the same amount of effort.

4. List the difference between knowledge acquisition and skill refinement. (An)

- knowledge acquisition (example: learning physics) — learning new symbolic information coupled with the ability to apply that information in an effective manner
- skill refinement (example: riding a bicycle, playing the piano) — occurs at a subconscious level by virtue of repeated practice

5. What is meant by analogical reasoning? (U)

Instead of using examples as foci for generalization, one can use them directly to solve new problems.

6. Define Explanation-Based Learning. (R)

The background knowledge is sufficient to explain the hypothesis. The agent does not learn anything factually new from the instance. It extracts general rules from single examples by explaining the examples and generalizing the explanation **7. What is meant by Relevance-Based Learning? (U)**

- uses prior knowledge in the form of determinations to identify the relevant attributes

- generates a reduced hypothesis space

8. Define Knowledge-Based Inductive Learning.(R)

Knowledge-Based Inductive Learning finds inductive hypotheses that explain set of observations with the help of background knowledge.

9. What is truth preserving? (U)

An inference algorithm that derives only entailed sentences is called sound or truth preserving.

10. Define Inductive learning. (R)

Learning a function from examples of its inputs and outputs is called inductive learning.

11. How the performance of inductive learning algorithms can be measured? (U)

It is measured by their learning curve, which shows the prediction accuracy as a function of the number of observed examples.

12. List the advantages of Decision Trees (R)

- It is one of the simplest and successful forms of learning algorithm.
- It serves as a good introduction to the area of inductive learning and is easy to implement.

13. What is the function of Decision Trees? (R)

A decision tree takes as input an object or situation by a set of properties, and outputs a yes/no decision. Decision tree represents Boolean functions. **14. List some of the practical uses of decision tree learning. (R)**

- Designing oil platform equipment
- Learning to fly

15. Define reinforcement learning. (R)

The task of reinforcement learning is to use rewards to learn a successful agent function.

16. Differentiate between Passive learner and Active learner. (An)

A passive learner watches the world going by, and tries to learn the utility of being in various states. An active learner acts using the learned information, and can use its problem generator to suggest explorations of unknown portions of the environment.

17. State the design issues that affect the learning element. (U)

- Which components of the performance element are to be improved
- What representation is used for those components
- What feedback is available • What prior information is available

18. State the factors that play a role in the design of a learning system. (U)

• Learning element

• Performance element

• Critic

• Problem generator

19. What is memorization? (R)

The technique of memorization is used to speed up programs by saving the results of computation. The basic idea is to accumulate a database of input/output pairs; when the function is called, it first checks the database to see if it can avoid solving the problem from scratch.

20. Define Q-Learning. (R)

The agent learns an action-value function giving the expected utility of taking a given action in a given state. This is called Q-Learning.

21. Differentiate between supervised learning & unsupervised learning. (An)

Any situation in which both inputs and outputs of a component can be perceived is called supervised learning. Learning when there is no hint at all about the correct outputs is called unsupervised learning.

22. Define Ockham's razor. (R)

Extracting a pattern means being able to describe a large number of cases in a concise way. Rather than just trying to find a decision tree that agrees with example, try to find a concise one, too.

23. Define Bayesian learning (R)

Bayesian learning simply calculates the probability of each hypothesis, given the data,

and makes predictions on that basis. That is, the predictions are made by using all the hypotheses, weighted by their probabilities, rather than by using just a single ―best‖ hypothesis.

24. What is meant by hidden variables? (R)

Many real-world problems have hidden variables (sometimes called latent variables) which are not observable in the data that are available for learning.

25. Define Cross validation.

(R)

The basic idea behind Cross validation is try to eliminate how well the current hypothesis will predict unseen data.

26. What are the operations in Genetic algorithms? (U)

It starts with a set of one or more individuals and applies selection and reproduction operators to evolve an individual that is successful, as measured by a fitness function.

27. List the various Components of the performance element (R)

1. A direct mapping from conditions on the current state to actions.
2. A means to infer relevant properties of the world from the percept sequence.
3. Information about the way the world evolves.

Information about the results of possible actions the agent can take.

Utility information indicating the desirability of world states.

4. Action-value information indicating the desirability of particular actions

5. Goals that describe classes of states whose achievement maximizes the agent\'s utility.

28. Differentiate between Parity function and majority function. (An)

If the function is the parity function, which returns 1 if and only if an even number of inputs are 1, then an exponentially large decision tree will be needed. A majority function, which returns 1 if more than half of its inputs are 1.

29. What is the function of a performance element? (U)

The performance element is responsible for selecting external actions.

30. What is the function of a learning element? (U)

Learning element is responsible for making improvements.

31. List the 3 approaches that can be used to learn utilities. (R)

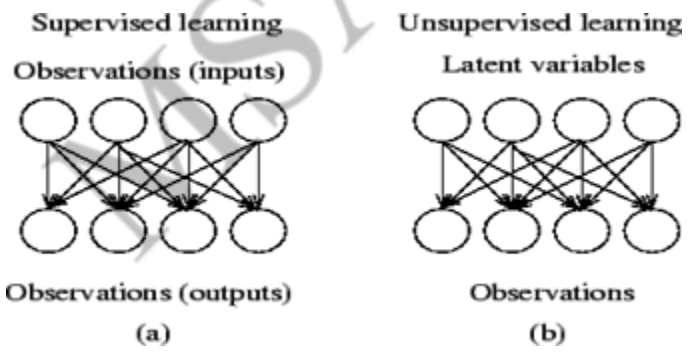
- Least-mean-square Approach
- Adaptive Dynamic Programming Approach
- Temporal Difference Approach

32. Distinguish between supervised learning and unsupervised learning (Nov/Dec2014) (An)

In supervised learning, the output datasets are provided which are used to train the machine and get the desired outputs whereas in unsupervised learning no datasets are provided, instead the data is clustered into different classes. Example: Face recognition

Supervised learning : Learn by examples as to what a face is in terms of structure, color, etc so that after several iterations it learns to define a face

Unsupervised learning : since there is no desired output in this case that is provided



33. What is over fitting (Nov/Dec2014)? (R)

Over fitting occurs when a statistical model describes random error or noise instead of the underlying relationship. Over fitting generally occurs when a model is excessively complex, such as having too many parameters relative to the number of observations. A model that has been over fit will generally have poor predictive performance, as it can exaggerate minor fluctuations in the data.

34. Distinguish between supervised learning and reinforcement learning (Nov/Dec 2012) (An)

―Reinforcement learning (RL) and supervised learning are usually portrayed as distinct methods of learning from experience. RL methods are often applied to problems involving sequential dynamics and optimization of a scalar performance objective, with online exploration of the effects of actions. Supervised learning methods, on the other hand, are frequently used for problems involving static input-output mappings and minimization of a vector error signal, with no explicit dependence on how training examples are gathered.

35. Define computational learning theory (Nov/Dec 2012) (R)

Computational learning theory is the analysis of computational complexity of machine learning algorithms. It is the intersection of theory of computation and machine learning. **36. What is meant by belief network? (U)**

A belief network is a graph in which the following holds

- A set of random variables
- A set of directive links or arrows connects pairs of nodes.
- The conditional probability table for each node • The graph has no directed cycles.

37. What are the ways in which one can understand the semantics of a belief network? (U)

There are two ways to see the network as a representation of the joint probability distribution to view it as an encoding of collection of conditional independence statements. **38. What is the basic task of a probabilistic inference? (U)**

The basic task is to reason in terms of prior probabilities of conjunctions, but for the most part, we will use conditional probabilities as a vehicle for probabilistic inference. **39. What is called as multiple connected graphs? (R)**

A multiple connected graph is one in which two nodes are connected by more than one path.

40. List the 3 basic classes of algorithms for evaluating multiply connected graphs. (R)

• Clustering methods

• Conditioning methods

• Stochastic simulation methods

41. Define Uncertainty. (R)

Uncertainty means that many of the simplifications that are possible with deductive inference are no longer valid.

42. What is meant by deterministic nodes? (U)

A deterministic node has its value specified exactly by the values of its parents, with no uncertainty.

43. What are all the various uses of a belief network? (R)

- Making decisions based on probabilities in the network and on the agent\'s utilities.
- Deciding which additional evidence variables should be observed in order to gain useful information.

- Performing sensitivity analysis to understand which aspects of the model have the greatest impact on the probabilities of the query variables (and therefore must be accurate). **44. What is the function of cut set conditioning method? (R)**

This method transforms the network into several simpler poly trees.

45. State Bayes' rule (Nov/Dec 2014) & Define the Bayes rule? (Nov/Dec2012) (R)
Bayes rule

True Bayesians actually consider conditional probabilities as more basic than joint probabilities . It is

easy to define P(A|B) without reference to the joint probability P(A,B). To see this note that we can rearrange the conditional probability formula to get: P(A|B) P(B) = P(A,B) but by symmetry we can also get: P(B|A) P(A) = P(A,B) It follows that:

$$P(A|B) = \frac{P(B|A)P(A)}{P(B)}$$

This is the so-called Bayes Rule.

46. What is first order Markov process (Nov/Dec2014) (R)

A Markov process is a stochastic model that has the Markov property. It can be used to model a random system that changes states according to a transition rule that only depends on the current state.

47. What do you mean hybrid Bayesian Networks? (Nov/Dec 2012) (R)

Definition: BN = (DAG, CPD)

- DAG: directed acyclic graph (BN's structure)
  - Nodes: random variables (typically binary or discrete, but methods also exist to handle continuous variables)
  - Arcs: indicate probabilistic dependencies between nodes (*lack* of link signifies conditional independence)
- CPD: conditional probability distribution (BN's parameters)
  - Conditional probabilities at each node, usually stored as a table (conditional probability table, or CPT) – Root nodes are a special case – no parents, so just use priors in CPD

48. What is partial order planning (Nov/Dec 2013) (R)

Partial-order planning is an approach to automated planning that leaves decisions about the ordering of actions as open as possible. It contrasts with total-order planning, which produces an exact ordering of actions.

49. Define inference in temporal models (Nov/Dec 2013) (R)

Inference is the act or process of deriving logical conclusions from premises known or assumed to be true.[1] The conclusion drawn is also called an idiomatic. The laws of valid inference are studied in the field of logic.

Q-learning uses temporal differences to estimate the value of $Q^*(s,a)$. In Q- learning, the agent maintains a table of $Q[S,A]$, where S is the set of states and A is the set of actions. $Q[s,a]$ represents its current estimate of $Q^*(s,a)$.

50. List down applications of Bayesian network (April/May 2015) (R)

- image processing
- gaming
- decision support systems
- information retrieval
- semantic search

51. Define uncertainty. How it is solved (APRIL/MAY 2015) (R)

the "reasoning with uncertainty" (or "reasoning under uncertainty") research in AI has been focused on the uncertainty of *truth value*, that is, to allow and process truth values other than "true" and "false".

- There is uncertainty in the facts we know:
  - What's the temperature? Imprecise measures
  - Is Bush a good president? Imprecise definitions
  - Where is the pit? Imprecise knowledge

52. Define Inductive learning. (NOVEMBER/DECEMBER 2011) (R)

Learning a function from examples of its inputs and outputs is called inductive learning.

53. Differentiate between supervised learning and unsupervised learning. (NOVEMBER/DECEMBER 2011 , 2016) (An)

- Any situation in which both inputs and outputs of a component can be perceived is called supervised learning.
- Learning when there is no hint at all about the correct outputs is called unsupervised learning.

54. What is rote learning? (MAY/JUNE 2016) (U)

- Rote learning is a memorization technique based on repetition.

problem Solving	Planning
Problem solving is the process of diminution or abolishment of the divergence	Planning represents this process of finding out the necessary steps
In contrast to a task, the necessary steps to take that transform the original state into the final state are not yet known and must still be figured	The steps are represented in a Plan.
Problem solving involves planning, as just a stage	Planning can be seen as a part of the proble solving process which is completed by th execution process.
If problems during plan execution occur, the plan may be altered during run time.	Execution itself might not be a completely predefined process.
DPS should enable the agents to work together in solving problems that are beyond a single agent‘s scope.	Distributed Planning activities involve a group of agents in the planning process.

- Requires least amount of interference

- Simply coping the knowledge in the same form that at will be used directly into knowledge base.

- Example: used for memorizing multiplication table.

- The idea is that one will be able to quickly recall the meaning of the material the more one repeats it.
- Some of the alternatives to rote learning include meaningful learning, associative learning, and active learning.

56. What are the different types of planning. (U)(Apr/May 2017)

State space search
Partial order planning

59. What is hierarchical planning (R))(Nov/Dec 2017)

Hierarchical task network (HTN) planning is an approach to automated planning in which the dependency among actions can be given in the form of hierarchically structured networks.

60. Define Adaptive learning (Nov/Dec 2017) (U)

Adaptive learning, also known as adaptive teaching, is an educational method which uses computer algorithms to coordinate the interaction with the learner and deliver customized resources and learning activities to address the unique needs of each learner.

61. Define Machine learning R (April / May 2018)

Machine learning (ML) is a field of artificial intelligence that uses statistical techniques to give computer systems the ability to "learn" (e.g., progressively improve performance on a specific task) from data, without being explicitly programmed. 62. When is a why explanation better than a how explanation An (April / May 2018)

―Why explanation‖ is a set of statements usually constructed to describe a set of facts which clarifies the causes, context, and consequences of those facts.

―How explanation‖ describes of the facts may establish rules or laws, and may clarify the existing rules and/or laws in relation to any objects, or phenomena examined.

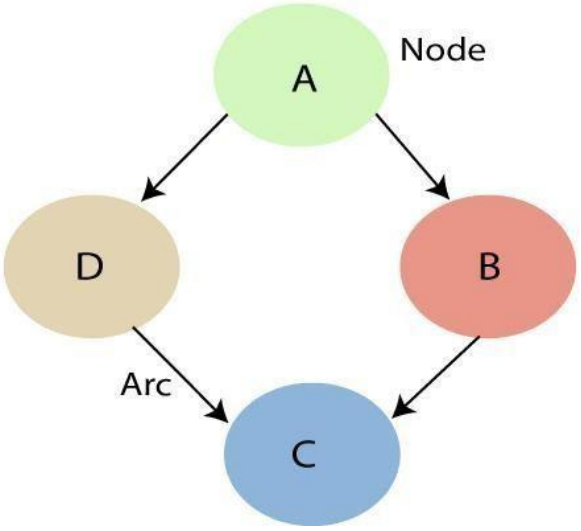
64. **What are the ways in which one can understand the semantics of a belief network? APRIL / MAY 2021**

Bayesian belief network is key computer technology for dealing with probabilistic events and to solve a problem which has uncertainty. We can define a Bayesian network as:

"A Bayesian network is a probabilistic graphical model which represents a set of variables and their conditional dependencies using a directed acyclic graph."

It is also called a Bayes network, belief network, decision network, or Bayesian model.

Bayesian networks are probabilistic, because these networks are built from a probability



distribution, and also use probability theory for prediction and anomaly detection

65. Infer the main difficulties involved with the gradient descent method. APRIL / MAY 2021

1. Vanishing Gradient
2. Exploding Gradient
3. Saddle Point (MiniMax Point)

Cause of Gradiznt Problems

1. Learning rate
2. Gradient Descent

66. Define Bayes theorem. Represent the Baye's rule equation. APRIL / MAY 2021

Bayes' theorem provides a way to revise existing predictions or theories (update probabilities) given new or additional evidence. In finance, Bayes' theorem can be used to rate the risk of lending money to potential borrowers. Bayes' theorem is also called Bayes' Rule or Bayes' Law and is the foundation of the field of Bayesian statistics.

$$P(A \mid B) = \frac{P(A \cap B)}{P(B)} = \frac{P(A) \cdot P(B \mid A)}{P(B)}$$

where:*P*(*A*)= The probability of A occurring

P(*B*)= The probability of B occurring
P(*A*|*B*)=The probability of A given B
P(B|A)= The probability of B given A

P(A∩B))= The probability of both A and B occurring

67. Identify the issues that affect the design of learning element. APRIL / MAY 2021

- Intellectual factor:
- Learning factors
- Physical factors
- Mental factors
- Emotional and social factors • Teacher's Personality • Environmental factor

PART- B

Explain the learning decision tree with algorithm **(U)**

1. Explain the explanation based learning? **(R)**
2. Explain how learning with complete data is achieved? **(An)**
3. Discuss learning with hidden variables? **(An)**
4. Explain all the statistical learning method available in AI. **(U)**
5. Explain about Reinforcement learning. **(R)**
6. Explain decision tree learning algorithm **(U) (Nov/Dec 2014)**
7. Discuss back propagation algorithm for learning in multilayer neural networks **(U) Nov/Dec 2014)**
8. Explain the basic concept of support vector machine **(R)(Nov/Dec 2014)**
9. Give the complete agent design for an exploratory Q learning agent **(U)(Nov/Dec 2014)**
10. Explain the concept of learning using Decision tree **(Ap)(Nov/Dec 2012)**
11. Write short notes on **(Nov/Dec 2012)**

    i) Reinforcement learning **(R)**

ii) Explanation based learning **(R)**

12. Explain the process of learning on action utility function **(U) (Nov/Dec 2013)**

13. Explain the temporal difference learning with example **(Ap) (Nov/Dec 2013)**

14. What are various approaches for instance based learning .Explain any one with example **(Ap) (Nov/Dec 2013)**

15. The following table consists of training data from an employee database. The data have been

generalized. Let status be the class label attribute. Construct Decision tree from the given data

16. Explain in detail about Active and Passive Reinforcement learning **(An)** (**April/May 2015)**

18. Explain variable elimination algorithm for answering queries on Bayesian networks **(U) (Nov/Dec 2014)**

19. Discuss forward-backward algorithm in details. **(U) (Nov/Dec 2014)**

20. Discuss the different design issues to be solved to use HMM for real world applications. **(U) (Nov/Dec 2014)**

21. Explain the method of performing exact inference in Bayesian networks. **(Ap) (Nov/Dec 2012)**

22. Explain the concept of inference in temporal models. **(U) (Nov/Dec 2012)**

23. How to handle uncertain knowledge with example .**(An) (Nov/Dec 2013)**

24. How to represent knowledge in uncertain domain **(An)** (**Nov/Dec 2013)**

25. **(i)** Describe the components of a planning system **(U) (MAY/JUNE 2016) (ii)** What is

ID3? Write the drawback of ID3? **(An) (MAY/JUNE 2016)**

26. **(i)** Describe the Hierarchical planning method with an example. **(U) (MAY/JUNE 2016)**

(ii) Describe the Learning with macro operators. **(Ap) (MAY/JUNE 2016) 27.** Describe Hierarchical planning method with an example. **(U) (Nov/Dec 2016)**

28. Describe learning with macro operators. **(U) (Nov/Dec 2016)**

29. Explain the various types of learning in problem solving. **(U)(Nov/Dec 2016)**

30. Explain learning in Decision Tree with example. **(U)(Nov/Dec 2016)**

31. Discuss in detail the process of machine learning with example. **(U) (Apr/May 2017)**

32. Explain in detail the STRIPS. **(U) (Apr/May 2017)**

33. Write short notes on the

i) Learning by parameter adjustment ii) Learning with Macro-Operators iii) Learning by Chunking **(U)(Nov/Dec 2017)**

34. (i)Write down STRIP style operators that corresponds to the following blocks world description
ON(A,B,SO)^ONTABLE(B,SO)^CLEAR(A,SO)

(ii) Write short notes on Nonlinear planning using Constraint Posting **(U)(Nov/Dec 2017)**

35. Discuss planning methodology used by STRIPS in detail**(U) (Apr/May 2018)**

36. Discuss the various types of machine learning with appropriate examples. **(U) (Apr/May 2018)**

36. Describe briefly about **APRIL / MAY 2021**
(i) Continuous model for Maximum likelihood Estimation (ii) Learning with Hidden Variables.

37. What is the maximum number of edges in a Bayesian network (BN) with n nodes? Prove that a valid BN containing this number of edges can be constructed (remember that thestructure of a BN has to be a Directed Acyclic Graph). **APRIL / MAY 2021**

38. Construct the Bayseian network and define the necessary CPTs for the given scenario we have a bag of three biased coins a, b and c with probabilities of coming up heads of 20%, 60%and 80% respectively. One coin is drawn randomly from the bag (with equal likelihood of drawing each of the three coins) and then the coin is flipped three times to generate the outcomes X1, X2 and X3.

COURSE OUTCOME: Improve problem solving skills using the acquired knowledge in the areas of reasoning.

UNIT V INTELLIGENCE AND APPLICATIONS

Natural language processing-Morphological Analysis-Syntax analysis-Semantic Analysis-Al 1 applications – Language Models - Information Retrieval – Information Extraction - Machine Translation – Machine Learning - Symbol-Based – Machine Learning: Connectionist – Machine Learning.

COURSE OBJECTIVE: Introduce the concepts of Expert Systems.

1. Define Natural Language Processin

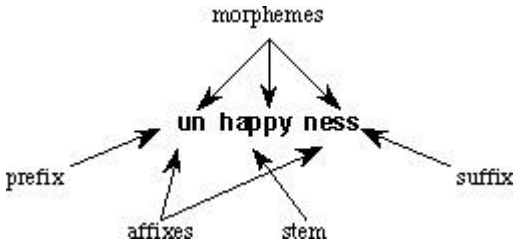
Language is a method of communication with the help of which we can speak, read and write. Natural Language Processing (NLP) is a subfield of Computer Science that deals with Artificial Intelligence (AI), which enables computers to understand and process human language

2. Whatis Natural Language Processing? (U)

Natural Language Processing, usually shortened as NLP, is a branch of artificial intelligence that deals with the interaction between computers and humans using the natural language. The ultimate objective of NLP is to read, decipher, understand, and make sense of the human languages in a manner that is valuable. Most NLP techniques rely on machine learning to derive meaning from human languages.

3. Whatis Morphological Analysis ? (U)

Morphology is the study of the structure and formation of words. Its most important unit is the *morpheme*, which is defined as the "minimal unit of meaning". (Linguistics textbooks usually define it slightly differently as "the minimal unit of grammatical analysis".) Consider a word like: "unhappiness". This has three parts:



- There are three morphemes, each carrying a certain amount of meaning. *un* means "not", while *ness* means "being in a state or condition". *Happy* is a *free morpheme* because it can
  appear on its own (as a "word" in its own right). *Bound morphemes* have to be attached to a free morpheme, and so cannot be words in their own right. Thus you can't have sentences in English such as "Jason feels very un ness today".
- Armed with these definitions, we can look at ways used to classify languages according to their morphological structure.

4. What is *Morphological processes(U)*

In the example given above of *unhappiness*, we saw two kinds of affix, a prefix and a suffix.
Just to show that languages do really vary greatly, there are also infixes. For instance the Bontoc language from the Philippines use an infix *um* to change adjectives and nouns into verbs. So the word *fikas*, which means "strong" is transformed into the verb "be strong" by the addition of the infix: *f-um-ikas.*

There are a number of morphological processes of which some are more important than others for NLP. The account given here is selective and unusual in that it points out the practical aspects of the processes selected.

Inflection

Inflection is the process of changing the form of a word so that it expresses information such as number, person, case, gender, tense, mood and aspect, but the syntactic category of the word remains unchanged. As an example, the plural form of the noun in English is usually formed from the singular form by adding an *s.*

- car / cars
- table / tables
- dog / dogs

In each of these cases, the syntactic category of the word remains unchanged.

It doesn't take long to find examples where the simple rule given above doesn't fit. So there are smaller groups of nouns that form plurals in different ways:

wolf / wolves knife / knives switch / switches.

A little more thought and we can think of apparently completely irregular plural forms, such as:

 foot / feet child / children.

English verbs are relatively simple (especially compared with languages like Finnish which has over 12,000 verb inflections).

 mow - stem

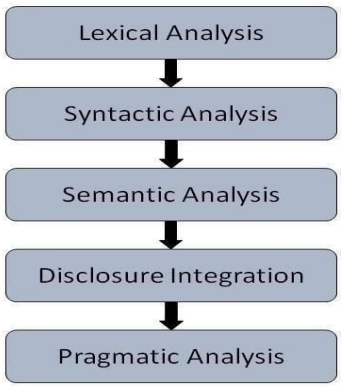
 mow**s** - third person singular, present tense mow**ed** - past tense and past participle mow**ing** - present continuous tense

5. List out the steps in NLP (U)

There are general five steps −

 Lexical Analysis − It involves identifying and analyzing 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.

 Syntactic Analysis (Parsing) − It involves analysis of words in the sentence for grammar and arranging words in a manner that shows the relationship among the words. The sentence such as ―The school goes to boy‖ is rejected by English syntactic analyzer.



- **Semantic Analysis** − It draws the exact meaning or the dictionary meaning from the text. The text is checked for meaningfulness. It is done by mapping syntactic structures and objects in the task domain. The semantic analyzer disregards sentence such as ―hot ice-cream‖.

- **Discourse Integration** − The meaning of any sentence depends upon the meaning of the sentence just before it. In addition, it also brings about the meaning of immediately succeeding sentence.

- **Pragmatic Analysis** − During this, what was said is re-interpreted on what it actually meant. It involves deriving those aspects of language which require real world knowledge.

6. What are semantic analyses used for? (R)

Semantics means the meaning and interpretation of words, signs, and sentence structure. Semantics largely determine our reading comprehension, how we understand others, and even what decisions we make as a result of our interpretations. Semantics can also refer to the branch of study within linguistics that deals with language and how we understand meaning. This has been a particularly interesting field for philosophers as they debate the essence of meaning, how we build meaning, how we share meaning with others, and how meaning changes over time.

7. List out the Applications of AI (R)

- Here are the applications of AI in various sectors:

Artificial Intelligence in Healthcare • Artificial Intelligence in Business

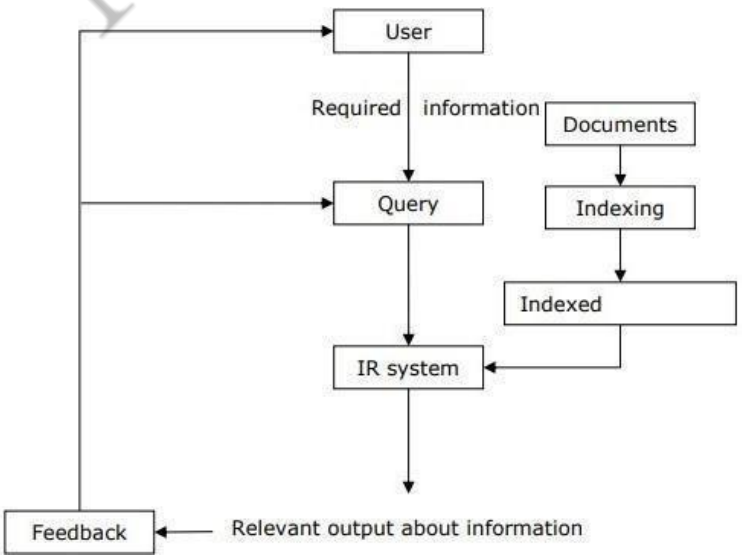
- Artificial Intelligence in Education
- Artificial Intelligence in Autonomous Vehicles
- Artificial Intelligence in Social Media
- Artificial Intelligence for a Better World
- Artificial Intelligence in Tourism

- Types of Artificial Intelligence
  - Weak AI
  - Strong AI
- Further, Artificial Intelligence is categorized into **four types based on functionality**, and these are as follows:
  - Reactive Machines
  - Limited Memory
  - Theory of Mind
  - Self-awareness

8. What is a language model? (R)

A statistical language model is a probability distribution over sequences of words. Given such a sequence, say of length m, it assigns a probability (P*w1*……P*wn*) to the whole sequence. The language model provides context to distinguish between words and phrases that sound similar. For example, in American English, the phrases "recognize speech" and "wreck a nice beach" sound similar, but mean different things. **9. Explain in details about Information Retrieval**

Information retrieval (IR) may be defined as a software program that deals with the organization, storage, retrieval and evaluation of information from document



repositories particularly textual information. The system assists users in finding the information they require but it does not explicitly return the answers of the questions. It informs the existence and location of documents that might consist of the required information. The documents that satisfy user‘s requirement are called relevant documents. A perfect IR system will retrieve only relevant documents. With the help of the following diagram, we can understand the process of information retrieval (IR) It is clear from the above diagram that a user who needs information will have to formulate a request in the form of query in natural language. Then the IR system will respond by retrieving the relevant output, in the form of documents, about the required information.

10. Whatarethe Types of Information Retrieval (IR) Model (R)

Types of Information Retrieval (IR) Model

An information model (IR) model can be classified into the following three models −

Classical IR Model

It is the simplest and easy to implement IR model. This model is based on mathematical knowledge that was easily recognized and understood as well. Boolean, Vector and Probabilistic are the three classical IR models.

Non-Classical IR Model

It is completely opposite to classical IR model. Such kind of IR models are based on principles other than similarity, probability, Boolean operations. Information logic model, situation theory model and interaction models are the examples of non-classical IR model.

Alternative IR Model

It is the enhancement of classical IR model making use of some specific techniques from some other fields. Cluster model, fuzzy model and latent semantic indexing (LSI) models are the example of alternative IR model.

11. Whatis Machine Translation(R)

"Machine translation (MT) is the application of computers to the task of translating texts from one natural language to another. One of the very earliest pursuits in computer science, MT has proved to be an elusive goal, but today a number of systems are available which produce output which, if not perfect, is of sufficient quality to be useful in a number of specific domains."

12. Whatis Machine Learning? (R) A definition

Machine learning is an application of artificial intelligence (AI) that provides systems the ability to automatically learn and improve from experience without being explicitly programmed. Machine learning focuses on the development of computer programs that can access data and use it learn for themselves.

The process of learning begins with observations or data, such as examples, direct experience, or instruction, in order to look for patterns in data and make better decisions in the future based on the examples that we provide. The primary aim is to allow the computers learn automatically without human intervention or assistance and adjust actions accordingly.

13. Listoutthe machine learning methods (R)

- Machine learning algorithms are often categorized as supervised or unsupervised.
  - Supervised machine learning algorithms can apply what has been learned in the past to new data using labeled examples to predict future events. Starting from the analysis of a known training dataset, the learning algorithm produces an inferred function to make predictions about the output values. The system is able to provide targets for any new input after sufficient training. The learning algorithm can also compare its output with the correct, intended output and find errors in order to modify the model accordingly.
  - In contrast, unsupervised machine learning algorithms are used when the information used to train is neither classified nor labeled. Unsupervised learning studies how systems can infer a function to describe a hidden structure from unlabeled data. The system doesn‘t figure out the right output, but it explores the data and can draw inferences from datasets to describe hidden structures from unlabeled data.
  - Semi-supervised machine learning algorithms fall somewhere in between supervised and unsupervised learning, since they use both labeled and unlabeled data for training – typically a small amount of labeled data and a large amount of unlabeled data. The systems that use this method are able to considerably improve learning accuracy. Usually, semi-supervised learning is chosen when the acquired labeled data requires skilled and relevant resources in order to train it / learn from it. Otherwise, acquiring unlabeled data generally doesn‘t require additional

resources.

- Reinforcement machine learning algorithms is a learning method that interacts with its environment by producing actions and discovers errors or rewards. Trial and error search and delayed reward are the most relevant characteristics of reinforcement learning. This method allows machines and software agents to automatically determine the ideal behavior within a specific context in order to maximize its performance. Simple reward feedback is required for the agent to learn which action is best; this is known as the reinforcement signal.

14. Define Expert Systems? (Nov/Dec 2016) (R)

The expert systems are the computer applications developed to solve complex problems in a particular domain, at the level of extra-ordinary human intelligence and expertise.

15. What are the Characteristics of Expert Systems (U)

- High performance
- Understandable
- Reliable
- Highly responsive

16. List out the Capabilities of Expert Systems (R)

The expert systems are capable of Instructing and assisting human in decision making

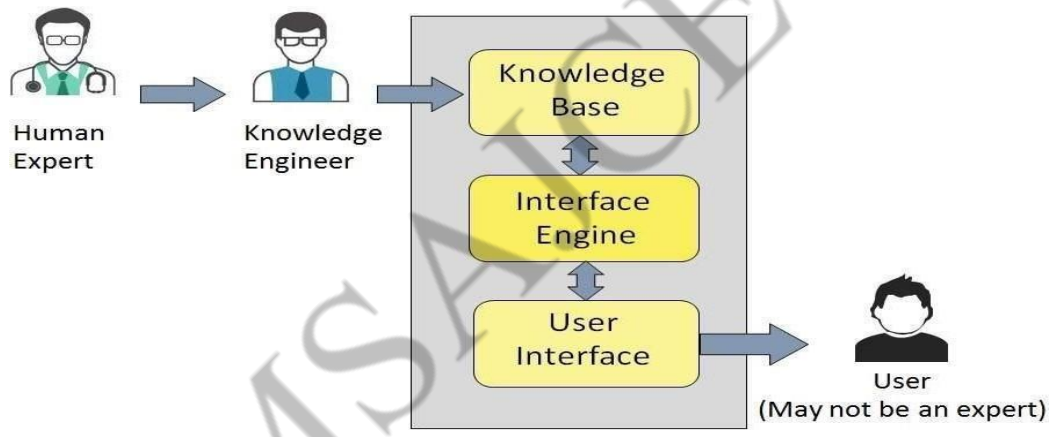
- Demonstrating
- Deriving a solution
- Diagnosing
- Explaining
- Interpreting input
- Predicting results

- Justifying the conclusion
- Suggesting alternative options to a problem

17. Whatarethe Components of Expert Systems (R)

The components of ES include −

- Knowledge Base
- Interface Engine
- **User Interface**



18. What are the Requirements of Efficient ES User Interface? (U)

- It should help users to accomplish their goals in shortest possible way.
- It should be designed to work for user‘s existing or desired work practices.
- Its technology should be adaptable to user‘s requirements; not the other way round.

- It should make efficient use of user input.

19. Limitations of Expert Systems? (U)

No technology can offer easy and complete solution. Large systems are costly, require significant

development time, and computer resources. ESs has their limitations which include −

- Limitations of the technology

Application	Description
Design Domain	Camera lens design, automobile design.
Medical Domain	Diagnosis Systems to deduce cause of disease from observed data, conduction medical operations on humans.
Monitoring Systems	Comparing data continuously with observed system or with prescribed behavior such as leakage monitoring in long petroleum pipeline.
Process Control Systems	Controlling a physical process based on monitoring.
Knowledge Domain	Finding out faults in vehicles, computers.
Finance/Commerce	Detection of possible fraud, suspicious transactions, stock market trading, Airline scheduling, cargo scheduling.

- Difficult knowledge acquisition
- ES are difficult to maintain
- High development costs

20. Write the Applications of Expert System? (U)

The following table shows where ES can be applied

21. List out the steps of Development of Expert Systems (U)

The process of ES development is iterative. Steps in developing the ES include −

- Identify Problem Domain
- Design the System
- Develop the Prototype
  - Test and Refine the Prototype
  - Develop and Complete the ES
- Maintain the ES

22. What are the Benefits of Expert Systems (U)

- Availability − they are easily available due to mass production of software.
- Less Production Cost − Production cost is reasonable. This makes them affordable.
- Speed − they offer great speed. They reduce the amount of work an individual puts in.
- Less Error Rate − Error rate is low as compared to human errors.
- Reducing Risk − they can work in the environment dangerous to humans.
- Steady response − they work steadily without getting motional, tensed or fatigued.

23. List out the expert System Technology (R)

- Expert System Development Environment
- Tools
- Shells

24. Give an importance of Expert System Shells (U)

The part of an expert system that does not contain any domain specific or case specific knowledge is the expert system shell. A single expert system shell can be used to build a number of different expert systems. An example of an expert system shell is CLIPS.

25. Write notes on Knowledge Engineering of experts system? (U)

- Takes knowledge from experts and inputs it into the expert system.
- Usually choose which expert system shell to use.
- Responsible for entering meta-rules.

26. Explain Backward Chaining in Expert Systems (U)

Backward chaining is often used in expert systems that are designed for medical diagnosis:

- For each hypothesis, H:
- If H is in the facts database, it is proved.
- Otherwise, if H can be determined by asking a question, then enter the user's answer in the facts database. Hence, it can be determined whether H is true or false, according to the user's answer**.**

27. Write a Simple Medical Expert System? (U)

Rules

- If headache then prescribe pain killer
- If headache and sore throat and coughing than diagnose flu

- If tired and headache then diagnose glandular fever
- If tired and sore throat then diagnose tonsillitis
- If tired than diagnose stress.

28. Define Knowledge acquisition in AI? (R)

• Knowledge acquisition from human experts the ―paradox of expertise‖

29. What are the Activities in AI (U)

- Knowledge acquisition
- Knowledge representation
- Knowledge inferencing
- Knowledge transfer to the user

30. Draw the Three Major ES Components in AI. (R)

31. List out all ES Components in AI (R)

- Knowledge Acquisition Subsystem

- Knowledge Base
- Inference Engine
- User Interface
- Blackboard (Workplace)
- Explanation Subsystem (Justifier)
- Knowledge Refining System
- User
- Most ES *do not have* a Knowledge Refinement Component

32. List out the two Basic Knowledge Base Elements (R)

- Facts
- Special heuristics, or rules that direct the use of knowledge
- Knowledge is the primary raw material of ES
- Incorporated knowledge representation

33. How Expert Systems Work in Artificial intelligence (U)

- Development
- Consultation
- Improvement

34. What are the Problem Areas Addressed by Expert Systems(U)

- Interpretation systems
- Prediction systems

- Diagnostic systems
- Design systems
- Planning systems
- Monitoring systems
- Debugging systems
- Repair systems
- Instruction systems
- Control systems

35. What is Meta knowledge? How Meta knowledge is represented in rule based expert systems? (May/June 2016) (U)

In ES, Meta knowledge refers to knowledge about the operation of knowledge-based systems

- Meta knowledge is knowledge about knowledge and expertise.
- Most successful expert systems are restricted to as small a domain as possible.
- In an expert system, ontology is the Meta knowledge that describes everything known about the problem domain.
- Wisdom is the meta knowledge of determining the best goals of life and how to obtain them

36. Write any four earliest expert systems? (May/June 2016) (R)

- MYCIN
- DART

- XOON
- Expert systems shells.

37. What is XCone? (Nov/Dec 2016) (R)

The R1 (internally called XCON, for eXpert CONfigurer) program was a production-rule-based system written in OPS5 by John P. McDermott of CMU in 1978 to assist in the ordering of DEC's VAX computer systems by automatically selecting the computer system components based on the customer's requirements.

38. List out the problem areas addressed by expert systems. (U) (Apr/May 2017)

- Banking and financial Sector
- Production industries and military

39. What are the advantages of MYCIN? (U) (Apr/May 2017)

- Provide answers for decisions, processes and tasks that are repetitive
- Hold huge amounts of information
- Minimize employee training costs
- Centralize the decision making process
- Make things more efficient by reducing the time needed to solve problems
- Combine various human expert intelligences
- Reduce the number of human errors
- Provide strategic and comparative advantages that may create problems for competitors

40. List the characteristics features of expert system (Nov/Dec 2017) (U)

- Should be able to display the intelligent behavior.
- Should be able to explain the reasoning.
- Should be able to draw the conclusions from the relationships that are very complex in the nature.
- Should be able to provide the much needed portable knowledge.
- Should be able to deal with the certainty.
- Is not used or tested much due to the reason which says that it is difficult to use.
- Does not possess the ability to deal with the mixed knowledge.
- Cannot refine own knowledge base.
- Are very much difficult to maintain.
- Limited to the narrow problems.

41. What is MOLE (Nov/Dec 2017) (R)

MOLE (Eshelman & McDermott, 1986) is an expert-system shell that can be used in building systems that do heuristic classification. It is both a performance system which interprets a domain-dependent knowledge base and a knowledge-acquisition tool for building and refining this knowledge base.

58. What are the common mechanisms supported in an expert system shell R (April / May 2018)

- Knowledge base
- Inference engine

- Explanation facility
- Knowledge acquisition facility

59. List the three activities supported by the programs that interact with domain experts to extract expert knowledge. R (April / May 2018)

- A Domain expert
- Knowledge engineer

BASIS FOR COMPARISON	SYNTAX	SEMANTICS
Basic	Permitted phrases of a language.	Interpretation of the phrases.
Errors	Handled at the compile time.	Confronted at runtime.

Relation	Syntactic interpretation must have some distinctive meaning.	Semantic component is associated with a syntactic representation.

- User

60. Identify the components of Natural language processing APRIL / MAY 2021

Two components of NLP

1. Natural Language Understanding (NLU)
   - Natural Language Understanding **(NLU)** helps the machine to understand and analyse human language.
   - NLU used in Business applications to understand the customer's problem in both spoken and written language.
   - NLU involves the two tasks - o Used to map the given input into useful representation.
     - Used to analyze different aspects of the language.
2. Natural Language Generation (NLG)
   - Natural Language Generation **(NLG)** acts as a translator that converts the computerized data into natural language representation. It involves in **Text planning, Sentence planning, and Text Realization**.

61. Differentiate syntax and semantic analysis in NLP terminologies. APRIL / MAY 2021

PART-B

1. Explain in details about Natural language processing **(R)**
2. Explain in details about Morphological Analysis **(R)**
3. Explain in details about Syntax analysis **(R)**
4. Explain in details about Semantic Analysis **(R)**
5. Explain in details about AIl applications **(R)**
6. Explain in details about Language Models **(R)**
7. Explain in details about Information Retrieval **(R)**
8. Explain in details about Information Extraction **(R)**
9. Explain in details about Machine Translation **(R)**
10. Explain in details about Machine Learning **(R)**
11. Explain in details about Symbol Based Machine Learning **(R)**

12. (i) Explain about the knowledge acquisition **(U) (May/June 2016)**

(ii) Write the Characteristics features of Expert systems **(U) (May/June 2016)**

13. (i) Explain the basic components of an expert systems **(U) (May/June 2016)**

(ii) Write any six applications of expert systems. **(U) (May/June 2016)**

14. Explain about the knowledge acquisition. **(U) (Nov/Dec 2016)**

15. Briefly any six application of expert systems. **(U)(Nov/Dec 2016)**

16. Explain with neat diagram the architecture of expert system and mention its features. **(U)(Nov/Dec2016)**

17. Define Expert system. Explain the architecture of an expert system in detail with a neat
diagram(AP)APR/MAY 2017

18. Explain the expert system architectures: **(U)(Nov/Dec 2017)**

i) Rule-based system architecture

ii) Associative or Semantic network architecture iii) Network architecture iv) Blackboard system architecture

19. Design an expert system for Travel recommendation and discuss its roles **(An)(Nov/Dec 2017)**

20. Analyze any two machine learning algorithms with an example **(An)(Nov/Dec 2017)**

21. Write a detailed note on expert systems including representation, usage of domain knowledge, reasoning and explaining. **(U) (Apr/May 2018)**

22. Find the algorithm that is capable of learning to recognize the handwritten digits and squeezing every last drop of predictive performance out of them. **APRIL / MAY 2021**

23. Illustrate the structure and research models involved in machine translation. **APRIL / MAY 2021**

COURSE OUTCOME: Improve problem solving skills using the acquired knowledge in the areas of, reasoning, natural language understanding, computer vision, automatic programming and machine learning..

COURSE OUTCOMES

COURSE NAME : IT8601 COMPUTATIONAL INTELLIGENCE
YEAR/SEMESTER : III / VI
YEAR OF STUDY : 2021 –2022EVEN (R – 2017)

On Completion of this course student will gain

CO309.1	To provide a strong foundation on fundamental concepts in Computational Intelligence.
CO309.2	To enable Problem-solving through various searching techniques.
CO309.3	To apply these techniques in applications which involve perception, reasoning and learning
CO309.4	To apply Computational Intelligence techniques for information retrieval
CO309.5	To apply Computational Intelligence techniques primarily for machine learning.

CO – PO MATRIX:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO309.1	3	3	3	3	-		-	-	-	-	-	-
CO309.2	3	3	3	3	-		-	-	-	-	-	-
CO309.3	3	3	3	3	-		-	-	-	-	-	-
CO309.4	3	3	3	3	-		-	-	-	-	-	-
CO309.5	3	3	3	3	-		-	-	-	-	-	-
CO309	3	3	3	3	-	2	-	-	-	-	-	-

CO – PSO MATRIX:

CO	PSO1	PSO2	PSO3
CO309.1	2	3	3
CO309.2	2	3	3
CO309.3	2	3	3
CO309.4	2	3	3
CO309.5	2	3	3
CO309	2	3	3