

CS8691 – ARTIFICIAL INTELLIGENCE

CS8691**ARTIFICIAL INTELLIGENCE****L T P C 3 0 0 3****OBJECTIVES:**

- To understand the various characteristics of Intelligent agents
- To learn the different search strategies in AI
- To learn to represent knowledge in solving AI problems
- To understand the different ways of designing software agents
- To know about the various applications of AI.

UNIT I INTRODUCTION

Introduction–Definition – Future of Artificial Intelligence – Characteristics of Intelligent Agents– Typical Intelligent Agents – Problem Solving Approach to Typical AI problems.

UNIT II PROBLEM SOLVING METHODS

Problem solving Methods – Search Strategies- Uninformed – Informed – Heuristics – Local Search Algorithms and Optimization Problems -Searching with Partial Observations – Constraint Satisfaction Problems – Constraint Propagation
– Backtracking Search – Game Playing – Optimal Decisions in Games – Alpha –Beta Pruning – Stochastic Games

UNIT III KNOWLEDGE REPRESENTATION

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

UNIT IV SOFTWARE AGENTS

Architecture for Intelligent Agents – Agent communication – Negotiation and Bargaining – Argumentation among Agents – Trust and Reputation in Multi-agentsystems.

UNIT V APPLICATIONS

AI applications – Language Models – Information Retrieval- Information Extraction – Natural Language Processing – Machine Translation – Speech Recognition – Robot – Hardware –Perception – Planning – Moving

OUTCOMES:

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

- Use appropriate search algorithms for any AI problem
- Represent a problem using first order and predicate logic
- Provide the apt agent strategy to solve a given problem

- Design software agents to solve a problem
- Design applications for NLP that use Artificial Intelligence.

TEXT BOOKS:

- 1 S. Russell and P. Norvig, "Artificial Intelligence: A Modern Approach", PrenticeHall, Third Edition, 2009.
- 2 I. Bratko, —Prolog: Programming for Artificial Intelligence, Fourth edition, Addison-Wesley Educational Publishers Inc., 2011.

REFERENCES:

1. M. Tim Jones, —Artificial Intelligence: A Systems Approach (Computer Science), Jones and Bartlett Publishers, Inc.; First Edition, 2008
2. Nils J. Nilsson, —The Quest for Artificial Intelligence, Cambridge University Press, 2009.
3. William F. Clocksin and Christopher S. Mellish, Programming in Prolog: Using the ISO Standard, Fifth Edition, Springer, 2003.
4. Gerhard Weiss, —Multi Agent Systems, Second Edition, MIT Press, 2013. 5. David L. Poole and Alan K. Mackworth, —Artificial Intelligence: Foundations of Computational Agents, Cambridge University Press, 2010

COURSE OUTCOMES

Course Outcome	Statement
CO1	Understand the various characteristics of Intelligent agents
CO2	Use appropriate search algorithms for any AI problem
CO3	Represent a problem using first order and predicate logic
CO4	Provide the apt agent strategy to solve a given problem
CO5	Design software agents to solve a problem
CO6	Design applications for NLP that use Artificial Intelligence

UNIT I**INTRODUCTION**

Introduction–Definition – Future of Artificial Intelligence – Characteristics of Intelligent Agents–Typical Intelligent Agents – Problem Solving Approach to Typical AI problems.

PART A**1. What is ridge?(U)(MAY/JUNE2016)**

Ridge: special kind of local maximum. It is an area of the search space that is higher than the surrounding areas and that itself has the slope.

2. How much knowledge would be required by a perfect program for the problem of playing chess? Assume that unlimited computing power is available. (U)(MAY/JUNE2016)

Knowledge would be required by a perfect by a perfect program.

- Rules for determining legal moves
- Control mechanism that implements an appropriate search procedure
- Good strategy and tactics

3. What is artificial intelligence? (U)

The exciting new effort to make computers think machines with minds in the full and literal sense. Artificial intelligence systemizes and automates intellectual tasks and is therefore potentially relevant to any sphere of human intellectual activities.

4. Define Turing test. (R)

The Turing test proposed by Alan Turing was designed to provide a satisfactory operational definition of intelligence. Turing defined intelligent behavior as the ability to achieve human- level performance in all cognitive tasks, sufficient to fool an interrogator.

5. Define an agent. (R)

An agent is anything that can be viewed as perceiving its environment through sensors and acting upon the environment through effectors.

6. Define rational agent. (R)(DEC 2011) (APRIL/MAY 2015)

A rational agent is one that does the right thing. Here right thing is one that will cause agent to be more successful. That leaves us with the problem of deciding how and when to evaluate the agent success.

7. Define an Omniscient agent. (R)

An omniscient agent knows the actual outcome of its action and can act accordingly; but omniscience is impossible in reality.

8. What are the factors that a rational agent should depend on at any given time?

The factors that a rational agent should depend on at any given time are,

- The performance measure that defines criterion of success;

- Agent prior knowledge of the environment;
- Action that the agent can perform;
- The agent percept sequence to date.

6. List the measures to determine agent's behavior. (R) The measures to determine agent's behavior are,

- Performance measure,
- Rationality,
- Omniscience, Learning and Autonomy.

7. List the various types of agent programs. (U)(DEC 2012)(Apr/May-2022)

The various types of agent programs are

- Simple reflex agent program
- Agent that keep track of the world
- Goal based agent program
- Utility based agent program.

8. Define problem formulation. (R)

Problem formulation is the process of deciding what actions and states to consider for a goal that has been developed in the first step of problem solving.

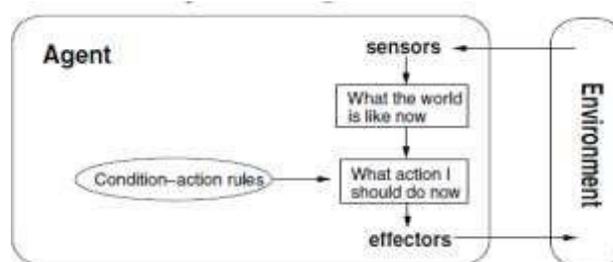
9. List the four components of a problem? (R) The four components of a problem are,

- An initial state; Actions;
- Goal test;
- Path cost.

10. What does Software Agent mean? (U)(NOV/DEC 2013)

A software agent is a piece of software that functions as an agent for a user or another program, working autonomously and continuously in a particular environment. It is inhibited by other processes and agents, but is also able to learn from its experience in functioning in an environment over a long period of time.

15. Give the structure of an agent. (R)(MAY/JUNE 2014)



16. Why problem formulation should follow goal formulation?(U)(APRIL/MAY 2015)(APR/MAY 2021)

In goal formulation, we decide which aspects of the world we are interested in, and which can be

ignored or abstracted away. Then in problem formulation we decide how to manipulate the important aspects (and ignore the others). If we did problem formulation first we would not know what to include and what to leave out. That said, it can happen that there is a cycle of iterations between goal formulation, problem formulation, and problem solving until one arrives at a sufficiently useful and efficient solution.

17. List the components of a learning agent? (R)

The components of a learning agent are,

- Learning element;
- Performance element; Critic;
- Problem generator.

18. List out some of the applications of Artificial Intelligence. (R)(APR / MAY 2021)

Some of the applications of Artificial Intelligence are,

- Autonomous planning and
- Scheduling Game playing;
- Autonomous control; Diagnosis;
- Logistics planning; Robotics.

19. List down the agent characteristics?

Agent Characteristics	Definition
Autonomy	Operates without the direct intervention of humans or others
Sociability	Interacts with other agents, that is, communicates with external environment such as sensors, fusion systems and human operators
Reactivity	Perceives its environment and responds in a timely fashion
Pro-activity	Exhibits goal-directed behavior by taking the initiative
Learnability	Learns from the environment over time to adjust knowledge and beliefs
Mobility	Moves with code to a node where data resides
Anthromorphicity	Externally behaves like human

20. What is the Goal of AI?(U)

- **To Create Expert Systems** – The systems which exhibit intelligent behavior, learn, demonstrate, explain, and advice its users.
- **To Implement Human Intelligence in Machines** – Creating systems that understand, think, learn, and behave like humans.

21. State the Future of AI?(U)

- **Transportation:** Although it could take a decade or more to perfect them, autonomous cars will one day ferry us from place to place.
- **Manufacturing:** AI powered robots work alongside humans to perform a limited range of tasks like assembly and stacking, and predictive analysis sensors keep equipment

running smoothly.

- **Healthcare:** In the comparatively AI-nascent field of healthcare, diseases are more quickly and accurately diagnosed, drug discovery is sped up and streamlined, virtual nursing assistants monitor patients and big data analysis helps to create a more personalized patient experience.
 - **Education:** Textbooks are digitized with the help of AI, early-stage virtual tutors assist human instructors and facial analysis gauges the emotions of students to help determine who's struggling or bored and better tailor the experience to their individual needs.
- **Media:** Journalism is harnessing AI, too, and will continue to benefit from it. Bloomberg uses Cyborg technology to help make quick sense of complex financial reports. The Associated Press employs the natural language abilities of Automated Insights to produce 3,700 earning reports stories per year — nearly four times more than in the recent past.
- **Customer Service:** Last but hardly least, Google is working on an AI assistant that can place human-like calls to make appointments at, say, your neighborhood hair salon. In addition to words, the system understands context and nuance.

22. How to Evaluate an Agent's Behavior/Performance? (C)

- Rationality => Need a performance measure to say how well a task has been achieved. An ideal rational agent should, for each possible percept sequence, do whatever actions will maximize its performance measure based on (1) the percept sequence, and (2) its built-in and acquired knowledge. Hence includes information gathering, not "rational ignorance."
- Types of objective performance measures: false alarm rate, false dismissal rate, time taken, resources required effect on environment, etc.
- Examples: Benchmarks and test sets, Turing test (there is no homunculus!)

23. Write the Characteristics of Agent? (U)

- **Situatedness**
The agent receives some form of sensory input from its environment, and it performs some action that changes its environment in some way. Examples of environments: the physical world and the Internet.
- **Autonomy**
The agent can act without direct intervention by humans or other agents and that it has control over its own actions and internal state.
- **Adaptivity**
The agent is capable of (1) reacting flexibly to changes in its environment; (2) taking goal-directed initiative (i.e., is pro-active), when appropriate; and (3) learning from its own experience, its environment, and interactions with others.
- **Sociability**
The agent is capable of interacting in a peer-to-peer manner with other agents or humans.

24. Write the major AI problems.(U)

1. Domain Expert: Problems Which Involve Reasoning Based On a Complex Body of knowledge
2. Domain Extension: Problems Which Involve Extending a Complex Body of Knowledge
3. Complex Planner: Tasks Which Involve Planning
4. Better Communicator: Tasks Which Involve Improving Existing Communication
5. New Perception: Tasks Which Involve Perception
6. Enterprise AI: AI Meets Re-Engineering the Corporation!
7. Enterprise AI Adding Unstructured Data and Cognitive Capabilities to ERP and Data Warehousing

8. Problems Which Impact Domains Due to Second Order Consequences of AI
9. Problems in the Near Future That Could Benefit From Improved Algorithms
10. Evolution of Expert Systems
11. Super Long Sequence Pattern Recognition
12. Extending Sentiment Analysis Using AI

25. Write ways to formulate a problem. (U)(Nov/Dec-18)

- **Initial state** of the agent.
- **The possible actions** available to the agent
- The transition model describing what each action does.
- **The goal test**, determining whether the current state is a goal state.
- **The path cost function**, which determines the cost of each path, which is reflecting in the performance measure.

26. What are the applications of AI? (Nov / Dec 2020 And April / May 2021)

- AI Application in E-Commerce
- Applications of Artificial Intelligence in Education
- Applications of Artificial Intelligence in Lifestyle
- Applications of Artificial intelligence in Navigation
- Applications of Artificial Intelligence in Robotics
- Applications of Artificial Intelligence in Human Resource
- Applications of Artificial Intelligence in Healthcare
- Applications of Artificial Intelligence in Agriculture
- Applications of Artificial Intelligence in Gaming

27. Name the elements of an agent and list out the characteristics of intelligent agent. (Nov / Dec 2020 and April / May 2021)

Sensor: Sensor is a device which detects the change in the environment and sends the information to other electronic devices. An agent observes its environment through sensors.

Actuators: Actuators are the component of machines that converts energy into motion.

The actuators are only responsible for moving and controlling a system. An actuator can be an electric motor, gears, rails, etc.

Effectors: Effectors are the devices which affect the environment. Effectors can be legs, wheels, arms, fingers, wings, fins, and display screen.

28. How does differ artificial intelligence from human intelligence? (Apr/May-2022)

- **Nature of Existence**
Human intelligence revolves around adapting to the environment using a combination of Several cognitive processes.
The field of Artificial intelligence focuses on designing machines that can mimic human behavior.
- **Memory usage**
Humans use content memory and thinking whereas, robots are using built-in instructions, Designed by scientists.
- **Mode of creation**
Human intelligence is bigger because its creation of God and artificial intelligence as the name suggests is artificial, little and temporary created by humans. also, Humans intelligence is the real creator of the artificial intelligence even but they cannot create a human being with superiority.
- **Learning process**
Human intelligence is based on the variants they encounter in life and responses they get which may result in millions of functions overall in their lives. However, Artificial intelligence

is defined or developed for specific tasks only and its applicability on other tasks may not be easily possible.

- **Dominance**

Artificial intelligence can beat human intelligence in some specific areas such as in Chess a supercomputer has beaten the human player due to being able to store all the moves played by all humans so far and being able to think ahead 10 moves as compared to human players who can think 10 steps ahead but cannot store and retrieve that number of moves in Chess.

PART – B

1. Define Artificial Intelligence (AI). Explain the techniques of AI and describe the characteristics of AI. **(Apr/May 2021)**
2. Write in detail about Intelligent Agents. **(AP)**
3. Solve the given problem. Describe the operators involved in it. **(AN)** Consider a water jug problem: You are given two jugs, a 4-gallon one a 3-gallon one. Neither have any 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 a jug onto the ground, water can be poured from one jug to another and that there are no other measurements and that there are no other measuring devices available. **(May/June-2016-Nov/Dec-2016)**
4. Explain in detail on the characteristics and applications of learning agents. **(U)(Apr/May-11).**
5. Explain in detail learning agent. **(U) (May- 2013)**
6. Describe the various properties of the task environment in AI. **(U)(Msy- 2012)**
7. Explain in detail any of the four agent structure. **(U) (Dec 2012)**
8. Describe briefly the various problem characteristics? **(R)(NOV/DEC 2016)(APRIL/MAY 2018)**
9. Explain in detail about the mean end analysis procedure with example? **(AN)**
10. Evaluate a problem as a state space search with an example? **(E)**
11. Exemplify the necessary components to define an AI problem with an example. **(U)(NOV/DEC 2016)**
12. Explain in detail about AI problems with real time example.
13. Analyze the following problems with respect to the seven problem characteristics. **(AN)(8)(April/May-2019)**
 - (1) Travelling Salesman problem
 - (2) 8-puzzle problem
 - (3) Towers of Hanoi
 - (4) chess

14. You have 12 litres of apple juice in a 12litres bucket and you want share it with your best friend. But you have all empty 8litre and an empty 5litre bottle. Design the production system for it. (AP)(7)(April/May-19)

15. Define Artificial Intelligence (AI). Explain the techniques of AI and describe the characteristics of AI. (13)(Nov / Dec 2020 and April / May 2021)

16. i) Show the performance measure of various search algorithms. (5)

ii) List out and brief the necessary components to define an AI problem with an example. (8)
(Nov / Dec 2020 and April / May 2021)

17. Define crypt arithmetic problem. Explain with the problem.

SEND+MORE=MONEY (rule –No two letters have the same value) (values-0to9) (13)
(Apr/May-2022)

18. Why an agent is important and explains in detail about intelligent agents. (13)(Apr/May-2022)

UNIT II

PROBLEM SOLVING METHODS

Problem solving Methods – Search Strategies- Uninformed – Informed – Heuristics –Local Search Algorithms and Optimization Problems -Searching with Partial Observations – Constraint Satisfaction Problems – Constraint Propagation – Backtracking Search – Game Playing – Optimal Decisions in Games – Alpha – Beta Pruning – Stochastic Games

PART A

1. What is Problem Solving?

Problems are the issue which comes across any system. A solution is needed to solve that particular problem.

2. Write the process for problem solving process in AI?

- Defining The Problem: The definition of the problem must be included precisely. It should contain the possible initial as well as final situations which should result in acceptable solution.
- Analyzing The Problem: Analyzing the problem and its requirement must be done as few features can have immense impact on the resulting solution.
- Identification of Solutions: This phase generates reasonable amount of solutions to the given problem in a particular range.
- Choosing a Solution: From all the identified solutions, the best solution is chosen basis on the results produced by respective solutions.
- Implementation: After choosing the best solution, its implementation is done.

3. What are the performance measures used for analyzing the search algorithms?(April/May-19)

Memory Space Time
Complexity Order of
time $O(n)$

4. Define problem formulation. (R)

Problem formulation is the process of deciding what actions and states to consider for a goal that has been developed in the first step of problem solving.

5. List the four components of a problem? (R) The four components of a problem are,

- An initial state;
- Actions;
- Goal test;
- Path cost.

6. Mention the criteria's for the evaluation of search strategy. (U) (MAY/JUNE 2014)

The criteria_s for the evaluation of search strategy are,

- Completeness;
- Time complexity;
- Space complexity;
- Optimality.

7. Define Constraint Satisfaction Problem (CSP). (R)

A constraint satisfaction problem is a special kind of problem satisfies some additional structural properties beyond the basic requirements for problem in general. In a CSP, the states are defined by the values of a set of variables and the goal test specifies a set of constraint that the value must obey.

8. List some of the uninformed search techniques. (R) (APRIL/MAY 2017) Some of the uninformed search techniques are,

- Breadth-First Search (BFS);
- Depth-First Search (DFS);
- Uniform Cost Search;
- Depth Limited Search;
- Iterative Deepening Search; Bidirectional Search.

9. Define Abstraction? (R) (May 2012)

Abstraction is the process by which data and programs are defined with a representation similar in form to its meaning (semantics), while hiding away the implementation details. Abstraction tries to reduce and factor out details so that the programmer can focus on a few concepts at a time.

10. Define the effect of heuristic accuracy on performance (R) (DEC 2011) (NOV/DEC 2013)

A heuristic is a method that might not always find the best solution but is guaranteed to find a good solution in reasonable time. By sacrificing completeness it increases efficiency. Useful in solving tough problems which could not be solved any other way. Solutions take an infinite time or very long time to compute. The classic example of heuristic search methods is the travelling salesman problem.

11. Why problem formulation should follow goal formulation? (U) (APRIL/MAY 2015)

In goal formulation, we decide which aspects of the world we are interested in, and which can be ignored or abstracted away. Then in problem formulation we decide how to manipulate the important aspects (and ignore the others). If we did problem formulation first we would not know what to include and what to leave out. That said, it can happen that there is a cycle of iterations between goal formulation, problem formulation, and problem solving

until one arrives at a sufficiently useful and efficient solution.

12. Define Heuristic function, $h(n)$. (R) (NOV/DEC 2016)

$h(n)$ is defined as the estimated cost of the cheapest path from node n to a goal node.

13. What are the categories of production systems? (U) (NOV/DEC 2016)

- Monotonic Production System
- Non-Monotonic Production system
- Partially commutative Production system
- Commutative Production system

14. What is a monotonic production system?(U) (APRIL/MAY 2018)

A system in which the application of a rule never prevents the later application of another rule, that could have also been applied at the time the first rule was selected is called as monotonic production system.

15. Will Breadth-First Search always find the minimal solution. Why?(AN)(APRIL/MAY 2018)

Yes. If there is more than one solution then BFS can find the minimal one that requires less number of steps.

16. What is a Commutative production system?(U) (NOV/DEC 2017)

A Commutative production system is a production system that is both monotonic and partially commutative.

17. State the advantage of Breadth First Search.(R)(NOV/DEC 2017)

- BFS is a systematic search strategy- all nodes at level n are considered before going to $n+1$ th level.
- If any solution exists then BFS guarantees to find it.
- If there are many solutions, BFS will always find the shortest path solution.
- Never gets trapped exploring a blind alley

18. What is alpha-beta pruning? (U) (MAY/JUNE 2016)

To handle both maximizing and minimizing players, it is also necessary to modify the branch- and-bound strategy to include two bounds, one for each of the players.

- i.* Lower bound on the value that a maximizing node ultimately assigned as α .
- ii.* Upper bound on the value that a minimizing node ultimately assigned as β .

19. Write the Applications of Game playing in AI?

Game playing is a very important topic in AI. Game playing attracts many people because its states are well defined and it is intelligent.

For example: State plays a very important role in two player game. States of each player are dependent on actions of another player. Search techniques are commonly used in game.

20. What are the states are used to represent a game tree.

1. **The board state:** This is an initial stage.
2. **The current player:** It refers to the player who will be making the next move.
3. **The next available moves:** For humans, a move involves placing a game token while the computer selects the next game state.
4. **The game state:** It includes the grouping of the three previous concepts.
5. **Final Game States**
In final game states, AI should select the winning move in such a way that each move assigns a numerical value based on its board state.

21. What is MiniMax Algorithm used in Game Tree.

The Min-Max algorithm is generally used for a game consisting of two players such as tic-tac-toe, checkers, chess etc.

Example: Tic Tac Toe Game.

22. What is stochastic game?

Stochastic game is repeated game with probabilistic transitions. There is different states of a game.

23. Differentiate between uninformed and informed search algorithms. (APR / May 2021)**Informed Search**

- They contain information on goal state.
- It helps search efficiently.
- The information is obtained by a function that helps estimate how close a current state is, to the goal state.
- Examples of informed search include greedy search and graph search.
- It uses the knowledge in the process of searching.
- It helps find the solution quickly.
- It may or may not be complete.
- It is inexpensive.
- It consumes less time.
- It gives the direction about the solution.
- It is less lengthy to implement.

Uninformed Search

- They don't have any additional information.
- The information is only provided in the problem definition.
- The goal state can be reached using different order and length of actions.
- Examples of uninformed search include depth first search (DFS) and breadth first search (BFS).
- It doesn't use the knowledge in the process of searching.
- It takes more time to show the solution.
- It is always complete.
- It is expensive.
- It consumes moderate time.
- There is no suggestion regarding finding the solution.
- It is lengthy to implement.

24. List out the classification of CSP with respect to constraints (APR/MAY 2021)

- Unary constraint
- Binary Constraint

28. Differentiate between uninformed and informed search algorithms. (Nov / Dec 2020 and April / May 2021)

Parameters	Informed Search	Uninformed Search
Utilizing Knowledge	It uses knowledge during the process of searching.	It does not require using any knowledge during the process of searching.
Speed	Finding the solution is quicker.	Finding the solution is much slower comparatively.
Completion	It can be both complete and incomplete.	It is always bound to be complete.
Consumption of Time	Due to a quicker search, it consumes much less time.	Due to slow searches, it consumes comparatively more time.
Cost Incurred	The expenses are much lower.	The expenses are comparatively higher.
Suggestion/ Direction	The AI gets suggestions regarding how and where to find a solution to any problem.	The AI does not get any suggestions regarding what solution to find and where to find it. Whatever knowledge it gets is out of the information provided.
Efficiency	It costs less and generates quicker results. Thus, it is comparatively more efficient.	It costs more and generates slower results. Thus, it is comparatively less efficient.
Length of Implementation	Implementation is shorter using AI.	The implementation is lengthier using AI.
Examples	A few examples include Graph Search and Greedy Search.	A few examples include Breadth-First Search or BFS and Depth-First Search or DFS.

29. List out the classification of CSP with respect to constraints. (Nov / Dec 2020 and April / May 2021)

- Variables - a finite number.
- Domain - finite or infinite domain.
- Constraints - Restricting what values variables can simultaneously take.

Example: 8 - Queens’s problem Variables: The eight queens’ positions.

Domain: The Chessboard squares. Constraints: No queen attacks the other.

Goal: To find an “Assignment” of Variables satisfying all the constraints.

30. What is the importance of Optimal Solution.(Apr/May-2022)

The term optimal solution refers to the best solution for a company to solve a problem or achieve its aims.

The term is common in business. However, we can also use it in economics, for military options, mathematics, and in other situations. It is an alternative approach that provides the best outcome for a situation.

31. Differentiate BFS and DFS?(Apr/May-2022)

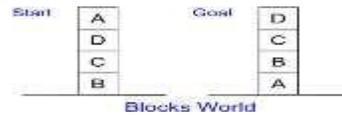
Sr. No.	Key	BFS	DFS
1	Definition	BFS, stands for Breadth First Search.	DFS, stands for Depth First Search.
2	Data structure	BFS uses Queue to find the shortest path.	DFS uses Stack to find the shortest path.
3	Source	BFS is better when target is closer to Source.	DFS is better when target is far from source.

Sr. No.	Key	BFS	DFS
4	Suitability for decision tree	As BFS considers all neighbour so it is not suitable for decision tree used in puzzle games.	DFS is more suitable for decision tree. As with one decision, we need to traverse further to augment the decision. If we reach the conclusion, we won.
5	Speed	BFS is slower than DFS.	DFS is faster than BFS.
6	Time Complexity	Time Complexity of BFS = $O(V+E)$ where V is vertices and E is edges.	Time Complexity of DFS is also $O(V+E)$ where V is vertices and E is edges.

PART – B

1. i) Explain the heuristic functions with examples. (U) (MAY/JUNE2016)
 ii) Write the algorithm for Generate and test and simple Hill Climbing.
2. Show the performance measure of various search algorithms. (APR/MAY 2021)
- 3...List out and brief the necessary components to define an AI problem with an example.(APR/MAY 2021)
4. Define Heuristic search. What are the advantages of Heuristic search?
5. Describe the mini max algorithm with an example.
6. Explain in detail about uninformed search strategies. (U) (APRIL/MAY 2015)
7. Write in detail about any two informed search strategies. (U)(May/June 2009),(April/May2015)
 (April/May2017)
8. Explain AO* algorithm. (U) (APR/MAY11) (DEC 2012)
9. Define CSP and Discuss about backtracking search for CSPs. (U) (May2013)(APRIL/MAY2015)
10. Prove that breadth first search is special case of uniform cost search. (E) (MAY2012)
11. Explain Depth-First search. (U) (MAY 2012)(NOV/DEC 2016)
12. (i)Identify the problems encountered during hill climbing and list the ways available to deal with these problems? (R)
13. (ii)Describe the process of simulated annealing with example?
 (R)(APRIL/MAY2017)(NOV/DEC 2017)
14. Illustrate in detail about the constraint satisfaction procedure with example? (AP)(NOV/DEC 2017)
15. Show how the steepest ascent hill climbing works? (AP) (NOV/DEC 2016)(NOV/DEC 2017)
16. Explain in detail about the mean end analysis procedure with example? (AN)
17. Prepare the merits and demerits of depth-first and breadth-first search with the algorithm? C)
18. Evaluate a problem as a state space search with an example? (E)
21. Exemplify the necessary components to define an AI problem with an example.(U)(NOV/DEC 2016)

22. Consider the Blocks World problem with four blocks A,B,C and D with the start and goal states given below. (AP) (APRIL/MAY 2018)



Assume the following two operations: Pick and a block and put it on table, pick up a block and put it on another block. Solve the above problem using Hill Climbing algorithm and a suitable heuristic function. Show the intermediate decisions and states.

23.(i) Explain the constraint satisfaction procedure to solve the crypt arithmetic problem.(7)

$$\text{CROSS} + \text{ROADS} = \text{DANGER}$$

(ii) Explain AO* algorithm with an example. (6)(April/May-19)

24.(i) Explain the Min Max game playing algorithm with an example.(6)(April/May-19) 26. Elaborate on the following Search technique.(Nov/Dec-19)

(i) Greedy best-first search (5)(ii) A*

Search (5)

(iii) Memory Bounded Heuristic Search (3)

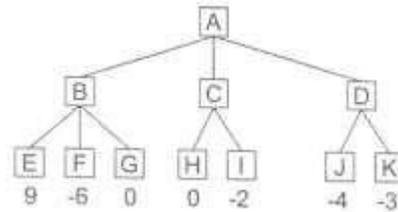
25. Explain backtrack searching for Constraint Satisfaction Problem for map coloring problem.(13)(Nov/Dec-18)

26. Explain Alpha-Beta Pruning and Alpha-Beta algorithm. (U)(APRIL/MAY 2017)

27. Elaborate upon the process of knowledge engineering with electronic circuit domain.(AN)

30. Explain minimax algorithm in detail. (U) (APRIL/MAY 2017)

31. 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 is the maximum player and needs to make the next move. What move be chosen at this point? Can the search be optimized?(AN)(APRIL/MAY 18)



27. Explain why problem formulation must follow goal formulation. (13)(Nov / Dec 2020 and April / May 202)

28.i) Define Heuristic search. What are the advantages of Heuristic search?(8) (Nov / Dec 2020 and April / May 2021)

ii) Describe the mini max algorithm with an example.(5) (Nov / Dec 2020 and April / May 2021)

29. Explain Constraint Satisfaction Problem with example? (13)(Apr/May-2022)

30. What is the Significance of Pruning System? What is Alpha-Beta Pruning? How it is advantageous of Min-Max?(13)(Apr/May-2022)

31.13Apr/May-2022(15)

Consider the given problem. Describe the process involved in it. Consider the water jug problem: you are given two water jugs, a 4 gallon one and 3 gallon one. Neither has any measuring marker on it. There is a pump that can be used to fill the jugs with water. How can you get exactly 2 gallon of water from the 4-gallon jug? Explicit.

15

Assumptions: A jug can be filled from the pump, water can be poured from one jug to another and that there are no other measuring devices available.

UNIT III

KNOWLEDGE REPRESENTATION

First Order Predicate Logic – Prolog Programming – 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.

PART A

1. When probability distribution is used? (U)

If we want to have probabilities of all the possible values of a random variable probability distribution is used.

Eg: $P(\text{weather}) = (0.7, 0.2, 0.08, 0.02)$. This type of notations simplifies many equations.

2. What is an atomic event? (U)

An atomic event is an assignment of particular values to all variables, in other words, the complete specifications of the state of domain.

3. Compare production based system with frame based system. (NOV/DEC 2017)

Production-based expert systems – most popular type today. Knowledge is represented as multiple rules that specify what should/not be concluded from different situations.

Frames are record-like structures that have slots & slot-values for an entity

Using frames, the knowledge about an object/event can be stored together in the KB as a unitA slot in a frame

- Specify a characteristic of the entity which the frame represents

- Contains information as attribute-value pairs, default values etc.

8..For the given sentence “All pompeians were Romans” write a well formed formula in predicate logic.(C) (MAY/JUNE2016)

Well formed formula in predicate logic.

All pompeians were Romans

$$\forall x: \text{pompeians}(x) \Rightarrow \text{Romans}(x)$$

9.What are the standard quantifiers of First Order Logic? (R)

The First Order Logic contains two standard quantifiers. They are:Universal

Quantifiers

Existential \exists

Quantifiers \forall

10.Define Universal Quantifier with an example.(R)

To represent -All elephants are mammal -Raj is an elephant is represented by $\text{Elephant}(\text{Raj})$ and -Raj is a mammal. The first order logic

is given by

$$\forall x \text{ Elephant}(x) \Rightarrow \text{Mammal}(x)$$

\forall Refers to -For all. P is any logical expression, which is equivalent to the conjunction(i.e. the \wedge) of all sentences obtained by substituting the name of an object for the variable x where if appears in p. The above sentence is equivalent to

$\text{Elephant}(\text{Raj}) \Rightarrow \text{Mammal}(\text{Raj})$

$\text{Elephant}(\text{John}) \Rightarrow \text{Mammal}(\text{John})$

Thus it is true if and only if, all the above sentences are true that is if p is true for all objects x in the universe. Hence, \forall is called universal quantifier.

11.Define Existential Quantifier with an example.(R)

Universal quantification makes statements about every object. Similarly, we can make statement about some object in the universe without naming it, by using an existential quantifier.

To say, for example, that king john has a crown on his head, we write

$$\exists x \text{ Crown}(x) \wedge \text{OnHead}(x, \text{John})$$

X is pronounced -There exists an x such that ... Or -For some x... The sentence says that P is true for at least one object x. Hence, \exists is called existential quantifier.

12. Define Nested Quantifier with an example.(R)

The Nested Quantifier is to express the more complex sentences using multiple quantifiers. For

example, -Brothers are siblings|| can be written as

$$\forall x \forall y \text{ Brother}(x,y) \Rightarrow \text{Sibling}(x,y)$$

Consecutive quantifiers of the same type can be written as one quantifier with several variables. For example, to say that siblinghood is a symmetric relationship, we can

write

$$\forall x, y \text{ Sibling}(x,y) \Leftrightarrow \text{Sibling}(y,x)$$

13. Explain the connections between \forall and \exists (U)

The two quantifiers can be connected with each other through negation. It can be explained through negation. It can be explained with the following

example.

Eg: $\forall x \text{ Likes}(x, \text{Ice Cream})$ is equivalent to $\exists x \forall y \text{ Likes}(x, \text{Ice cream})$
 This means -Everyone likes ice cream|| is equivalent to -there is no one who does not like ice cream||.

14. What is the use of equality symbol? (R)

The equality symbol is used to make the statements more effective that two terms refer to the same object.

Eg: **Father (John)=Henry**

15. Define Higher Order Logic. (R)

The Higher Order Logic allows quantifying over relations and functions as well as over objects. Eg: The two objects are equal if and only if, all the properties to them are equivalent.

$$\forall x, y (x=y) \Leftrightarrow (\forall p \ p(x) \Leftrightarrow p(y))$$

16. Define First Order Logic. (R)

First Order Logic, a representation language that is far more powerful than propositional logic. First Order Logic commits to the existence of objects and relations.

17. What is called declarative approach? (R)

The representation language makes it easy to express the knowledge in the form of sentences. This simplifies the construction problem enormously.

This is called as declarative approach.

17. A knowledge Representation language is defined in two aspects:

i. Syntax: The syntax of a language describes the possible configuration that can constitute sentences.

ii. Semantics: It determines the facts in the world to which the sentences refer.

18. What is called entailment? (R)

The generations of new sentences that are necessarily true given the old sentences are true. This relation between sentences is called **entailment**.

19. What is meant by tuple? (U)

A tuple is a collection of objects arranged in a fixed order and is written with angle brackets surrounding the objects.

{<Richard the Lionheart, King John>, <King John, Richard the Lion heart>}

20. What is Propositional Logic? (U)

Propositional Logic is a declarative language because its semantics is based on a truth relation between sentences and possible worlds. It also has sufficient expressive power to deal with partial information, using disjunction and negation.

21. What is compositionality in propositional logic? (U)

Propositional Logic has a third property that is desirable in representation languages, namely compositionality. In a compositionality language, **the meaning of sentences is a function of the meaning of its parts**. For example, $\neg S1 \wedge S2$ is related to the meanings of $\neg S1$ and $S2$.

22. Define ground term, Inference. (R)

The term without variables is called ground term.

The task of deriving the new sentence from the old is called Inference.

23. Define Data log. (R)

The set of first order definite clauses with no function symbols is called datalog. Eg: "The country Nono, an enemy of America" **Enemy(Nono, America)** The absence of function symbols makes inference much easier.

24. What is Pattern Matching? (U)

The inner loop of the algorithm involves finding all possible unifiers such that the premise of a rule unifies with a suitable set of facts in the knowledge base. This is called Pattern Matching.

25. What is Data Complexity? (U)

The complexity of inference as a function of the number of ground facts in the database is called data complexity.

26. Define Prolog. (R)

Prolog programs are sets of definite clauses written in a notation somewhat different from standard first-order logic.

27. Define conjunctive normal form. (R)

First Order resolution requires that sentences be in conjunctive normal form that is, a conjunction of clauses, where each clause is a disjunction of literals. Literals can contain variables, which are assumed to be universally quantified. For ex, the sentence

$\forall x \text{American}(x) \wedge \text{Weapon}(y) \text{Sells}(x,y,z) \wedge \text{Hostile}(z) \Rightarrow \text{Criminal}(x)$ Becomes, in
CNF,

$\neg \text{American}(x) \vee \neg \text{Weapon}(y) \vee \neg \text{Sells}(x,y,z) \vee \neg \text{Hostile}(z) \vee \text{Criminal}(x)$

28. Define Skolemization. (R)

Skolemization is the process of removing existential quantifiers by elimination.

29. What is the other way to deal with equality? (R)

Another way to deal with an additional inference rule is Demodulation Paramodulation

30. Define the ontology of situation calculus. (R) (APR/MAY 2021)

Situations which denote the states resulting from executing actions. This approach is called Situation Calculus.

- **Situations** are logical terms consisting of the initial situation and all situations that are generated by applying an action to a situation.
- **Fluent** are functions and predicates that vary from one situation to the next, such as the location of the agent.
- **A temporal or eternal** predicates and functions are also allowed.

31. Define unification. (R) (Dec 2012) (May 2012)

Lifted inference rule require finding substitutions that make different logical expressions look identical (same). this is called unification

32. Distinguish between predicate and propositional logic? (AN) (Dec 2011) (APRIL/MAY 2017)

Propositional logic (also called sentential logic) is the logic that includes sentence letters (A, B, C) and logical connectives, but not quantifiers. The semantics of propositional logic uses truth assignments to the letters to determine whether a compound propositional sentence is true.

Predicate logic is usually used as a synonym for first-order logic. Syntactically, first-order logic has the same connectives as propositional logic, but it also has variables for individual objects, quantifiers, symbols for functions, and symbols for relations.

33. With an example show objects properties functions and relations. (AN) (Dec 2012)

Example: Evil king john brother of Richard rules England in 1200 | Objects:

john, Richard, england, 1200 Relation : Brother of Properites: evil, king

Functions: ruled

34. Define synchronic and diachronic sentence(R) (May 2012) Sentences dealing with same time are called synchronic sentences, sentences that allow reasoning -a cross time are called diachronic sentence

35. Define Modus Ponens rule in Propositional logic? (R) (MAY/JUNE 2014) The standard patterns of inference that can be applied to derive chains of conclusions that lead to the desired goal is said to be Modus Ponens rule.

36. What is the significance in using the unification algorithm? (U) (Nov/Dec2012) Unification is an algorithmic process of solving equations between symbolic expressions.

37. Define Meta rules. (R)(APRIL/MAY 2017)
The rules that determine the conflict resolution strategy are called metarules, Meta rules define knowledge about how the system will work.

38. List the two levels of knowledge representation.(R)(NOV/DEC 2016)

- The knowledge level-at which facts are described
- The symbol level-at which representations of objects are defined in terms of symbols that can be manipulated in programs.

39. What is alpha-beta pruning? (U)(NOV/DEC 2016)
Alpha-beta pruning is a search algorithm that seeks to decrease the number of nodes that are evaluated by the minimax algorithm in its search tree. It is an adversarial search algorithm used commonly for machine playing of two-player games (Tic-tac-toe, Chess, Go, etc.).

40. Convert the following into Horn clauses. (AP)(NOV/DEC 2017)

$$\forall x : \forall y : cat(x) \wedge fish(y) \rightarrow likes_to_eat(x, y)$$

$$\neg cat(x) \vee \neg fish(y) \vee likes_to_eat(x, y)$$

41. Differentiate forward and backward reasoning. (AN)(NOV/DEC 2017)

Attribute	Forward reasoning	Backward reasoning
Known as	Data driven	Goal driven
Starts from	New data	Conclusion
Aims for	Conclusion	Initial data
Approach	Bottom-Up	Top-Down
Type of search	BFS	DFS
Processing	Less efficient	More efficient
Application	Design expert system	Diagnostic expert system

42. Write the following in a predicate logic: For all a and y, if x is a parent of y then y is a child of x. (AP) (NOV/DEC 2017)

$$\forall x,y (Parent(x,y) \rightarrow Child(y,x))$$

43. List any three methods to select an initial structure knowledge representation.(R)

(APRIL/MAY 2018)

- Semantic Net
- Frames
- Scripts

44. Distinguish between predicate logic and propositional logic. (Apr/May-19)

Propositional Logic	Predicate Logic
Each Fact is represented by one symbol	Representation of world in terms of objects and predicates on objects (i.e. properties of objects or relations between objects)
Proposition symbols can be connected with Boolean connectives, to give more complex meaning. Connectives : , , , = ,	Connectives and quantifiers are used to represent the meaning of the sentence. Connectives : , , , = , Quantifiers : ,
Simple statements are implemented Example : Plato is man PLATOMAN	Complex statements are implemented Example : Plato is man MAN (PLATO)

45. State how the knowledge is represented using structured format.

- (i) Representational Adequacy:- The ability to represent all kinds of knowledge that are needed in that domain.
- (ii) Inferential Adequacy: - The ability to manipulate the represented structure and infer new structures.
- (iii) Inferential Efficiency:- The ability to incorporate additional information into the knowledge structure that will aid the inference mechanisms.
- (iv) Acquisitional Efficiency: - The ability to acquire new information easily, either by direct insertion or by program control.

46. State Generalized Modus Ponens.

Generalized Modus Ponens

Given a set of n atomic sentences, p_1', p_2', \dots, p_n' , and q , and one implication $p_1 \& p_2 \& \dots \& p_n \Rightarrow q$, the generalized MP rule states that:

$$p_1', p_2', \dots, p_n', (p_1 \& p_2 \& \dots \& p_n \Rightarrow q) \implies \text{Subst}(\theta, q)$$

where $\text{Subst}(\theta, p_i') = \text{Subst}(\theta, p_i)$ for all i . The process of computing substitution θ is called **unification**.

48. Compare Forward and Backward Chaining. (Nov / Dec 2020 and April / May 2021)

<i>Forward Chaining</i>	<i>Backward Chaining</i>
Planning monitoring and control	Diagnosis
Present to future	Present to past
Antecedent to consequence	Consequene to antecedent
Data driven, bottom up reasoning	Goal –driven , top down reasoning
Work forward to find what solutions follow from the facts	Work backwards to find facts that support the hypothesis
Good for breadth first search	Good for depth first search
Antecedents determine where the search goes	Consequences determine search
Exaplanations are not easily facilitated	Explanation facilitated

48. What are the elements and symbols of first order logic? (Nov / Dec 2020 and April / May 2021)

Constant	1, 2, A, John, Mumbai, cat,....
Variables	x, y, z, a, b,....
Predicates	Brother, Father, >,....
Function	sqrt, LeftLegOf,
Connectives	$\wedge, \vee, \neg, \Rightarrow, \Leftrightarrow$
Equality	$=$
Quantifier	\forall, \exists

49. In which situation do we use the concept of Existential instantiation. (Apr/May-2022)

Existential instantiation is the rule that allows us to conclude that there is an element c in the domain for which $P(c)$ is true if we know that $\exists xP(x)$ is true.

50. Define mental event and mental object. (Apr/May-2022)

mental event is any **event** that happens within the mind of a conscious individual.

Examples include thoughts, feelings, decisions, dreams, and realizations. Some believe that **mental events** are not limited to human thought but can be associated with animals and artificial intelligence as well.

mental object - the sum or range of what has been perceived, discovered, or learned.
 cognitive content, content. cognition, knowledge, noesis - the **psychological** result of
 perception and learning and reasoning. tradition - an inherited pattern of thought or action.

PART-B

1. Explain in detail about forward chaining and backward chaining with algorithms. (AN)
(MAY/JUNE2016) (NOV/DEC 2016)(APRIL/MAY 2017)
2. Explain the production based knowledge representation technique. (U)(NOV/DEC2017).
3. How are frames used in knowledge representation? Give the structure of a general frame.
(AN)(APRIL/MAY 2018)
4. What is predicate logic? Explain the predicate logic representation with reference to suitable example.
(APR/MAY2021)
5. Consider the following sentences: Marcus was a man Marcus was a Pompeian Marcus was born in 40 AD
All men are mortal All Pompeian's died the Volcano erupted in 79 AD No mortal lives for more than 150
years i). convert them to clause form. ii). Answer the question — is Marcus dead now in two different
ways. Clearly state the assumption made. (APR/May 2021)
6. (ii)Consider the following facts
All students in 4th year are intelligent
Raja is a4th year student.
Ragu is a 5rd year student
3rd year student are not intelligent
4th year students have no friend in 3rd year
Represent the facts in predicate, convert the to clause form and prove by resolution,-Raja is not friend of
Raghul.
7. Explain the unification algorithm with an example.(U) (Apr/May-19)
8. Consider the following facts: (Apr/May-19) (1)There are 5000
employees in XYZ Company.
(2)Employees earning more than Rs.25000/annum pay tax(3)John is a manager in
XYZ company
(4)Manager earns Rs.50,000
Represent the facts in predicate logic, convert to clause form and prove by resolution, -John pays tax ll,
9. Relate first order logic with propositional logic and discuss in detail about the same.(Nov/Dec-18)
10. What is predicate logic? Explain the predicate logic representation with reference to suitable example.
(13)(NOV / DEC 2020 AND APRIL / MAY 2021)
11. Consider the following sentences: (13)(NOV / DEC 2020 AND APRIL / MAY 2021)
Marcus was a man
Marcus was a Pompeian
Marcus was born in 40 AD
All men are mortal
All Pompeian's died the Volcano erupted in 79 AD
No mortal lives for more than 150 years
i). convert them to clause form.
ii). Answer the question “ is Marcus dead now” in two different ways.Clearly state the assumpti
on made

13. List out and explain each step to convert the first order logic sentence to Normal form? What is the use of doing that?(13) (Apr/May-2022)

14. Explain about any one uninformed search algorithm in details?(13)(Apr/May-2022)

15. Translate into predicate logic and clause form of the following.(15)(Apr/May-2022)

- John like all kinds of food.
- Apples are food
- Chicken is food
- Anything anyone eats and isn't killed is food
- Bill eats peanuts and still alive

UNIT IV

SOFTWARE AGENTS

Architecture for Intelligent Agents – Agent communication – Negotiation and Bargaining – Argumentation among Agents – Trust and Reputation in Multi-agent systems.

PART A

1. Define software agent.(R) (APR/May2021)

An intelligent software agent is an autonomous program that is capable of perceiving and interpreting data sensed from its environment, reflecting events in its environment, and taking actions to achieve given goals without permanent guidance from its user.

2. Write about anatomy of agent.(AP)

An agent is commonly made up of a number of elements.

These include one or more sensors that are used to perceive the environment, one or more effectors that manipulate the environment, and a control system.

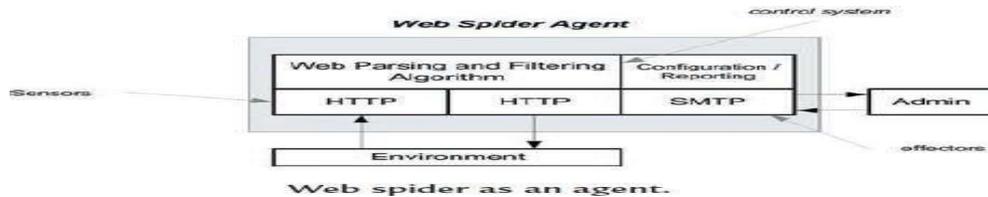


The control system provides a mapping from sensors to effectors, and provides intelligent (or rational) behavior.

3. Give example for software agent.(U)

A web spider, for example, is a virtual agent that gathers and filters information for another party. A web spider uses a primary sensor of the Hyper text Transport Protocol, or HTTP, as a

meant to gather data from web pages. Its control system is an application, which can be written in almost any language that drives the behavior of the web spider. This behavior includes web-data filtering. The web spider can identify new links to follow to collect additional information, and use the HTTP protocol to navigate the web environment. Finally, the web spider can communicate with a managing user through email using the Simple Mail Transport Protocol, or SMTP. The user can configure the web spider for collection, navigation, or filtering, and also receive emails indicating its current status.



4. List the properties of agent. Or Define the major agent properties and how they affect an agent. (R)

Rationale - Able to act in a rational (or intelligent) way

Autonomous - Able to act independently, not subject to external control
Persistent - Able to run continuously

Communicative - Able to provide information, or command other agents

Cooperative - Able to work with other agents to achieve goals

Mobile - Able to move (typically related to network mobility)
Adaptive - Able to learn and adapt

5. List the characteristics of Agent Environment. (R)

Observability - Are all elements visible to the agent?

Change - Does the environment change (dynamic) or does it stay the same (static) and change only when the agent performs an action to initiate change?

Deterministic - Does the state of the environment change as the agent expects after an action (deterministic), or is there some randomness to the environment change from agent actions (stochastic)?

Episodic - Does the agent need prior understanding of the environment (prior experience) to take an action (sequential), or can the agent perceive the environment and take an action (episodic)?

Continuous - Does the environment consist of a finite or infinite number of potential states?

(During action selection by the agent)? If the number of possible states is large, then the task environment is continuous, otherwise it is discrete.

Multi-Agent - Does the environment contain a single agent, or possibly multiple agents acting in a cooperative or competitive fashion?

6. What are the types of Agents?(U)

- Interface Agents
- Virtual Character Agents
- Entertainment Agents
- Game Agents
- Chatter Bots
- Mobile Agents
- User Assistance Agent
- Hybrid Agents

7. What do you mean by Agent Architectures? (U)

Agent architectures, like software architectures, are formally a description of the elements from which a system is built and the manner in which they communicate. Further, these elements can be defined from patterns with specific constraints.

8. What are the types of Intelligent Agents Architectures?(U)

- Reactive Architectures
- Deliberative Architectures
- Blackboard Architectures
- Belief-Desire-Intention (BDI) Architecture
- Hybrid Architectures
- Mobile Architectures

9. List the languages used to develop Agents.(R)

- Telescript
- Aglets
- Obliq
- Agent TCL

10. Compare and contrast the reactive and deliberative agent architectures.(AN)

Reactive agents simply retrieve pre-set behaviors similar to reflexes without maintaining any internal state. On the other hand, deliberative agents behave more like they are thinking, by searching through a space of behaviors, maintaining internal state, and predicting the effects of actions.

11. What are the attributes of negotiation?(U)

Efficiency: the agents should not waste resources in coming to an agreement. Stability: no agent should have an incentive to deviate from agreed-upon strategies.

Simplicity: the negotiation mechanism should impose low computational and bandwidth demands on the agents.

Distribution: the mechanism should not require a central decision maker.

Symmetry: the mechanism should not be biased against any agent for arbitrary or inappropriate reasons.

12. What do you mean by bargaining?(U)

In a bargaining setting, agents can make a mutually beneficial agreement, but have a conflict of interest about which agreement to make.

13. What do you understand about the term agent communication? (APR/MAY 2021)

Agent communication is based on message passing, where agents communicate by formulating and sending individual messages to each other. The FIPA ACL specifies a standard message language by setting out the encoding, semantics and pragmatics of the messages.

14. What is a software agent? (Nov / Dec 2020 and April / May 2021)

A software agent is a computer program that is situated in some environment and capable of autonomous action in order to meet its design objectives. such as expert systems and neural networks, and aim to achieve complex goals.

15. What do you understand about the term agent communication? (Nov / Dec 2020 and April / May 2021)

Agent communication is based on message passing, where agents communicate by formulating and sending individual messages to each other.

The FIPA ACL specifies a standard message language by setting out the encoding, semantics and pragmatics of the messages.

Instead, since different agents might run on different platforms and use different networking technologies. The syntax of the ACL is very close to the KQML communication language.

16. Define Agent Communication.(Apr/May-2022)

Agent communication is based on message passing, where agents communicate by formulating and sending individual messages to each other.

Example: KQML Language.

17. What happened if Coherent value is low?(Apr/May-2022)

The low coherence score is the percentage of time there is no wave like activity in the HRV value. Medium coherence is percentage of time that there is some wave like activity and high coherence is the percentage of time there is very like activity.

Part B

1. Explain properties of agent in detail.(U)
2. Explain agent environment in detail.(U)
3. What are the types of Agents? Explain in detail.(U)
4. Explain various Intelligent Agents Architectures in detail.(U)
5. Describe the languages used to develop Agents. (R)
6. Create and design the architecture of Intelligence agent with an example.(APR/MAY 2021)
7. With diagrammatic representation, explain Trust and Reputation in Multagent systems in detail
.(APR/MAY 2021)
8. Explain about negotiation and bargaining.(U)
9. Explain Argumentation among Agents in detail. (U)
10. With Diagrammatic representation .Explain in detail about Trust and Reputation in Multi-agent systems. (Nov / Dec 2020 and April / May 2021)
Create and design the architecture of Intelligence agent with an example. (Nov / Dec 2020 and April / May 2021)
11. Explain briefly on Concrete architecture for intelligent systems.(13) (Apr/may-2022)
12. Explain on the negotiation and bargaining in software agents?(13) (Apr/May-2022)
13. Explain the expected problems on build an intelligent systems to change the manual functionalities your college library into an automatic one. What are steps would you follow to overcome those problems?(Assume minimum of two functionalities)(15)(Apr/May-2022)

UNIT V**APPLICATIONS**

AI applications – Language Models – Information Retrieval- Information Extraction – Natural Language Processing – Machine Translation – Speech Recognition – Robot –Hardware –Perception – Planning – Moving

PART-A**1. Define Language.(R)**

A language can be defined as a set of strings.

2. What is a language model?(U)

- Probability distributions over sentences(i.e., word sequences)
- $P(W) = P(1234 \dots)$
- Can use them to generate strings $P(|2 \quad 3 \quad 4 \dots -1)$
- Rank possible sentences

3. What are the applications of Language model applications?(U)

- Context-sensitive spelling correction
- Autocomplete
- Smart Reply
- Language generation

4. What are the techniques needed to process and manipulate language at a number of levels.(U)

- Phonology.
- Morphology.
- Syntax.
- Semantics.

5. What is Semantics?(U)

This involves the examination of the meaning of words and sentences. It is possible for a sentence to be syntactically correct but to be semantically meaningless. Conversely, it is desirable that a computer system be able to understand sentences with incorrect syntax but that still convey useful information semantically.

6. What is Pragmatics?(U)

This is the application of human-like understanding to sentences and discourse to determine meanings that are not immediately clear from the semantics. For example, if someone says, -Can you tell me the time?||, most people know that -yes|| is not a suitable answer. Pragmatics enables a computer system to give a sensible answer to questions like this.

7. What is an N-gram?(U)

An n-gram is a subsequence of n items from a given sequence i.e. a sequence of written symbols of length n is called an n-gram.

- Unigram: n-gram of size 1
- Bigram: n-gram of size 2
- Trigram: n-gram of size 3

8. What is an N-gram model?(U)

N-Grams is a word prediction algorithm using probabilistic methods to predict next word after observing N-1 words. Therefore, computing the probability of the next word is closely related to computing the probability of a sequence of words.

A model of the probability distribution of n-letter sequences is thus called an n-gram model. We can have n-gram models over sequences of words, syllables, or other units. An n-gram model is also defined as a Markov chain of order n - 1 since in a Markov chain the probability of character c_i depends only on the immediately preceding characters, not on any other characters.

9. Define unigram, bigram and trigram with an example?(R)

Ngram, bigram, trigram are methods used in search engines to predict the next word in a incomplete sentence. If $n=1$, it is unigram, if $n=2$ it is bigram and so on...
 If input is — wireless speakers for tv, output will be the following- $N=1$ Unigram-
 Ouput- -wireless, -speakers, -for, -tv
 $N=2$ Bigram- Ouput- -wireless speakers, -speakers for, -for tv
 $N=3$ Trigram –
 Output- -wireless speakers for, -speakers for tv

10. What can we do with n-gram character models?(U)

One task for which they are well suited is language identification: given a text, determine what natural language it is written in. This is a relatively easy task; even with short texts such as –Hello, world or –Wie geht es dir, it is easy to identify the first as English and the second as German.

11. What is corpus?(U)

In linguistics and NLP, corpus refers to a collection of texts. Such collections may be formed of a single language of texts, or can span multiple languages.

12. What is Laplace Smoothing?(U)

Laplace Smoothing is also called as add-one smoothing. The simplest way to do smoothing is to add one to all the bigram counts, before we normalize them into probabilities. All the counts that used to be zero will now have a count of 1 , the counts of 1 will be 2, and so on. This algorithm is called Laplace smoothing.

13. Define Information retrieval.(R)

Information retrieval is the task of finding documents that are relevant to a user's need for information. The best-known examples of information retrieval systems are search engines on the WorldWideWeb.

14. What are the characteristics of Information retrieval?(U)

- **A corpus of documents.** Each system must decide what it wants to treat as a document: a paragraph, a page, or a multipage text.
- **Queries posed in a query language.** A query specifies what the user wants to know. The query language can be just a list of words, such as [AI book]; it can specify a phrase of words that must be adjacent, as in [-AI book]; it can contain Boolean operators as in [AI AND book]; it can include non- Boolean operators such as [AI NEAR book] or [AI book site:www.aai.org].
- **A result set.** This is the subset of documents that the IR system judges to be relevant to the query. By relevant, we mean likely to be of use to the person who posed the query, for the particular information need expressed in the query.

- **A presentation of the result set.** This can be as simple as a ranked list of document titles or as complex as a rotating color map of the result set projected onto a three dimensional space, rendered as a two-dimensional display.

15. State the role of AI in IR.(U)

The Artificial Intelligence models and techniques are used in the design of a small Information Retrieval system. In particular, some knowledge representation models, such as semantic networks and frame-like structures, are viewed as interesting tools for the implementation of a thesaurus, and also for a description of the stored documents' contents.

16. Define the term Stemming.(R)

Conflation algorithms are used in information retrieval systems for matching the morphological variants of terms for efficient indexing and faster retrieval operations. The Conflation process can be done either manually or automatically. The automatic conflation operation is also called stemming.

17. What is a page rank? (U)

The PageRank for a page p is defined as:

$$PR(p) = \frac{1-d}{N} + d \sum_i \frac{PR(in_i)}{C(in_i)}$$

where PR(p) is the PageRank of page p, N is the total number of pages in the corpus, in_i are the pages that link in to p, and C(in_i) is the count of the total number of out-links on page in_i . The constant d is a damping factor.

18. What is HITS algorithm?(U)

Hypertext Induced Topic selection (HITS) (HITS; also known as hubs and authorities) is a link analysis algorithm that rates Web pages. The idea behind Hubs and Authorities stemmed from a particular insight into the creation of web pages when the Internet was originally forming; that is, certain web pages, known as hubs, served as large directories that were not actually authoritative in the information that they held, but were used as compilations of a broad catalog of information that led users direct to other authoritative pages.

19. What is Question answering?(U)

Question answering is a somewhat different task, in which the query really is a question, and the answer is not a ranked list of documents but rather a short response—a sentence, or even just a phrase.

20. Define Information extraction.(U)

Information extraction is the process of acquiring knowledge by skimming a text and looking for occurrences of a particular class of object and for relationships among objects. A typical task is to extract instances of addresses from Web pages, with database fields for street, city, state, and zip code; or instances of storms from weather reports, with fields for temperature, wind speed, and precipitation.

21. What is attribute-based extraction system?(U)

The simplest type of information extraction system is an attribute-based extraction system that assumes that the entire text refers to a single object and the task is to extract attributes of that object.

22. What is FASTUS?(U)

FASTUS is a (slightly permuted) acronym for Finite State Automaton Text Understanding System. It is a system for extracting information from free text in English, Japanese, and potentially other languages as well.

23. What are the stages FASTUS?(U)

- Tokenization
- Complex-word handling
- Basic-group handling
- Complex-phrase handling
- Structure merging

□

24. What is Hidden Markov Models?(U)

An HMM is a finite-state automaton with stochastic state transitions and symbol emissions (Rabiner 1990). The automaton models a probabilistic generative process. In this process, a sequence of symbols is produced by starting in an initial state, emitting a symbol selected by the state, making a transition to a new state, emitting a symbol selected by the state, and repeating this transition–emission cycle until a designated final state is reached.

25. What is Machine reading?(U)

A system that could read on its own and build up its own database is called as Machine reading.

26. What is Natural Language Processing?(U)

Natural Language Processing (NLP) refers to AI method of communicating with an intelligent systems using a natural language such as English. Natural language processing (NLP) can be defined as the automatic (or semi-automatic) processing of human language.

The term 'Natural language processing' (NLP) is normally used to describe the function of software or hardware components in a computer system which analyze or synthesize spoken or written language.

27. Why is NLP hard?(U)

- Languages are complex
- Languages are ambiguous
- Understanding requires vast knowledge
- Human input is scarce

28. Define Syntax.(R)

The study of the structure of the language units and their relationships is called syntax. Syntax refers to the arrangement of words in a sentence such that they make grammatical sense. In NLP, syntactic analysis is used to assess how the natural language aligns with the grammatical rules.

29. Define Semantics.(R)

Semantics refers to the meaning that is conveyed by a text. Semantic analysis is one of the difficult aspects of Natural Language Processing that has not been fully resolved yet.

30. What is NLP used for?(U)

- Language translation applications such as Google Translate
- Word Processors such as Microsoft Word and Grammarly that employ NLP to check grammatical accuracy of texts.
- Interactive Voice Response (IVR) applications used in call centers to respond to certain users' requests.
- Personal assistant applications such as OK Google, Siri, Cortana, and Alexa.

31. What are the applications of NLP?(U)

- Automatic translation
- Human-computer dialogue
- Question answering
- Text mining
- Accessibility

32. What is Machine translation?(U)

Machine translation is the automatic translation of text from one natural language (the source) to another (the target).

33. What is Speech recognition?(U)

Speech recognition is the task of identifying a sequence of words uttered by a speaker, given the acoustic signal. It has become one of the mainstream applications of AI—millions of people interact with speech recognition systems every day to navigate voice mail systems, search the Web from mobile phones, and other applications. Speech is an attractive option when hands-free operation is necessary, as when operating machinery.

34. What is perception?(U)

Perception provides agents with information about the world they inhabit by interpreting the response of sensors.

35. What is an object model?(U)

An object model describes the objects that inhabit the visual world—people, buildings, trees, cars, etc. The object model could include a precise 3D geometric model taken from a computer-aided design (CAD) system, or it could be vague constraints, such as the fact that human eyes are usually 5 to 7 cm apart.

36. What is an rendering model?(U)

A rendering model describes the physical, geometric, and statistical processes that produce the stimulus from the world. Rendering models are quite accurate, but they are ambiguous. For example, a white object under low light may appear as the same color as a black object under intense light. A small nearby object may look the same as a large distant object. Without additional evidence, we cannot tell if the image that fills the frame is a toy Godzilla or a real monster.

37. What is a Robot?(U)

Robots are physical agents that perform tasks by manipulating the physical world. To do so, they are equipped with effectors such as legs, wheels, joints, and grippers. Effectors have a single purpose: to assert physical forces on the environment. Robots are also equipped with sensors, which allow them to perceive their environment.

38. Define sensor.(R)

Sensors are the perceptual interface between robot and environment. Passive sensors, such as cameras, are true observers of the environment: they capture signals that are generated by other sources in the environment.

39. Define Effectors.(R)

Effectors are the means by which robots move and change the shape of their bodies.

40. What is Robotic Perception?(U)

Perception is the process by which robots map sensor measurements into internal representations of the environment.

41. What is planning in AI?(U)

The planning in Artificial Intelligence is about the decision making tasks performed by the robots or computer programs to achieve a specific goal.

The execution of planning is about choosing a sequence of actions with a high likelihood to complete the specific goal.

42. State the advantages of horizontal layered Architectures. (Nov / Dec 2020 and April / May 2021)

The advantage of horizontal layer architecture is that only n layers are required for mapping to n different types of behaviors. However, a mediator function is used to control the inconsistent actions between layer interactions.

43. Define Ontology. (Nov / Dec 2020 and April / May 2021)

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.

44. What causes NLP concept to be used and where?(Apr/May-2022)

Natural Language Processing (NLP) allows machines to break down and interpret human language.

It's at the core of tools we use every day – from translation software, Chabot's, spam filters, and search engines, to grammar correction software, voice assistants, and social media monitoring tools.

45. what is the necessity of speech recognition in ai?(Apr/May-2022)

Speech recognition enables computers to “understand” what people are saying, which allows them to process information faster and more accurately. Speech recognition is also used in voice assistants like Siri and Alexa, which allow users to interact with computers using natural language.

PART-B

1. What is language model? Explain various language model with an example.(U)
2. How backoff model is better than smoothing process? Discuss.(R)
3. What is the difference between unigram, bigram and trigram models?(U)
4. What is information retrieval? Explain its characteristics and models.(U)
5. Write notes on IR scoring functions, IR system evaluation, IR refinements.(AP)
6. Explain the PageRank algorithm with an example.(U)
7. What is Information extraction? Explain how Finite-state automata used for information extraction.(U)
8. How is Hidden Markov model used for information extraction?(R)
9. Write note on ASKMSR System.(U)
10. Explain the Probabilistic models for information extraction.(U)
11. Explain the four classes of grammatical formalisms given by Chomsky with suitable example of each.(U)
12. What is a transfer model? What is its use in machine translation systems?(U)
13. Give examples to illustrate lexical ambiguity, syntactic ambiguity and semantic ambiguity.(U)
14. State the principle of trichromacy. What is its use in computer vision algorithm?(E)
15. Give example of any two types of contours.(U)
16. Identify the major differences between motion parallax and binocular stereopsis used in restructuring the 3D world.(U)

17. What is the process of perception as perceived by the robot? Why is it difficult for robots?(U)
18. Give an example where a reflex agent architecture using reactive control is useful in robotics.(U)
19. Explain the concept of machine translation in detail. (APR/MAY 2021)
20. What are the challenges in Speech Recognition techniques in Artificial Intelligence?
Explain.(APR/MAY 2021)
21. (i) Differentiate between the three architectures namely subsumption, three-layer and pipeline for robotic software architecture.(AN)
(ii) Explain how to translate text from one natural language (source) to another Language (target) with example (APR/MAY 2021) (Nov / Dec 2020 and April / May 2021)
22. (i) Explain the concept of machine translation in details(13)
(ii) What is the challenge in speech recognition techniques in intelligence?
Explain. (Nov / Dec 2020 and April / May 2021)
23. Explain how to translate text from one natural language (source) to another language (target) with example (15) (Nov / Dec 2020 and April / May 2021)
24. Explain the steps involved in the communication process between humans and robots? (13)
(Apr/May-2022)
25. Briefly explain about information retrieval and information exchange. (13)(Apr/May-2022)