M2-SEC-A

1. A) Given a set of propositional clauses, prove or disprove the following statement using resolution: "If it is raining or it is cloudy, then the picnic will be canceled unless the park has a covered area."
   B) Using resolution, determine the validity of the following argument: "If John is not at home, then the lights are off. The lights are off. Therefore, John is not at home."
   C) Consider a knowledge base consisting of propositional clauses representing a Sudoku puzzle. Use resolution to find a solution to the Sudoku puzzle if one exists.
   D) You have a set of propositional clauses representing the behavior of a complex system. Using resolution, determine whether the system will enter a critical state if certain conditions are met.
   E) Prove or disprove the following statement using resolution: "For any positive integer n, if n is even, then n squared is also even."

2. A) Using resolution in first-order logic, prove or disprove the statement: "All humans are mortal. Socrates is a human. Therefore, Socrates is mortal."
   B) Given a first-order knowledge base representing a family tree, use resolution to find out if John is Susan's uncle.
   C) Use resolution in first-order logic to determine the validity of the argument: "If all men are mortal, and Socrates is a man, then Socrates is mortal."
   D) Consider a first-order logic knowledge base representing a complex puzzle or game. Use resolution to find a solution to the puzzle or determine if it is unsolvable.
   E) Given a knowledge base describing a set of university courses, professors, and students, use resolution to find out if there is a professor who teaches all courses.

3. A) Consider a complex system with multiple sensors and actuators. Using forward chaining, determine the sequence of actions required to achieve a specific goal while satisfying various constraints and conditions.
   B) Given a set of propositional clauses representing a logical puzzle or game, use forward chaining to find a solution or make a series of moves to reach a winning state.
   C) Create a knowledge base in propositional logic for an autonomous driving system. Use forward chaining to determine the optimal actions for the vehicle to navigate through traffic and reach its destination safely.
   D) Imagine a scenario where you have a propositional logic knowledge base representing the behaviour of a robot in a dynamic environment. Use forward chaining to plan a path for the robot to collect objects while avoiding obstacles and hazards.
   E) Given a knowledge base that describes the behaviour of a multi-agent system, use forward chaining to coordinate the actions of the agents to achieve a common objective while adhering to communication and resource constraints.

4. A) In a complex diagnostic system for a spacecraft, use backward chaining to identify the root cause of an anomaly by tracing back from observed symptoms to potential subsystem failures.
   B) Given a knowledge base representing a multi-agent negotiation system, use backward chaining to determine the optimal negotiation strategy for a specific agent to reach an agreement while maximizing its utility.

C) Create a propositional logic knowledge base for a medical expert system. Use backward chaining to diagnose a patient's illness by starting with observed symptoms and working backward to identify the underlying medical condition.

D) Consider a complex legal expert system that uses propositional logic. Use backward chaining to determine the legal implications of a set of facts and evidence, leading to a legal conclusion.

E) Use backward chaining to plan a sequence of actions for a robotic arm in a manufacturing facility to assemble a complex product, starting from the final goal and working backward to determine the necessary steps.

5. A) Autonomous Navigation: Design a state space search problem for an autonomous vehicle navigating through a city. Consider obstacles, traffic conditions, and different routes. What heuristic functions can be used to guide the vehicle efficiently to its destination?

   B) Space Mission Planning: Create a state space search problem for planning a mission to explore a distant planet with a rover. Include challenges like limited fuel, terrain mapping, and communication constraints. How can you ensure that the rover maximizes scientific discoveries during its mission?

   C) Supply Chain Optimization: Develop a state space search problem for optimizing a supply chain network with multiple suppliers, manufacturers, and distribution centers. Consider factors like cost, delivery times, and demand fluctuations. How can you find the most cost-effective distribution strategy?

   D) Robot Manipulation: Formulate a state space search problem for a robot arm to manipulate objects on a cluttered table. Include considerations for object recognition, grasping, and collision avoidance. What search algorithms and heuristics are suitable for solving this problem?

   E) Game Strategy: Create a state space search problem for a complex board game like chess or Go. How can you develop an AI agent that uses state space search to make strategic decisions, considering the vast number of possible game states?

6. Justify Decision Tree Induction algorithm challenges and construct the decision tree for the given following database using Information Gain as relevance measure.

Outlook	Temperature	Humidity	Windy	Class
sunny	hot	high	false	N
sunny	hot	high	true	N
overcast	hot	high	false	P
rain	mild	high	false	P
rain	cool	normal	false	P
rain	cool	normal	true	N
overcast	cool	normal	true	P
sunny	mild	high	false	N
sunny	cool	normal	false	P
rain	mild	normal	false	P
sunny	mild	normal	true	P
overcast	mild	high	true	P
overcast	hot	normal	false	P
rain	mild	high	true	N

7. For the below sample data, apply Baye's theorem and find the classification Play ball (Yes/ No) for the unseen data X = <rain, hot, high, Strong>.

Day	Outlook	Temperature	Humidity	Wind	Play ball
D1	Sunny	Hot	High	Weak	No
D2	Sunny	Hot	High	Strong	No
D3	Overcast	Hot	High	Weak	Yes
D4	Rain	Mild	High	Weak	Yes
D5	Rain	Cool	Normal	Weak	Yes
D6	Rain	Cool	Normal	Strong	No
D7	Overcast	Cool	Normal	Strong	Yes
D8	Sunny	Mild	High	Weak	No
D9	Sunny	Cool	Normal	Weak	Yes
D10	Rain	Mild	Normal	Weak	Yes
D11	Sunny	Mild	Normal	Strong	Yes
D12	Overcast	Mild	High	Strong	Yes
D13	Overcast	Hot	Normal	Weak	Yes
D14	Rain	Mild	High	Strong	No

8. Consider below sample data and apply K-Means clustering. Take subjects 1 and 4 as initial cluster centers and then identify the cluster centers after two iterations. Note: Choose the Manhattan distance as distance measure.

Subject	A	B
1	1.0	1.0
2	1.5	2.0
3	3.0	4.0
4	5.0	7.0
5	3.5	5.0
6	4.5	5.0
7	3.5	4.5

Differentiate Hierarchical Clustering Algorithms with Partitioning Algorithms along with their working procedure?

9. Consider a vocabulary with the following symbols:

Occupation(p, o): Predicate. Person p has occupation o.
Customer (p1, p2): Predicate. Person p1 is a customer of person p2.
Boss(p1, p2): Predicate. Person p1 is a boss of person p2.
Doctor , Surgeon, Lawyer , Actor : Constants denoting occupations.
Emily, Joe: Constants denoting people.

Use these symbols to write the following assertions in first-order logic:
a. Emily is either a surgeon or a lawyer.
b. Joe is an actor, but he also holds another job.
c. All surgeons are doctors.
d. Joe does not have a lawyer (i.e., is not a customer of any lawyer).
e. Emily has a boss who is a lawyer.
f. There exists a lawyer all of whose customers are doctors.
g. Every surgeon has a lawyer.
h. Politicians can fool some of the people all of the time, and they can fool all of the people some of the time, but they can’t fool all of the people all of the time.
i. All Greeks speak the same language. (Use Speaks(x, l) to mean that person x speaks language l.)
j. Everyone who loves all animals is loved by someone.

10. Consider the problem faced by an infant learning to speak and understand a language. Explain how this process fits into the general learning model. Describe the percepts and actions of the infant, and the types of learning the infant must do. Describe the subfunctions the infant is trying to learn in terms of inputs and outputs, and available example data.