Module 1 (M-1) – Agents and Environments

1. Agents

- An agent is an **entity that perceives its environment and acts upon it** to achieve goals.
- It uses sensors to **receive information** and actuators to **perform actions**.
- Agents can be **software programs, robots, or humans**.
- Example: A vacuum cleaning robot is an agent in a home environment.

2. Types of Agents

- **Simple Reflex Agent:** Acts only on current percepts.
- **Model-Based Reflex Agent:** Maintains internal state about past percepts.
- **Goal-Based Agent:** Acts to achieve specific goals.
- **Utility-Based Agent:** Considers preferences and maximizes a utility function.
- **Learning Agent:** Improves performance based on experience.

3. Environment

- Environment is everything **outside the agent** with which it interacts.
- It can be **deterministic or stochastic**, static or dynamic.
- Agents perceive the environment via **sensors** and affect it via **actuators**.
- Example: Roads, traffic, and weather for a self-driving car.

4. Types of Environment

- **Observable vs Partially Observable:** Full vs partial percepts available.
- **Deterministic vs Stochastic:** Outcome predictable vs uncertain.
- **Static vs Dynamic:** Environment changes or remains constant.
- **Discrete vs Continuous:** Finite vs infinite states/actions.
- **Single-agent vs Multi-agent:** One agent or multiple agents interacting.

5. Difference between Simple Reflex Agent and Goal-Based Agent

Feature	Simple Reflex Agent	Goal-Based Agent
Decision basis	Current percept only	Current percept + goal state
Intelligence	Less intelligent	More intelligent
Flexibility	Limited	Can plan actions to achieve goal
Example	Light-following robot	Path-finding robot

6. Difference between Goal-Based Agent and Utility-Based Agent

Feature	Goal-Based Agent	Utility-Based Agent
Basis of decision	Achieves goal	Maximizes performance measure
Consideration	Goal satisfaction only	Goal + preferences + trade-offs
Complexity	Simple planning	Requires utility function
Example	Maze-solving robot	Self-driving car optimizing comfort & speed

7. PEAS (Performance measure, Environment, Actuators, Sensors)

- **Performance Measure:** Criteria to evaluate agent success (e.g., task completion, accuracy).
- **Environment:** External world where the agent acts.
- **Actuators:** Tools to perform actions (robot arms, motors).
- **Sensors:** Devices to perceive environment (camera, microphone, touch sensor).
- PEAS framework defines **AI agent architecture and evaluation**.

8. Define AI, its branches, and real-world applications

- **AI:** Study of creating machines that can **perform tasks requiring human intelligence**.
- **Branches:** Machine Learning, Expert Systems, Robotics, Natural Language Processing (NLP), Computer Vision.
- **Applications:** Self-driving cars, voice assistants, medical diagnosis, recommendation systems, industrial automation.

9. Concept of Learning Agent

- Learning agents **improve performance based on experience**.
- Consists of **Performance element, Learning element, Critic, and Problem Generator**.
- Can adapt to changing environments.
- Example: Chess-playing AI that learns from previous games.

Module 2 (M-2) – Knowledge Representation & Fuzzy Logic

1. Explain Frames in Knowledge Representation

- Frames are **data structures for representing stereotypical situations**.
- Contain **slots (attributes)** and **values**.
- Can store **default values and relationships** between concepts.
- Example: Frame for “Car” may have slots: color, engine type, wheels.

2. Explain Semantic Network in Knowledge Representation

- Semantic networks represent **knowledge as a graph**.
- Nodes = concepts, edges = relationships between concepts.
- Useful for **reasoning and inheritance of properties**.
- Example: “Bird → can fly” or “Penguin → cannot fly” in hierarchy.

3. Role of Ontology in Knowledge Representation

- Ontology is a **formal specification of concepts and relationships** in a domain.
- Provides a **shared vocabulary** for AI systems.
- Helps in reasoning, knowledge sharing, and decision-making.
- Example: Medical ontology defines diseases, symptoms, and treatments.

4. What is Reasoning and its Types?

- **Reasoning:** Drawing conclusions from facts or knowledge.
- **Types:**
  - Deductive: General rules → specific conclusion.
  - Inductive: Specific facts → general rule.
  - Abductive: Best explanation from observations.
  - Probabilistic: Reasoning under uncertainty.

5. Role of Fuzzy Logic in AI

- Fuzzy logic handles **uncertain, vague, or imprecise information**.
- Unlike classical logic, it allows **partial truth values** (0–1).
- Useful in **control systems, decision-making, and expert systems**.
- Example: Temperature control: “If hot → reduce heater slightly.”

6. Explain Fuzzy Set and its Difference from Classical Set

- **Fuzzy Set:** Elements have degrees of membership (0 to 1).
- **Classical Set:** Elements either belong (1) or not belong (0).
- Example: “Tall people” can have 0.6 membership, unlike strict cutoff in classical sets.
- Fuzzy sets handle **real-world vagueness**.

7. What is Membership Function in Fuzzy Logic?

- Membership function defines **degree of membership of elements** in a fuzzy set.
- Maps input value to a **number between 0 and 1**.
- Shapes can be **triangular, trapezoidal, or Gaussian**.
- Example: Temperature 30°C may have 0.7 membership in “Warm” set.

8. Applications of Fuzzy Logic

- **Control Systems:** Air conditioners, washing machines.
- **Decision-Making:** Risk assessment, stock prediction.
- **Medical Diagnosis:** Interpreting vague symptoms.
- **Industrial Automation:** Robot navigation, quality control.
- **Consumer Electronics:** Camera focus, smart devices.

1. Agent which uses if-then rule → Simple Reflex Agent

- A **Simple Reflex Agent** acts **only on current percepts** using condition-action rules.
- It uses **"if-then" rules** to decide the next action.
- Does not maintain history or internal state.
- Example: A vacuum cleaner that moves when it senses dirt.
- Fast and simple, but **cannot handle partially observable environments**.

2. Agent that uses performance feedback to improve → Model-Based Agent

- **Model-Based Agent** maintains an **internal model of the world**.
- Uses **performance feedback** to update its knowledge and improve decisions.
- Can handle **partially observable environments**.
- Example: Robot navigating while remembering obstacles.
- More intelligent than simple reflex agents due to **state tracking**.

3. Types of Environment

- **Fully Observable vs Partially Observable:** Complete vs partial perception.
- **Deterministic vs Stochastic:** Outcome predictable vs uncertain.
- **Static vs Dynamic:** Environment remains same vs changes over time.
- **Discrete vs Continuous:** Finite vs infinite states/actions.
- **Single-Agent vs Multi-Agent:** Only one agent or multiple interacting agents.

4. Select all possible sequence of action and resulting state → State Space

- **State Space** represents all possible configurations of a problem.
- Shows **all states, actions, and transitions** from initial to goal.
- Used in **search algorithms** to plan solution paths.
- Example: All possible moves in a chess game.
- Helps AI agents **evaluate best possible actions** to reach goals.

5. Identify component in production system that contains rules → Rule Base

- **Rule Base** stores **"if-then" rules** for decision-making.
- Part of a **production system** in AI.
- Works with a **working memory** and inference engine.
- Helps agent decide actions based on current knowledge.
- Example: Expert system for medical diagnosis using symptom rules.

6. Agent that evaluates success using utility function → Utility-Based Agent

- **Utility-Based Agent** selects actions that **maximize performance measure**.
- Uses a **utility function** to evaluate the desirability of states.
- Can handle **conflicting goals and trade-offs**.
- Example: Self-driving car choosing fastest and safest route.
- More flexible than goal-based agents because it **quantifies preferences**.

7. Define Goal

- A **goal** is a target state that satisfies a **desired condition**.
- Guides an agent in selecting actions.
- Goals provide a **criterion for success**.
- Example: Robot's goal = reach charging station.
- Used by **goal-based and utility-based agents** to plan actions.

8. Agent that uses internal model to maintain world knowledge → Model-Based Agent

- Maintains an **internal representation of environment**.
- Uses it to **predict outcomes of actions**.
- Can handle **partially observable environments**.
- Example: Robot navigating through a map with obstacles.
- More intelligent than reflex agents as it **remembers previous states**.

9. Correct sequence of solving state, space, search, problem

1. **Define States:** Identify initial, intermediate, and goal states.
2. **Define Actions:** Determine possible actions from each state.
3. **Apply Goal Test:** Check if the current state satisfies goal.
4. **Search:** Explore states using search algorithms to find solution.

- Helps systematically **solve AI problems using state-space approach**.

10. PEAS → Performance measure, Environment, Actuator, Sensor

- Framework to define **AI agent architecture**.
- **Performance Measure:** How success is evaluated.
- **Environment:** Where agent operates.
- **Actuators:** Tools to act on the environment.
- **Sensors:** Tools to perceive the environment.
- Example: Self-driving car PEAS: sensors = camera, actuator = steering wheel, performance = safety & speed.

11. Function of Performance Measure → How well agent is doing

- **Performance Measure** evaluates how effectively the agent achieves goals.
- Guides learning and decision-making.
- Example: In chess AI, performance = winning rate.
- Helps compare **different agents or strategies**.
- Core to designing **goal-based and utility-based agents**.

12. Difference between Reflex Agent and Model-Based Agent

Feature	Reflex Agent	Model-Based Agent
Decision basis	Current percept only	Current percept + internal model
Memory	No memory of past	Maintains state history
Complexity	Simple	More intelligent
Environment	Works in fully observable only	Handles partially observable
Example	Light-following robot	Maze-navigating robot

13. Difference between Utility-Based and Goal-Based Agent

Feature	Goal-Based Agent	Utility-Based Agent
Decision criterion	Achieve goal	Maximize utility or preference
Flexibility	Less flexible	Can handle trade-offs and conflicts
Evaluation	Boolean (goal reached or not)	Quantitative (utility value)
Example	Robot reaching destination	Self-driving car choosing optimal route

14. Agent Function Cycle → Sense, Decide, Act

- **Sense:** Agent perceives environment using sensors.
- **Decide:** Agent chooses action based on percept and goals.
- **Act:** Agent executes the chosen action using actuators.
- Forms the **core cycle of AI agent operation**.

- Helps agents **adapt and interact intelligently with environment**.