Unit 4: Learning and Expert Systems in AI - Theory Answers

1. Distinguish between Supervised, Unsupervised and Semi-supervised Learning

Supervised Learning:

- **Definition:** The model learns from labeled data, where each input has a corresponding output.
- **Goal:** Map input variables (X) to output variables (Y).
- **Example:** Image classification of cats and dogs.
- **Advantages:** Accurate predictions, works well for known datasets.
- **Disadvantages:** Requires large labeled datasets, computationally expensive.
- **Applications:** Risk assessment, fraud detection, spam filtering, medical diagnosis. (Refer to slides 5–17.)

Unsupervised Learning:

- **Definition:** The model learns from unlabeled data by identifying hidden patterns and structures.
- **Goal:** Group data into clusters or discover associations.
- **Example:** Grouping fruits by color and shape.
- **Advantages:** Useful for complex tasks with no labels.
- **Disadvantages:** Output may lack accuracy due to no predefined labels.
- **Applications:** Recommendation systems, anomaly detection, market segmentation. (Refer to slides 18–26.)

Semi-Supervised Learning:

- **Definition:** A hybrid method using a small amount of labeled data and a large amount of unlabeled data.
- **Goal:** Improve learning efficiency and reduce the cost of data labeling.
- **Example:** Labeling a few student answers and using those to predict the rest.
- **Advantages:** Cost-effective, bridges the gap between supervised and unsupervised.
- **Disadvantages:** Accuracy and stability may vary.
- **Applications:** Medical imaging, web content classification. (Refer to slides 27–32.)

2. Describe components of expert systems.

An **Expert System** is an AI-based software designed to simulate the decision-making ability of a human expert. It consists of three main components:

1. User Interface:

- Acts as the communication bridge between the user and the system.

- Accepts user queries in readable format and displays results.
- Makes the system accessible to non-expert users. (Refer to slide 67.)

2. Inference Engine:

- Core reasoning part, also known as the system's brain.
- Applies logical rules to the knowledge base to infer conclusions.
- Can be deterministic (based on facts) or probabilistic (based on uncertainty).
- Uses Forward Chaining and Backward Chaining to deduce solutions. (Refer to slides 68–70.)

3. Knowledge Base:

- Repository of domain-specific knowledge.
- Contains two types:
    - **Factual Knowledge:** Based on verified facts.
    - **Heuristic Knowledge:** Based on experience, rules of thumb.
- Includes knowledge representation and acquisition processes. (Refer to slides 71–73.)

These components work together to mimic the decision-making capabilities of human experts.

3. Explain capabilities of expert systems.

Expert Systems provide intelligent behavior similar to human experts in specific domains. They exhibit various capabilities that make them powerful AI tools:

Key Capabilities:

1. **Advising:** Offers expert-level advice and recommendations.
2. **Decision Making:** Helps make complex decisions, such as medical or financial decisions.
3. **Demonstrating Devices:** Explains the working and features of new tools or software.
4. **Problem Solving:** Identifies and resolves domain-specific problems.
5. **Explaining Problems:** Provides clear reasoning and explanations for its conclusions.
6. **Input Interpretation:** Understands user queries.
7. **Result Prediction:** Predicts outcomes based on existing data.
8. **Diagnosis:** Used extensively in medical diagnosis without human intervention.

Examples:

- Medical Expert Systems like MYCIN.
- Financial advisors that detect fraud.
- Troubleshooting tools for electronics.