EE6250
2025 JUNE

Q1

i) Define the term Artificial Neural Network (ANN). Briefly describe how it mimics the human brain. (1 mark)

Key Points:

- Definition: ANN is a computational model inspired by the structure and functioning of the human brain.
- Mimics brain: Consists of interconnected nodes (neurons) that process information similarly to biological neurons.

Instructions for Checking:

- 0.5 mark for correct definition.
- 0.5 mark for mentioning mimicry of human brain structure/function.

ii) Explain the structure and function of a perceptron. Illustrate with a simple example. (1 mark)

Key Points:

- Structure: Input layer, weighted sum, activation function, output.
- Function: Computes weighted sum, applies activation, produces output.
- Example: Simple binary classifier (e.g., AND gate).

Instructions for Checking:

- 0.5 mark for structure and function.
- 0.5 mark for a correct and clear example.

iii) Using an example, explain the concept of forward propagation in neural networks. (2 marks)

Key Points:

- Definition: Process of passing input data through network layers to get output.
- Example: Input values → weighted sum → activation → output.
- Mention flow from input to output layer.

Instructions for Checking:

- 1 mark for clear explanation of forward propagation.
- 1 mark for a relevant and accurate example.

iv) Discuss the key differences between expert systems and neural networks in terms of: (2 marks)

Key Points:

- Expert systems: Rule-based, explicit knowledge representation, deterministic.
- Neural networks: Data-driven, implicit knowledge, can learn from data, non-deterministic.
- At least two differences discussed.

Instructions for Checking:

- 1 mark per correct and distinct difference (max 2).

v) What are hybrid intelligent systems? Explain how neural networks and expert systems can be combined to form a neural expert system. Discuss the structure and benefits of such a system. (4 marks)

Key Points:

- Definition: Systems combining two or more AI techniques.
- Combination: Neural networks for learning, expert systems for reasoning.

- Structure: Integration of neural network module and rule-based module.
- Benefits: Improved accuracy, adaptability, and interpretability.

Instructions for Checking:

- 1 mark for definition of hybrid systems.
- 1 mark for explanation of combination.
- 1 mark for structure.
- 1 mark for benefits.

Q2

i) What is a genetic algorithm? Describe the biological principles that inspired its design. (1 mark)

Key Points:

- Definition: Search/optimization algorithm inspired by natural evolution.
- Biological principles: Selection, crossover, mutation.

Instructions for Checking:

- 0.5 mark for definition.
- 0.5 mark for mentioning biological inspiration.

ii) List and briefly explain three key genetic operators used in GAs. (2 marks)

Key Points:

- Selection: Choosing individuals for reproduction.
- Crossover: Combining parts of two parents to create offspring.
- Mutation: Randomly altering genes to maintain diversity.

Instructions for Checking:

- 0.5 mark per correctly named and explained operator (max 3).

iii) With the help of an example, explain how crossover and mutation affect the evolution of solutions in a GA. (2 marks)

Key Points:

- Crossover: Combines features from parents, creates new solutions.
- Mutation: Introduces random changes, prevents premature convergence.
- Example: Bit strings representing solutions, showing crossover and mutation steps.

Instructions for Checking:

- 1 mark for clear explanation of crossover and mutation.
- 1 mark for a relevant example.

iv) Compare value-based, policy-based, and model-based approaches in reinforcement learning. Include a relevant use case for each. (2 marks)

Key Points:

- Value-based: Learns value of actions/states (e.g., Q-learning); use case: game playing.
- Policy-based: Learns policy directly (e.g., policy gradient); use case: robotic control.
- Model-based: Builds model of environment; use case: planning in robotics.

Instructions for Checking:

- 0.5 mark for each approach with correct description and use case (max 3, but only 2 marks total).

v) Describe the Bellman Optimality Equation in reinforcement learning. How does it relate to decision making in uncertain environments? (3 marks)

Key Points:

- Bellman Optimality Equation: Recursive formula for optimal value function.
- Defines relationship between value of a state and possible actions.
- Helps in finding optimal policy in uncertain environments by breaking problem into subproblems.

Instructions for Checking:

- 1 mark for stating the equation or its essence.
- 1 mark for explaining its role in decision making.
- 1 mark for connecting to uncertainty/optimal policy.