Instructor Model Answer Guide: Full KBIS Exam

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

Key Points the Answer Should Include:

- Definition of ANN.

- Mention of neurons and layers.

- Explanation of similarity to biological brain.

- Role of learning through weights and activation functions.

Expanded Model Answer:

An Artificial Neural Network (ANN) is a computational model inspired by the structure and functioning of the human brain. It consists of layers of interconnected nodes (neurons), where each neuron receives input, processes it using an activation function, and passes the output to the next layer. The connections have associated weights that are adjusted through training. This mimics how the human brain learns and processes information through synapses. ANNs are capable of learning complex patterns, making them useful in fields like image recognition, natural language processing, and medical diagnosis.

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

Key Points the Answer Should Include:

- Definition of perceptron.

- Components: inputs, weights, bias, activation function.

- Formula: weighted sum + bias passed through activation.

- Illustrative binary example of input and output.

Expanded Model Answer:

A perceptron is a basic unit of a neural network used for binary classification. It consists of multiple inputs, each multiplied by a weight, summed together with a bias, and passed through an activation function such as a step function. For instance, if the inputs are x1 = 1, x2 = 0, with weights w1 = 0.5 and w2 = 0.3, and a bias of -0.2, the perceptron calculates:

output = step(1*0.5 + 0*0.3 - 0.2) = step(0.3) = 1. This demonstrates how a perceptron can be used to classify input into one of two categories.

Question 1 (iii): Using an example, explain the concept of forward propagation in neural networks.

Key Points the Answer Should Include:

- Definition of forward propagation.

- Process of data flowing through input, hidden, and output layers.

- Involves dot product, bias addition, activation function.

- Simple example calculation.

Expanded Model Answer:

Forward propagation refers to the process by which input data passes through the layers of a neural network to produce an output. Each neuron computes a weighted sum of its inputs, adds a bias, and applies an activation function. For example, consider an input [1, 2] passing through a single hidden layer with weights [[0.2, 0.4], [0.5, 0.3]], and a sigmoid activation function. The dot product and activation results yield the next layer's activations, which continue until the final output is generated. This process allows the network to make predictions.

Question 1 (iv): Discuss the key differences between expert systems and neural networks.

Key Points the Answer Should Include:

- Expert systems use IF-THEN rules; neural networks use learned weights.

- Expert systems are transparent; neural networks are black-boxes.

- Expert systems don’t learn; neural networks learn from data.

- Differences in knowledge representation and explainability.

Expanded Model Answer:

Expert systems and neural networks differ significantly. Expert systems rely on manually programmed IF-THEN rules that simulate expert knowledge, providing clear traceable decisions. Neural networks use learned synaptic weights to generalize patterns from data but are opaque in decision-making. Expert systems are deterministic and interpretable, suitable for stable domains, while neural networks excel in pattern-rich and uncertain environments, such as vision or language processing. Expert systems lack adaptability;

neural networks adapt through training. Thus, while expert systems are explainable, neural networks are more flexible but harder to interpret.

Question 1 (v): What are hybrid intelligent systems? Explain how neural networks and expert systems can be combined to form a neural expert system.

Key Points the Answer Should Include:

- Definition of hybrid intelligent systems.

- Motivation for combining multiple AI techniques.

- Characteristics and limitations of neural networks.

- Characteristics and limitations of rule-based expert systems.

- Components of a neural expert system: inference engine, knowledge base, rule extraction.

- Role of approximate reasoning.

- Real-world applications.

- Conclusion on benefits of hybrid approach.

Expanded Model Answer:

A hybrid intelligent system integrates multiple AI methodologies to produce a more robust and effective system. A common hybrid is the neural expert system, which combines the learning ability of neural networks with the logical reasoning of expert systems. Neural networks can learn patterns from data but lack explainability, while expert systems use human-readable rules but can't learn. In a neural expert system, the neural network serves as a learned knowledge base, the inference engine draws conclusions, and a rule extraction component converts neural outputs into interpretable rules. This allows the system to handle imprecise data and offer explanations, making it suitable for domains like medical diagnosis, fraud detection, and decision support. Overall, neural expert systems embody the strengths of soft computing: adaptivity, robustness, and interpretability.