Instruction to students: Attempt all questions

This is going to be a theoretical exam essay to examine if you grasped all the foundations of Neural networks and fuzzy logic. Please submit it to the invigilator once you are done.

1. **What does Single-Layer Neural Network mean?**
   A single-layer neural network represents the simplest form of neural network, in which there is only one layer of input nodes that send weighted inputs to a subsequent layer of receiving nodes, or in some cases, one receiving node. This single-layer design was part of the foundation for systems which have now become much more complex.

2. **In detail, discuss the difference between supervised learning and unsupervised learning**

i. Supervised learning is a machine learning approach that's defined by its use of labelled datasets. These datasets are designed to train or "supervise" algorithms into classifying data or predicting outcomes accurately. Using labelled inputs and outputs, the model can measure its accuracy and learn over time. Supervised learning can be separated into two types of problems when data mining: classification and regression:

- **Classification** problems use an algorithm to accurately assign test data into specific categories, such as separating apples from oranges. Or, in the real world, supervised learning algorithms can be used to classify spam in a separate folder from your inbox. Linear classifiers, support vector machines, decision trees and random forest are all common types of classification algorithms.
- **Regression** is another type of supervised learning method that uses an algorithm to understand the relationship between dependent and independent variables. Regression models are helpful for predicting numerical values based on different data points, such as sales revenue projections for a given business. Some popular regression algorithms are linear regression, logistic regression and polynomial regression.

ii. Unsupervised learning uses machine learning algorithms to analyze and cluster unlabelled data sets. These algorithms discover hidden patterns in data without the need for human intervention (hence, they are "unsupervised"). Unsupervised learning models are used for three main tasks: clustering, association and dimensionality reduction:

- **Clustering** is a data mining technique for grouping unlabelled data based on their similarities or differences. For example, K-means clustering algorithms assign similar data points into groups, where the K value represents the size of the grouping and granularity. This technique is helpful for market segmentation, image compression, etc.

- **Association** is another type of unsupervised learning method that uses different rules to find relationships between variables in a given dataset.
- **Dimensionality reduction** is a learning technique used when the number of features (or dimensions) in a given dataset is too high. It reduces the number of data inputs to a manageable size while also preserving the data integrity.

3. **What is an Activation function?**
   In artificial neural networks, the activation function of a node defines the output of that node given an input or set of inputs. A standard integrated circuit can be seen as a digital network of activation functions that can be "ON" (1) or "OFF" (0), depending on input. This is similar to the behavior of the linear perceptron in neural networks. However, only nonlinear activation functions allow such networks to compute nontrivial problems using only a small number of nodes, and such activation functions are called nonlinearities.
4. **Briefly discuss what you understand by Genetic algorithm**

   In computer science and operations research, a **genetic algorithm** is a metaheuristic inspired by the process of natural selection that belongs to the larger class of evolutionary algorithms (EA). Genetic algorithms are commonly used to generate high-quality solutions to optimization and search problems by relying on biologically inspired operators such as mutation, crossover and selection. A typical genetic algorithm requires a genetic representation of the solution domain and a fitness function to evaluate the solution domain.

5. **What is the difference between Fuzzification and defuzzification?**

   Fuzzification may be defined as the process of transforming a crisp set to a fuzzy set or a fuzzy set to fuzzier set. Basically, this operation translates accurate crisp input values into linguistic variables. **Defuzzification** may be defined as the process of reducing a fuzzy set into a crisp set or to convert a fuzzy member into a crisp member.

   Differences.

   Fuzzification

   Definition: Fuzzification is the process of transforming a crisp set to a fuzzy set or a fuzzy set to fuzzier set.

   Purpose: Fuzzification converts a precise data into imprecise data.

   Example: Voltmeter

   Methods used: Inference, Rank ordering, Angular fuzzy sets, Neural network.

   Complexity: Fuzzification is easy.

Approach: Fuzzification uses if-then rules to fuzzify the crisp value.

Defuzzification

Definition: Defuzzification is the process of reducing a fuzzy set into a crisp set or converting a fuzzy member into a crisp member.

Purpose: Defuzzification converts an imprecise data into precise data.

Example: Stepper motor, D/A converter.

Methods used: Maximum membership principle, Centroid method, Weighted average method, Center of sums.

Complexity: Defuzzification is quite complex to implement.

Approach: Defuzzification uses center of gravity methods to get centroid of sets.