CEG5301 Machine Learning with Applications:

Part I: Homework #3

Important note: the due date is 14/10/2025. Please submit the softcopy of your report to the submission folder in CANVAS. Late submission is not allowed unless it is well justified. Please supply the Python Code in your answer if computer experiment is involved.

Q1. Function Approximation with RBFN (50 Marks)

Consider using RBFN to approximate the following function:

$$y = 1.2\sin(\pi x) - \cos(2.4\pi x), \quad for\ x \in [-1, 1]$$

The training set is constructed by dividing the range $[-1, 1]$ using a uniform step length 0.05, while the test set is constructed by dividing the range $[-1, 1]$ using a uniform step length 0.01. Assume that the observed outputs in the training set are corrupted by random noise as follows.

$$y(i) = 1.2\sin\big(\pi x(i)\big) - \cos\big(2.4\pi x(i)\big) + 0.3n(i)$$

where the random noise $n(i)$ is Gaussian noise with zero mean and stand deviation of one, which can be generated by multiple ways, such as np.random.normal(mean, std_dev, size). Note that the test set is not corrupted by noises. Perform the following computer experiments:

a) Use the exact interpolation method and determine the weights of the RBFN. Assume the RBF is Gaussian function with standard deviation of 0.1. Evaluate the approximation performance of the resulting RBFN using the test set.

(30 Marks)

b) Follow the strategy of "Fixed Centers Selected at Random", randomly select 20 centers among the sampling points. Determine the weights of the RBFN. Evaluate the approximation performance of the resulting RBFN using test set. Compare it to the result of part a).

(20 Marks)