**CITY UNIVERSITY OF HONG KONG (DONGGUAN)**

Course title : Machine Learning

Session : Semester A 2024/25

Type : Sample Questions

**1.** Describe the similarities and differences for each pair of terms.

**1a)** Multi-layer perceptron (MLP) and convolutional neural network (CNN)

Similarities:

Differences:

**1b)** Principal Component Analysis (PCA) and Kernel Principal Component Analysis (KPCA)

Similarities:

Differences:

**1c)** Dimensionality Reduction and Feature Selection.

Similarities:

Differences:

**2.** Describe the advantages and disadvantages of each method.

**2a)** Ridge Regression.

Advantages:

Disadvantages:

**2b)** Naïve Bayes Classifier.

Advantages:

Disadvantages:

**2c)** Mini-batch Gradient Descent.

Advantages:

Disadvantages:

**3.** Answer each of the following questions.

**3a)** Bob plans to train a binary classifier to filter spam emails using -norm regularized logistic regression, whose objective function is given by

After training the classifier with gradient descent, he gets an unacceptable high test error. He has also plotted training and test error as a function of training set size

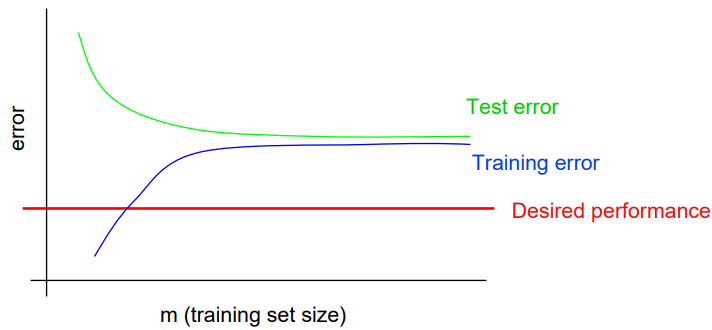


Image courtesy of Andrew Ng

Please help Bob diagnose the problem and suggest possible steps to improve the classification performance.

**3b)** Suppose our training set are drawn independently from a uniform distribution .

1. Derive the likelihood function of given the training set .
2. Find the maximum likelihood estimate for .

**4.** Answer each of the following questions.

**4a)** What is the effect of an unbalanced dataset when training a classifier? Give a real-world example of a classification problem that might have an unbalanced dataset. How do you fix this problem?

**4b)** Consider the following optimization problem

where is an N by 1 parameter vector to be optimized, is a fixed M by N matrix and is a fixed M by 1 vector, together imposing M constraints on .

1. Is it a convex optimization problem? Give your reasons.
2. Formulate the dual problem of the above primal problem. Hint: associate the right number of Lagrange multipliers to the constraints.

- END -