Q1:

(a) Describe the difference between “Linear Regression” and “Logistic Regression” in terms of their output. [4 marks]

(b) Explain the difference between Maximum a Posterior (MAP) estimates and Maximum Likelihood (ML) estimates. [4 marks]

(c) Explain the “gradient descent” algorithm. [4 marks]

(d) Explain what is “Regularization” and how it is applied in “Linear Regression”. Explain the problem and the “Regularization” solution. [5 marks]

(e) Explain “Linear Basis Function Models” for “Linear Regression”. Give three examples of the basis functions. [8 marks, 2 for the main explanation, 2 for each example]

Q2:

(a) Explain the process of training a neural network by optimising a cost function using the method of steepest gradient descent. In your answer, discuss the role of the network weights and the error measure, and explain why the use of a validation set is important. [6 marks]

(b) Sketch a diagram of a standard 3-layer Multilayer Perceptron (MLP) for classifying inputs x1, 2, xd to a single target value t. What key limitation of the original Perceptron is overcome by the MLP? [6 marks]

(c) Briefly explain “feed forward neural network” and “backpropagation” technique. [4 marks]

(d) Implement the logical XOR function using a neural network [9 marks]

Q3:

(a) Describe the difference between supervised and unsupervised learning. Give an example of a supervised learning problem and an example of an unsupervised learning problem. [4 marks]

(b) Describe in detail the steps of the K-means algorithm. Make sure that you define the input to the algorithm, the output, and the dimensionality of all the variables that you use. [8 marks]

(c) Give the formula that defines the quantity that is optimised by the K-means algorithm. [4 marks]

(d) What is the optimisation method used by K-means? Using a sketch show that this general method is warranted to converge. Show that it might converge to a local minimum. [4 marks]

(e) The K-Means algorithm terminates at local minimum. Describe a practical way to deal with this problem. [5 marks] Q4:

a) With a help of a diagram explain the main principles of the first-order Markov Model. Explain what is meant by the term ‘’first-order”. What are the differences with a hidden Markov model (HMM)? In your answer, define the states w\_i , the symbols v\_k , and the matrices A = [a\_ij] and B = [b\_jk] . [6 marks]

b) The decoding problem can be stated as follows: Given an HMM and a sequence of observation symbols V^{1:T} determine the most likely sequence of hidden states w^{1:T} .What are the other two types of problems considered in the context of HMMs? [6 marks]

c) What algorithm is used to solve the decoding problem described in 4.b). Give a brief description of the algorithm using pseudo code. [13 marks]