UNIVERSITY OF BIRMINGHAM
School of Computer Science

First Year – Undergraduate Affiliated Computer Science/Software Engineering
Final Year – BSc in Artificial Intelligence and Computer Science
Final Year – BSc Computer Science
Final Year – BEng Computer Science/Software Engineering
Final Year – BSc Computer Science with Study Abroad
Final Year – BSc Artificial Intelligence and Computer Science with an Industrial Year

06 20416

Neural Computation
Summer Examinations 2013

Time allowed: 1 hr 30 min

[Answer ALL Questions]
1. (a) List the main computational factors that are generally considered to make artificial neural networks worth studying. [5%]

(b) With the help of labelled diagrams, describe how a McCulloch-Pitts Neuron is related to a typical Biological Neuron. [7%]

(c) Write down an equation that gives the output of a McCulloch-Pitts neuron in terms of its inputs, weights and threshold. Then, using a simple logical function, derive inequalities for the weights and thresholds which demonstrate that there exists mappings that cannot be performed by a single McCulloch-Pitts neuron. [7%]

(d) Explain what makes it possible for a Multi-Layer Perceptron (MLP) to perform the kinds of mappings that McCulloch-Pitts neurons and Single Layer Perceptrons cannot. Why is it important that the MLP hidden unit activation functions are non-linear? [6%]

2. (a) Suppose a botanist had collected a large number of measurements of flowers and asked you to supply a neural network that could identify other flowers from their measurements. Design and justify a suitable Multi-Layer Perceptron architecture, including the specification of all activation functions. [6%]

(b) Explain how you could use a gradient descent based approach to train your neural network on the data supplied. [Detailed mathematical derivations are not required.] [7%]

(c) One approach to improving generalization is known as Early Stopping. Describe in detail how that would work in practice for this problem. [7%]

(d) Explain how Ensemble Averaging could further improve your generalization performance. [5%]
3. (a) A farmer believes it may be possible to predict crop yield and quality for each year from measurements of the average weather conditions earlier that year. Design an appropriate Radial Basis Function (RBF) Network that might be able to learn from past data to make such predictions. Explain what will be computed by each component of your network. [7%]

(b) Explain the operation of the K-Means Clustering algorithm, and how it might be helpful for training your RBF Network. [7%]

(c) Outline the full process required to obtain all weights/parameters of your RBF network. [6%]

(d) Describe how a regularization approach could be used to improve the generalization performance of your RBF network. [5%]

4. (a) Explain what is meant by the terms Self Organising Map and Topographic Map. Give an example of where a Topographic Map might be found in the human brain, and suggest why it might be useful there. [7%]

(b) Describe the architecture of the particular form of Self Organising Map known as a Kohonen Network. [7%]

(c) Briefly describe the key steps involved in the standard learning algorithm for a Kohonen network. [7%]

(d) Provide a simple intuitive justification of why it is normal to decrease the learning rate during the course of training a Kohonen Network. [4%]