A06490

THE UNIVERSITY OF BIRMINGHAM

Degree of B.Sc. with Honours
Artificial Intelligence and Computer Science. Second Examination
Computer Science/Software Engineering. Second Examination

Joint Degree of BSc with Honours
Mathematics and Artificial Intelligence. Second Examination
Psychology and Artificial Intelligence. Second Examination

Joint Degree of B.A. with Honours
Artificial Intelligence and Philosophy. Second Examination
French and Artificial Intelligence. Second Examination

MSc in Computer Science

06 02360

Introduction to Neural Networks

Monday 13th May 2002   0930 - 1130

[Answer ALL Questions]

THIS IS NOT AN OPEN-BOOK EXAMINATION - CANDIDATES MAY NOT CONSULT ANY REFERENCE MATERIAL DURING THE SITTING

No calculator

NB Mathematical derivations/details are NOT required unless explicitly requested.

1.   Outline the basic structure and components of a simple biological neuron.   [5%]

Describe how this is related to a McCulloch-Pitts neuron.   [5%]

Design networks of McCulloch-Pitts neurons that implement logical NOT, AND and OR gates. Draw each network and label all the weight and threshold values.   [6%]

In what way is XOR more difficult?   [4%]

2.   Describe how the basic "Back-Propagation Learning Algorithm" for Multi-Layer Perceptron (MLP) networks is related to gradient descent learning.   [10%]

What are local minima, and why are they a problem? How might we improve our chances of finding the global minimum?   [5%]

Explain the purpose of the "momentum term" that is often included in the Back-Propagation Learning Algorithm.   [7%]

Outline what is meant by a line search and why we might want to use one. Explain what the "Conjugate Gradient" algorithm is, and how it is able to speed up learning.   [8%]

3.   A company has collected a large amount of data in the form of pairs of input and output vectors, and wants you to build a system that will predict the outputs for new inputs. Design an appropriate Radial Basis Function (RBF) network for them. Explain what will be computed at each layer of your network.   [10%]

Explain how you will determine the input to hidden layer weights/parameters.   [5%]

Explain how you will determine the hidden to output layer weights/parameters.   [5%]

What is the main advantage your Radial Basis Function (RBF) network will have over a Multi-Layer Perceptron (MLP) network carrying out the same function?   [5%]

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4. Describe the architecture of the Self Organising Map (SOM) known as a Kohonen network. [5%]

What can such a network be useful for? [4%]

The self organising process can be said to have four major components: Initialization, Competition, Cooperation, and Adaptation. Briefly describe how each of these components is implemented. [8%]

Two equations used in the context of Kohonen networks are:

$$T_{j,I(\mathbf{x})}(t) = \exp(-S_{j,I(\mathbf{x})} / 2\boldsymbol{s}^2(t))$$

$$\Delta w_{ji} = \boldsymbol{h}(t) \cdot T_{j,I(\mathbf{x})}(t) \cdot (x_i - w_{ji})$$

What do each of the symbols in them mean, and how are these equations used in the self organising process? [8%]

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