Neural Computation : Exercise Sheet 4

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The following questions are of the kind that may come up in the exam this year. They are designed to help you monitor your progress – try to answer the questions without your notes, and then use your notes to check whether your answers are correct. The percentages indicate the corresponding fraction of a 1.5 hour exam.

Question 1

(a) Describe the essential features of a *Recurrent Neural Network*. **[3%]**

(b) In the context of *Recurrent Neural Networks*, explain what "unfolding over time" means and how it is relevant to neural network training. **[8%]**

(c) What is the *NARX Model* and for what application areas might it be useful? **[4%]**

(d) Outline the key features of *Hopfield Networks* and *Boltzmann Machines*. **[10%]**

Question 2

(a) What is meant by the term *Exact Interpolation*? **[5%]**

(b) Describe in detail the process by which a set of *Radial Basis Functions* can be used to perform *Exact Interpolation*. **[10%]**

(c) Explain why *Exact Interpolation* is generally not useful for dealing with real world applications, and what modifications to the *Radial Basis Function* approach for doing it can lead to a more useful technique. **[10%]**

Question 3

(a) Two equations used in the context of *Radial Basis Function* (RBF) mappings are:

$$y_k(\mathbf{x}) = \sum_{j=0}^{M} w_{kj}\phi_j(\mathbf{x}) \qquad \phi_j(\mathbf{x}) = \exp\left(-\frac{\|\mathbf{x}-\boldsymbol{\mu}_j\|^2}{2\sigma_j^2}\right)$$

Explain what each of the symbols in them mean, and what it is that is being computed by them. **[8%]**

(b) Show how the RBF mapping can be represented in the form of a network. **[4%]**

(c) Outline a time efficient procedure for training such a network. **[8%]**

(d) What factors will affect the choice of the number of hidden nodes to be used in such a network? **[6%]**

Question 4

(a) Describe the architecture of a *Radial Basis Function* (RBF) network with D input units and K output units, and state what exactly is computed at each layer. **[8%]**

(b) Specify a clustering based procedure you could use to determine the input to hidden layer weights/parameters of such a network, and outline an efficient procedure for determining the hidden to output layer weights/parameters. **[10%]**

(c) What is a *Validation Set*? Explain how would you use one to choose an appropriate number of hidden units for an RBF network. **[7%]**

Question 5

(a) A manufacturing company has collected a large amount of data in the form of pairs of real valued 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 network layer. **[8%]**

(b) Describe how you would determine the weights/parameters for such a network? **[8%]**

(c) Explain how you could modify those procedures to use regularization to improve the generalization performance of your network. **[5%]**

(d) What is the main advantage your *Radial Basis Function* (RBF) network will have over a *Multi-Layer Perceptron* (MLP) network designed for the same task? **[4%]**

Question 6

(a) Describe in detail the structure and components of a standard *Radial Basis Function* (RBF) network. **[9%]**

(b) Outline how you could use a gradient descent approach to train such a network. **[6%]**

(c) Explain the advantages and disadvantages of that approach over more conventional RBF network training algorithms. **[10%]**

Question 7

(a) Describe in detail the similarities and differences between *Multi-Layer Perceptron* (MLP) and *Radial Basis Function* (RBF) networks. **[15%]**

(b) Suppose you were given a set of real world data and were asked to produce a system to generate appropriate outputs for inputs that the system had not seen before. Explain the main factors you would consider when choosing whether to use an MLP network or an RBF network. **[10%]**