

Introduction to Neural Networks : Exercise Sheet 5

John A. Bullinaria - 2004

The syllabus and terminology for the Introduction to Neural Networks module have changed considerably over the years. The following questions are typical of what might come up in the exam this year. The percentages indicate what fraction of the two hour exam they correspond to.

Question 1 (Based on Question 7 in May 2001 Exam)

- (a) In unsupervised learning, there are no target output values. So, what does unsupervised learning learn? [5%]
- (b) How many layers are there in a Kohonen network (Self Organizing Map) and what do they do? [5%]
- (c) How are the weights in a Kohonen network (Self Organizing Map) updated? [5%]
- (d) How can a Kohonen network (Self Organizing Map) be used to compress data with minimum loss of information? [5%]

Question 2 (Based on Question 4 in May 2002 Exam)

- (a) Describe the architecture of the Self Organising Map (SOM) known as a Kohonen network. [5%]
- (b) What can such a network be useful for? [4%]
- (c) 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%]
- (d) Two equations used in the context of Kohonen networks are:

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

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

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

Question 3

- (a) Explain what is meant by the term *Self Organising Map (SOM)*? [3%]
- (b) In this context, what is meant by the term *Vector Quantization*? [4%]
- (c) What is *Density Matching*, and why is it an important feature of SOMs? [3%]

Question 4

- (a) Dimensionality reduction is a form of data compression. What does statement this mean? Is it always true? [3%]
- (b) Describe a practical example of when it would be useful to perform some form of compression on a set of data. [3%]
- (c) Describe in detail how we can carry out dimensionality reduction using a simple Multi-Layer Perceptron (MLP). [7%]
- (d) Describe in detail how we can carry out dimensionality reduction using a Kohonen Network (Self Organizing Map). [7%]

Question 5 (Based on Question 5 in May 2003 Exam)

- (a) Describe the form of data compression that Kohonen Networks perform. [6%]
- (b) Outline the main components of the self-organising process that is used to train a Kohonen Network. [8%]
- (c) In the context of Kohonen Networks, explain what is meant by the terms *Density Matching* and *Topological Ordering*. [6%]

Question 6 (Based on Question 5 in August 2003 Resit Exam)

- (a) Describe what is meant by a *Topographic Map*. Given an example of their presence in the human brain. [5%]
- (b) Outline the components of the self-organising process that is used to form topographic maps in a Kohonen Network. [8%]
- (c) Give intuitive explanations of why the size of the topological neighbourhood and the learning rate should both be decreased during a successful course of Kohonen Network training. [7%]

Question 7 (Based on Question 5 in May 2004 Exam)

- (a) Describe the properties of the mapping that is performed by an appropriately trained *Kohonen Network*. [8%]
- (b) In this context, explain what is meant by the term *Voronoi Tessellation*. [4%]
- (c) Outline how *Learning Vector Quantization (LVQ)* can improve the performance of a Kohonen Network. [8%]