2910311 Neural networks

Examiner's report: Zone A

The performance of the students from the western zone on this exam paper was very satisfactory. The overall impression is that they have made serious efforts during the preparation period. As a result most of them really succeeded in understanding the teaching material from the field of neural networks and acquired abilities to work in this area. Each of the questions in the exam paper contained two parts: theoretical and practical. The intention was to find out to what degree the candidates have acquired theoretical knowledge, and to what extent they can apply their knowledge to inductive problem solving using artificial neural networks.

The main observation that can be made is that the students were more successful on the theoretical parts in the questions, like these in questions 1, and 4. However, especially awkward was their difficulty in answering question 3, which is mainly theoretical. It seems that the candidates faced more difficulties in answering the questions from the practical parts, like these in questions 2 and 5. Overall our students in this subject demonstrated good analytical thinking and also potential to find practical solutions to most of the questions.

Question 1

The first question was devoted to the basics of single layer neural networks. In subquestion 1.a. the candidates were asked to describe the six main components of the artificial neuron as a computation device, that is to explain which are the components of the neuron including inputs, weights, thresholds, summation block, activation function, and output. In subquestion 1.b. the students were asked to train a single layer network with a neuron that has two incoming inputs with predefined weights associated with them. The task involved computing the neuron output with three different given activation functions. Many candidates however failed on the last sigmoidal activation function because they did not use a constant term. In subquestion 1.c. the candidates were asked to explain the difference between supervised and unsupervised training algorithms, which are the main approaches to connectionist training. The training is supervised when the targets are provided together with the inputs.

Question 2

The second question covered training algorithms for single layer neural networks. It should be noted that most students presented the training algorithm for a single discrete neuron in subquestion 2.a, which indicates that they really have acquired the basic knowledge in the field. The students produced also satisfactory results in subquestion 2.b. where they were asked to train a sigmoidal neuron, with a sigmoidal activation function, using three training examples. The problem is that many students

failed to give correct answers in subquestion 2.c. which was also dedicated to sigmoidal neurons. Although a very similar example is given in the subject guide the candidates misused the formula.

Question 3

The third question was developed to test the theoretical understanding of the material. This was not a difficult question, moreover such an example is well explained in the subject guide but a large percentage of the candidates avoided question 3. In subquestion 3.a. the students were asked to define the equations of a single layer network with two inputs and two neurons so that it enclosed a given point on the plane. The second subquestion 3.b. required to explain what a geometric configuration a given single layer from a neural network defines. Most students constructed correctly the lines in the two-dimensional plane defined by the network, but many of them failed to provide the analytical equations that model these lines. The effect of this was that they could not also derive the matrix with the neuron connections. Overall the students seemed unprepared for this question despite having several such questions in previous exam papers. The candidates showed worst performance on this compared with all other questions in this examination paper.

Question 4

The fourth question was central for this exam paper as it was devoted to the popular backpropagation algorithm for training multilayer neural networks, which are widely used in practical applications. The backpropagation algorithm is very important as its implementations are available in every practical software tool, and its understanding is essential for the ability of the students to do practical work on classification and regression tasks with multilayer neural networks. It is quite satisfactory to note that almost all of the candidates who attempted this question gave correct answers. It should be noted also that the given neural network architecture was not trivial, it featured an irregular topology with direct connections from the inputs to the output layer modelling linear terms. The students succeeded in providing accurate derivations of the analytical equations for developing the backpropagation training algorithm for this neural network. Only some students who attempted this question did not deserve the highest mark.

Question 5

The fifth question was developed to test the abilities of the candidates to work with Hopfield neural networks. The first subquestion 5.a required the students to explain the Widrow-Hoff rule for learning in a Hopfield network, which most students answered correctly. Second, in subquestion 5.b they were required to explain the main difference between the two modes of training Hopfield networks: synchronous and asynchronous. The students performed best on the third subquestion 5.c. where they computed the neuron output using the provided input vector using the predefined weight matrix. Next, they trained the weights entering the selected neuron with highest activation. Overall, the candidates avoided this question and only a very small percentage of students worked on it. One reason for this could be that Hopfield networks are not very popular in practical applications.

Question 6.

The sixth question considered the self-organising Kohonen type neural networks. Traditionally students have been quite successful on this kind of question. The first subquestion 6.a. asked the candidates to train the weights in the Kohonen layer, after prenormalisation. The students found this easy and many of them provided proper answers. The second subquestion 6.b. required candidates to calculate the summation block of a self-organising network with two neurons in the Kohonen layer and four inputs. The following practical task was to apply the training algorithm for doing learning in the Kohonen layer and to update the weights of the winning neuron. As most of the students seemed familiar with the training algorithm, they worked very well in general. Overall the students worked well on this question.