CS 672 – Neural Networks – Fall 2010
Instructor: Marc Pomplun

Practice Midterm Exam

Duration: 75 minutes

No calculators, no books, and no notes are allowed (in the actual exam).

Question 1: _____ out of _____ points
Question 2: _____ out of _____ points
Question 3: _____ out of _____ points
Question 4: _____ out of _____ points
Question 5: _____ out of _____ points (bonus question)

Total Score:

Grade:
**Question 1: Is it true?**

Tell whether each of the following statements is true or false by checking the appropriate box. Do not check any box if you do not know the right answer, because you will lose points for incorrect answers.

<table>
<thead>
<tr>
<th>Statement</th>
<th>True</th>
<th>False</th>
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<tbody>
<tr>
<td>a) A perceptron is guaranteed to perfectly learn a given linearly separable function within a finite number of training steps.</td>
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<td>b) For effective training of a neural network, the network should have at least 5-10 times as many weights as there are training samples.</td>
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<td>c) A single perceptron can compute the XOR function.</td>
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<td>d) The more hidden-layer units a BPN has, the better it can predict desired outputs for new inputs that it was not trained with.</td>
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<td>e) In backpropagation learning, we should start with a small learning parameter $\eta$ and slowly increase it during the learning process.</td>
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<td>f) A three-layer BPN with 5 neurons in each layer has a total of 50 connections and 50 weights.</td>
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<td>g) Supervised learning like in the BPN is biologically plausible.</td>
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<td>h) The backpropagation learning algorithm is based on the gradient-descent method.</td>
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<td>i) Some conflicts among training exemplars in a BPN can be resolved by adding features to the input vectors and adding input-layer neurons to the network.</td>
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<td>j) Typically, Adalines produce better results for new (untrained) inputs than do perceptrons.</td>
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Question 2: The Soccer Network

Once again, here is an idea for an ANN that would make you rich if it performed well. This ANN predicts the results of soccer matches. The network receives information about the two competing teams and the conditions of the match and is supposed to predict how many goals each team will score. With this knowledge, you could bet on the projected winner team and gain a lot of money.

Let us say that every team consists of 20 players. You are providing the following input data to the network:

- The skill level of every player on each of the two teams. Skill is rated by a group of soccer reporters on a scale from 0 (“is unable to kick the ball”) to 10 (“world class player”).

- The number of matches that each team has played during the last two weeks. There are never more than seven matches in that period of time.

- The statistics of former matches between the same two teams within the past 10 years (e.g., Team A won 30% of the matches, Team B 45%, and 25% of the matches were tied).

- The continent that each team comes from (North America, South America, Europe, Africa, Asia, or Australia).

- Where the match takes place (Team A’s stadium, Team B’s stadium, or neutral place).

- The phase of the soccer season (early season vs. late season).

You want to build and train a backpropagation network that, based on this information, is able to predict the number of goals each team will score. Describe an appropriate way of formatting the input, interpreting the output, collecting exemplars, constructing the network, training the network, and testing the network. **Give reasons** for the decisions that you make. Describe everything in **great detail** so that a computer programmer who does not know anything about ANNs would be able to successfully build this network application, predict results, and become rich. The programmer can look up the BPN equations for training and operation in a book, but needs precise explanations for everything else. Please help him/her out!
Question 3: Linear Neurons

The following is a network of linear neurons, that is, neurons whose output is identical to their net input, \( o_i = \text{net}_i \). The numbers in the circles indicate the output of a neuron, and the numbers at connections indicate the value of the corresponding weight.

![Network Diagram]

a) Compute the output of the hidden-layer and the output-layer neurons for the given input \((0.5, 1)\) and enter those values into the corresponding circles.

b) What is the output of the network for the input \((1, 2)\), i.e. the left input neuron having the value 1 and the right one having the value 2? Do you have to do all the network computations once again in order to answer this question? Explain why you do or do not have to do this.
Question 4: Adalines

(a) Explain how an Adaline works, i.e., describe the function that it computes and its learning algorithm. If you do not remember how the weights are modified during training, just describe what exactly the purpose of these changes is and how their magnitude can be derived (no equations necessary).

(b) What is the advantage of Adalines over perceptrons? How is it achieved?

(c) Explain how we can use a layer of Adalines to perform classification for more than two classes. How are the units trained, and how do we interpret the units’ output in production mode to determine the class of the current input?

Question 5 (Bonus Question): Brains and Computers

Please describe the main differences between the human brain and today’s computers (such as your desktop PC) in terms of information processing.