Artificial Intelligence
Tutorial 5 on Neural Networks

December 2021.

Introduction

The following questions about Neural Networks are examples of typical questions one can expect on the AI exam, but the exam questions are MC. After the tutorial the answers to the MC will be available on BB.

Questions on Neural Networks

1. Assume that we are training a logistic classifier (linear classifier with logistic regression) using the `Logistic` function (called the `sigmoid` function in the slides) and that the current logistic classifier has the weights $(w_0, w_1, w_2) = (1, 2, -1)$. The next feature point in our training set is given by $x = (1, -1)$.

   (a) What is the output (activation) of this logistic classifier for the input x?

   (b) How will the feature point x be classified, 0 or 1, given the current weights $w = (1, 2, -1)$ of the linear classifier?

   (c) Assume that the feature point x is misclassified and we use the L_2 (quadratic) loss function $(y - h_{\mathbf{w}}(x))^2$. How will the weights of the linear classifier be adapted. Assume a learning rate α of 0.7.

   (d) How will x be classified after the above adaptation of the weight vectors w? Is this adaptation a step in the right direction? **Motivate your answer!**

2. Consider the Neural Network of Figure 18.22 of the book, also depicted below. As stated in the text, the dummy inputs are not shown!

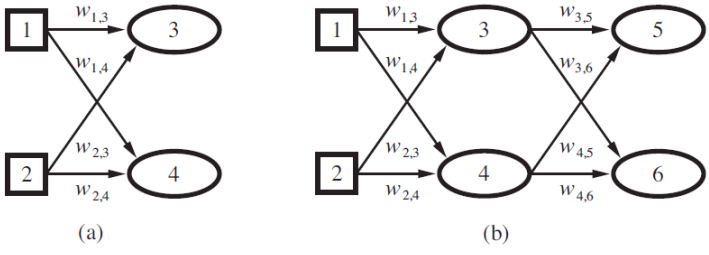

Figure 18.20 FILES: figures/neural-net.eps (Wed Nov 4 11:08:22 2009). (a) A perceptron network with two inputs and two output units. (b) A neural network with two inputs, one hidden layer of two units, and one output unit. Not shown are the dummy inputs and their associated weights.

More specific we consider the NN on the left and assume the following weights: $w_{0,3} = 2,\ w_{1,3} = 1,\ w_{2,3} = -2,\ w_{0,4} = 1,\ w_{1,4} = 2,\ w_{2,4} = -1$. The activation function of the neurons 3 and 4 is the `Logistic` function.

(a) What is the output of this NN on the input $x = (1, 2)$?

(b) The target output for x is $(0, 1)$. What are the delta's $\Delta(3)$ and $\Delta(4)$ for the neurons 3 and 4 if we assume the L_2 loss function?

(c) How will the weights of NN be adapted if the learning parameter for all neurons is $\alpha = 0.5$?

3. Consider the Neural Network of Figure 18.22 of the book, also depicted below. As stated in the text, the dummy inputs are not shown!

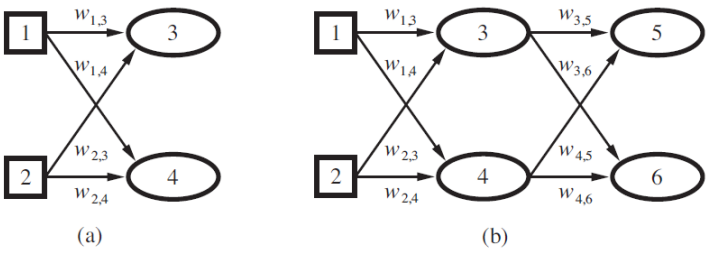

Figure 18.20 FILES: figures/neural-net.eps (Wed Nov 4 11:08:22 2009). (a) A perceptron network with two inputs and two output units. (b) A neural network with two inputs, one hidden layer of two units, and one output unit. Not shown are the dummy inputs and their associated weights.

More specific we consider the NN on the right and assume the following weights: $w_{0,3} = 2,\ w_{1,3} = 1,\ w_{2,3} = -2,\ w_{0,4} = 1,\ w_{1,4} = 2,\ w_{2,4} = -1,\ w_{0,5} = 0,\ w_{3,5} = -1,\ w_{4,5} = -1$ and $w_{0,6} = -1,\ w_{3,6} = 1,\ w_{4,6} = -2$. The activation function of the hidden neurons 3 and 4 is the `Logistic` function and the activation function of the output neurons 5 and 6 is the identity function $g(x) = x$.

(a) What is the output of this NN on the input $x = (1, 2)$?

(b) The target output for x is $(0, 1)$. What are the delta's $\Delta(5)$ and $\Delta(6)$ for the output neurons if we assume the L_2 loss function?

(c) What are the delta's $\Delta(3)$ and $\Delta(4)$ for the hidden neurons?

(d) How will the weights of NN be adapted if the learning parameter for all neurons is $\alpha = 0.5$?