Deep Learning

Theoretical Exercises – Week 9 – Chapter 7

Exercises on the book "Deep Learning" written by Ian Goodfellow,
Yoshua Bengio, and Aaron Courville.
Exercises and solutions by T. Méndez and G. Schuster

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1 Exercises on Regularization for Deep Learning

1. Describe the following regularization methods in your own words by explaining the idea behind the method and describing how it acts as a regularizer.

   (a) Early Stopping

   (b) Bagging

   (c) Dropout

2. Given is the network in Figure 1, which has the following weights and biases:

$$\boldsymbol{W}^{(1)} = \begin{bmatrix} -0.4 & 0.1 & 0.9 \\ 0.8 & -0.2 & -0.7 \end{bmatrix}, \qquad \boldsymbol{b}^{(1)} = \begin{bmatrix} 0.6 & -0.4 & -0.7 \end{bmatrix}$$

   and

$$\boldsymbol{w}^{(2)} = \begin{bmatrix} -0.9 \\ -0.8 \\ 0.6 \end{bmatrix}, \qquad b^{(2)} = 0.4.$$

   In addition, an 4×2 matrix

$$\boldsymbol{X} = \begin{bmatrix} 0 & 0 \\ 0 & 1 \\ 1 & 0 \\ 1 & 1 \end{bmatrix}$$

   is given, where line i contains the input example $\boldsymbol{x}^{(i)}$.

   (a) Calculate the mean value of the output y by using the given training set $\boldsymbol{X}$ as input.

   (b) The hidden units are now dropped with the probability of $p = 0.6$. Recalculate the mean value of the output y by using the given training set $\boldsymbol{X}$ as input and the

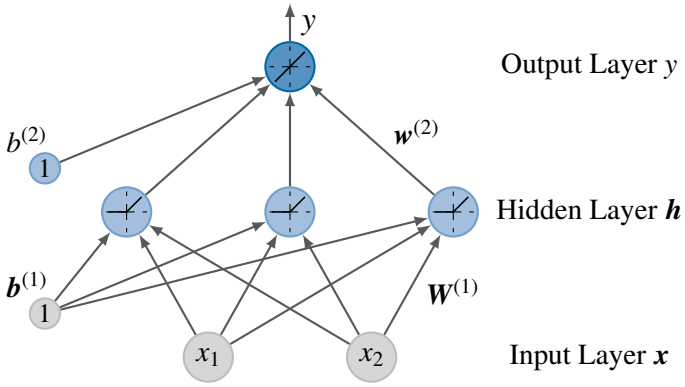

Figure 1: A neural network with two input units, three hidden units and one output. The activation function in the output layer is linear and in the hidden layer a rectified linear unit (ReLu) is used.

networks modified by dropout. Calculate the mean value for each modification given in the matrix

$$\boldsymbol{D} = \begin{bmatrix} 0 & 0 & 1 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & 1 & 1 \end{bmatrix},$$

where each line corresponds to one network. 0 means that the corresponding hidden unit is dropped and 1 means that it is kept. Then average all calculated mean values and compare the result with the one of task (a).

Hint:
Remember to adjust the weights accordingly when using dropout.