Pattern Recognition 2024
Assignment#4

May 20, 2024

The format of your report is up to you. In general, your report should clearly show how you have obtained the results and a detailed analysis of your solutions. If you feel a bit inexperienced with writing scientific reports, have a look at the line[1]. I recommend chapter 4 of this document if (like me) English is not your mother language.

Q1. Consider a three-layer feedforward neural network with *two* input neurons, *two* hidden neurons, and *two* output neurons, as illustrated in Fig. 1. The activation function of the hidden layer is *Sigmoid* function $f(x) = \frac{1}{1+e^{-x}}$ and the activation function of the output layer is *tanh* function $g(x) = \frac{e^x - e^{-x}}{e^x + e^{-x}}$. Given the initial model $\mathbf{w} = \left\{w_{11}^{(1)}, w_{12}^{(1)}, w_{21}^{(1)}, w_{22}^{(1)}, w_{11}^{(2)}, w_{12}^{(2)}, w_{21}^{(2)}, w_{22}^{(2)}\right\} = \{0.2, 0.2, 0.4, 0.3, 0.5, 0.5, 0.7, 0.6\}$, where $\left\{w_{11}^{(1)}, w_{12}^{(1)}, w_{21}^{(1)}, w_{22}^{(1)}\right\}$ correspond to the input-to-hidden layer weights and $\left\{w_{11}^{(2)}, w_{12}^{(2)}, w_{21}^{(2)}, w_{22}^{(2)}\right\}$ correspond to the hidden-to-output layer weights. Suppose *Stochastic Backpropagation Algorithm* is used to train the neural network, and the randomly chosen training example is $\mathbf{x} = (1, 5)^\top$ with $\mathbf{t} = (2, 0)^\top$. What is the learned model $\mathbf{w}$ after training the neural networks (Learning rate $\eta = 1$, round the results to the fourth decimal place).

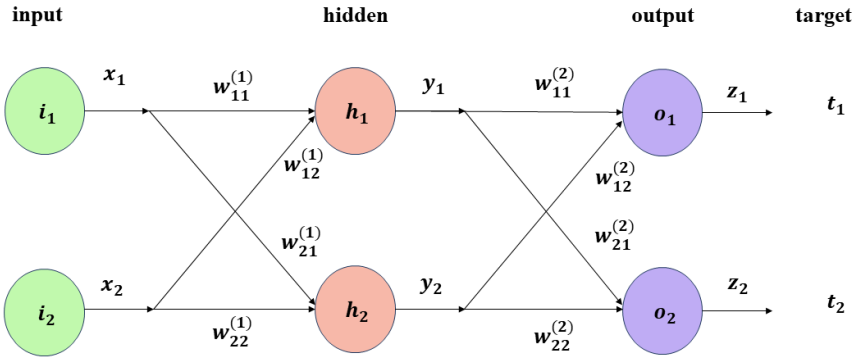

Figure 1: The architecture of a three-layer feedforward neural network.

[1] http://www.cs.joensuu.fi/pages/whamalai/sciwri/sciwri.pdf

Q2. Consider a three-layer feedforward neural network with *two* input neurons, *three* hidden neurons, and *one* output neurons, as illustrated in Fig 2. The activation function of the hidden layer and output layer is *Sigmoid* function $f(x) = \frac{1}{1+e^{-x}}$. Given the initial model $\mathbf{w} = \left\{w_{11}^{(1)}, w_{12}^{(1)}, w_{21}^{(1)}, w_{22}^{(1)}, w_{31}^{(1)}, w_{32}^{(1)}, w_{11}^{(2)}, w_{12}^{(2)}, w_{13}^{(2)}\right\} = \{0.1, 0.2, 0.2, 0.3, 0.3, 0.4, 0.5, 0.6, 0.7\}$, where $\left\{w_{11}^{(1)}, w_{12}^{(1)}, w_{21}^{(1)}, w_{22}^{(1)}, w_{31}^{(1)}, w_{32}^{(1)}\right\}$ correspond to the input-to-hidden layer weights and $\left\{w_{11}^{(2)}, w_{12}^{(2)}, w_{13}^{(2)}\right\}$ correspond to the hidden-to-output layer weights. Suppose *Stochastic Backpropagation Algorithm* is used to train the neural network, and the randomly chosen training example is $\mathbf{x} = (2, 3)^\top$ with $\mathbf{t} = 1$. What is the learned model $\mathbf{w}$ after training the neural networks (Learning rate $\eta = 1$, round the results to the fourth decimal place).

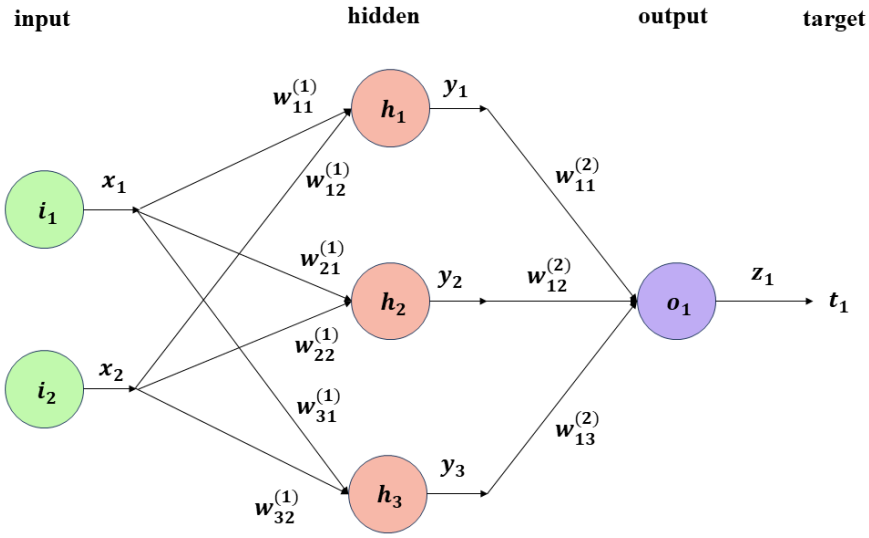

Figure 2: The architecture of a three-layer feedforward neural network.