Neural Networks - Exercise

PROBLEM: Figure 1 shows a multilayer feed-forward neural network. Let the learning rate be 0.9. The initial weight and bias values are given in Table 1, along with the first training sample, X = (1, 0, 1), whose output is 1. *(Han and Kamber, 2001)*

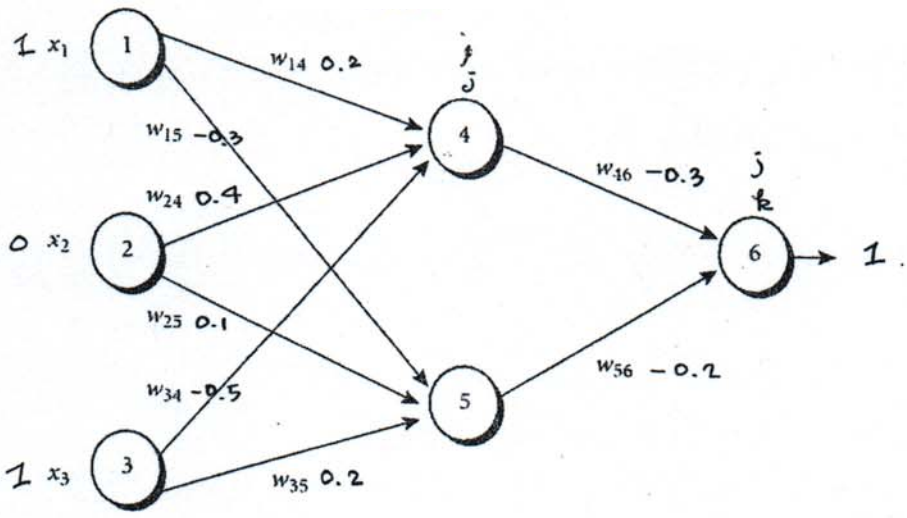

Figure 1: An example of a multilayer feed-forward neural network

Initial input, weight, and bias values.

x_1	x_2	x_3	w_{14}	w_{15}	w_{24}	w_{25}	w_{34}	w_{35}	w_{46}	w_{56}	θ_4	θ_5	θ_6
1	0	1	0.2	−0.3	0.4	0.1	−0.5	0.2	−0.3	−0.2	−0.4	0.2	0.1

Table 1: Initial input, weight, and bias values

Perform the calculations for backpropagation for the given first training sample X.

FORMULAS:

I_j: net input to unit j

$$I_j = \sum w_{ij} O_i + \theta_j$$

where:

w_{ij} is the weight of the connection from unit i in the previous layer to unit j
O_i is the output of unit i from the previous layer
θ_j is the bias (threshold) of the unit j

O_j: output of unit j

$$O_j = \frac{1}{1+e^{-I_j}}$$

where:

I_j is the net input to unit j

Err_j: error of unit j

Case A: unit j is in the output layer

$$Err_j = O_j * (1 - O_j) * (T_j - O_j)$$

where:

O_j is the actual output of unit j
T_j is the true output of unit j (based on known value from the training sample)

Case B: unit j is in a hidden layer

$$Err_j = O_j * (1 - O_j) * \sum_k Err_k w_{jk}$$

where:

O_j is the actual output of unit j
Err_k is the error of unit k in the next layer
w_{jk} is the weight of the connection from unit j to unit k in the next layer

Δw_{ij} : change in weight w_{ij}

$$\Delta w_{ij} = \ell * Err_j * O_i$$

where:

ℓ is the learning rate (typically between 0.0 and 1.0)
Err_j is the error of unit j
O_i is the actual output of unit *i*

New old
$$w_{ij} = w_{ij} + \Delta w_{ij}$$

$\Delta \theta_j$: change in bias θ_j

$$\Delta \theta_j = \ell * Err_j$$

where:

ℓ is the learning rate (typically between 0.0 and 1.0)
Err_j is the error of unit j

$$\theta_{ij} = \theta_{ij} + \Delta \theta_{ij}$$

Neural Networks - Exercise

PROBLEM: Figure 1 shows a multilayer feed-forward neural network. Let the learning rate be 0.9. The initial weight and bias values are given in Table 1, along with the training sample, Y = (-1, 1, 0), whose output is 1.

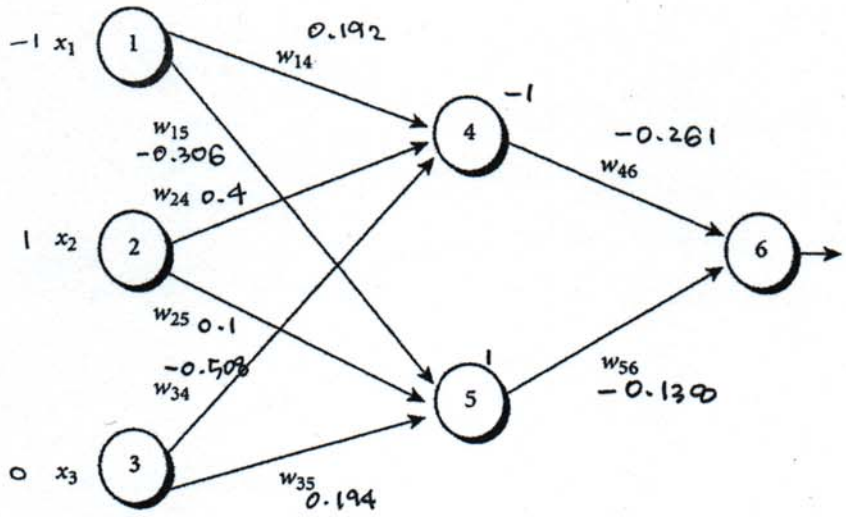

Figure 1: multilayer feed-forward neural network

Table 1: weight, and bias values

W46	W56	W14	W15	W24	W25	W34	W35	Θ6	Θ5	Θ4
-0.261	-0.138	0.192	-0.306	0.4	0.1	-0.508	0.194	0.218	0.194	-0.408

Perform the calculations for backpropagation for the given training sample Y.

FORMULAS:

I_j: net input to unit j

$$I_j = \sum w_{ij} O_i + \theta_j$$

where:

w_{ij} is the weight of the connection from unit i in the previous layer to unit j

O_i is the output of unit i from the previous layer

θ_j is the bias (threshold) of the unit j

O_j: output of unit j

Use Sign function

Err_j: error of unit j

Case A: unit j is in the output layer

$$Err_j = O_j * (1 - O_j) * (T_j - O_j)$$

where:

O_j is the actual output of unit j

T_j is the true output of unit j (based on known value from the training sample)

Case B: unit j is in a hidden layer

$$Err_j = O_j * (1 - O_j) * \sum_k Err_k w_{jk}$$

where:

O_j is the actual output of unit j

Err_k is the error of unit k in the next layer

w_{jk} is the weight of the connection from unit j to unit k in the next layer

Δw_{ij} : change in weight w_{ij}

$$\Delta w_{ij} = \ell * Err_j * O_i$$

where:

ℓ is the learning rate (typically between 0.0 and 1.0)
Err_j is the error of unit j
O_i is the actual output of unit *i*

$$w_{ij} = w_{ij} + \Delta w_{ij}$$

$\Delta \theta_j$: change in bias θ_j

$$\Delta \theta_j = \ell * Err_j$$

where:

ℓ is the learning rate (typically between 0.0 and 1.0)
Err_j is the error of unit j

$$\theta_{ij} = \theta_{ij} + \Delta \theta_{ij}$$