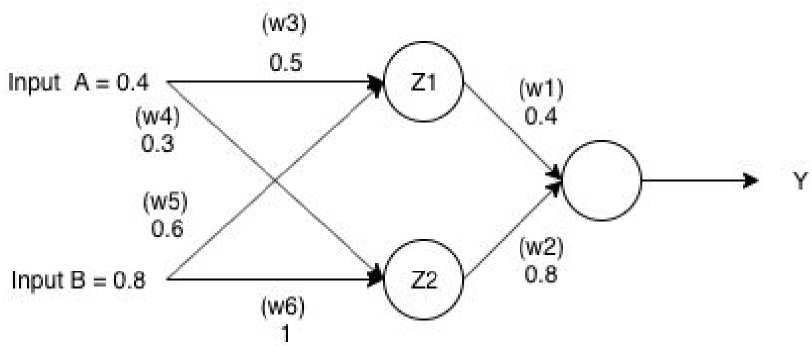
In Class Activity – Pattern Classification (ICA 15) - Solutions

Please enter your responses to the questions at https://tinyurl.com/AIF19-ICA15a

1) Consider the following neural network architecture (Assume that the neurons have a sigmoid activation f(x)):



Using inputs of A = 0.4, B = 0.8, the output is 0.70 for the forward pass (see calculations below)

f(Z1) = sigmoid(0.5*0.4 + 0.6*0.8) = sigmoid(0.68) = 0.66
f(Z2) = sigmoid(0.3*0.4 + 1*0.8) = sigmoid(0.92) = 0.72
f(Y) = sigmoid(0.4 * 0.66 + 0.8*0.72) = sigmoid(0.84) = 0.70

Assuming the target output is 0.5 and the learning rate is set to 1, what is the:

a) output error (delta)
b) error at Z1 (hidden neuron delta)
c) updated weight w1
d) updated weight w3

Hint: The formulas are shown in the back.

Solution:
Output $\delta_y = Out_y (1 - Out_y) (Target_y - Out_y) = (0.7) (1 - 0.7) (0.5 – 0.7) = -0.042$

New Weights at output layer:

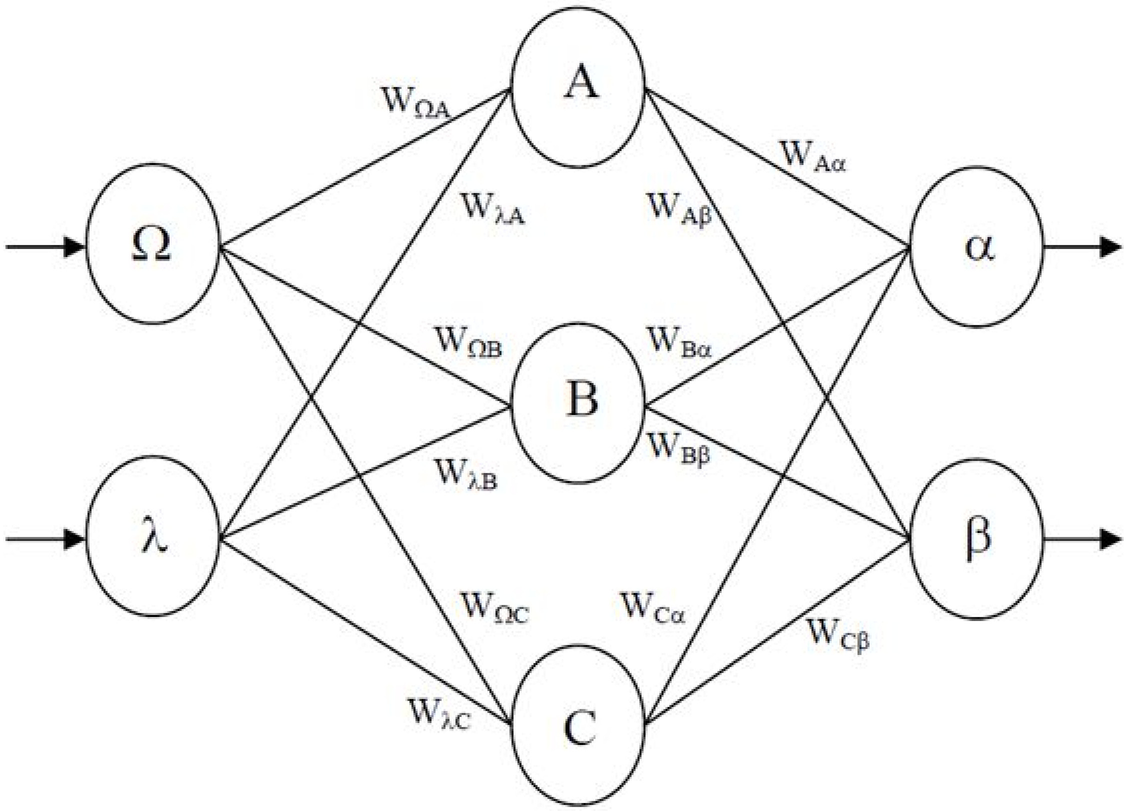
$W^+_1 = W_1 + \eta*\delta_y * Out_{z1} = 0.4 + (-0.042 * 0.66) = 0.37$
$W^+_2 = W_2 + \eta*\delta_y* Out_{z2} = 0.8 + (-0.042 * 0.72) = 0.76$

δ at hidden layer:

$\delta_{z1} = Out_{z1} * (1 - Out_{z1}) * (\delta_y * W_1) = (1 - 0.66) * 0.66 * (-0.042 * 0.37) = - 0.0035$
$\delta_{Z2} = Out_{z2} * (1 - Out_{z2}) * (\delta_y * W2) = (1 - 0.72) * 0.72 * (-0.042 * 0.76) = - 0.0064$

New Weights at hidden layer:

$W_3 = W_3 + \eta* \delta_1 * in_A = 0.5 + (-0.0035 * 0.4) = 0.49$
$W_4 = W_4+ \eta*\delta_1 * in_B = 0.6 + (-0.0035 * 0.8) = 0.59$
$W_5 = W_5 + \eta*\delta_2 * in_A = 0.3 + (-0.0064 * 0.4) = 0.29$
$W_6 = W_6 + \eta*\delta_2 * in_B = 1 + (-0.0064 * 0.8) = 0.99$



1. Calculate errors of output neurons

$$\delta_\alpha = out_\alpha\ (1 - out_\alpha)\ (Target_\alpha - out_\alpha)$$
$$\delta_\beta = out_\beta\ (1 - out_\beta)\ (Target_\beta - out_\beta)$$

2. Change output layer weights

$$W^{+}_{A\alpha} = W_{A\alpha} + \eta\delta_\alpha\, out_A \qquad W^{+}_{A\beta} = W_{A\beta} + \eta\delta_\beta\, out_A$$
$$W^{+}_{B\alpha} = W_{B\alpha} + \eta\delta_\alpha\, out_B \qquad W^{+}_{B\beta} = W_{B\beta} + \eta\delta_\beta\, out_B$$
$$W^{+}_{C\alpha} = W_{C\alpha} + \eta\delta_\alpha\, out_C \qquad W^{+}_{C\beta} = W_{C\beta} + \eta\delta_\beta\, out_C$$

3. Calculate (back-propagate) hidden layer errors

$$\delta_A = out_A\ (1 - out_A)\ (\delta_\alpha W_{A\alpha} + \delta_\beta W_{A\beta})$$
$$\delta_B = out_B\ (1 - out_B)\ (\delta_\alpha W_{B\alpha} + \delta_\beta W_{B\beta})$$
$$\delta_C = out_C\ (1 - out_C)\ (\delta_\alpha W_{C\alpha} + \delta_\beta W_{C\beta})$$

4. Change hidden layer weights

$$W^{+}_{\lambda A} = W_{\lambda A} + \eta\delta_A\, in_\lambda \qquad W^{+}_{\Omega A} = W^{+}_{\Omega A} + \eta\delta_A\, in_\Omega$$
$$W^{+}_{\lambda B} = W_{\lambda B} + \eta\delta_B\, in_\lambda \qquad W^{+}_{\Omega B} = W^{+}_{\Omega B} + \eta\delta_B\, in_\Omega$$
$$W^{+}_{\lambda C} = W_{\lambda C} + \eta\delta_C\, in_\lambda \qquad W^{+}_{\Omega C} = W^{+}_{\Omega C} + \eta\delta_C\, in_\Omega$$