Quiz 8

**Problem.** Consider the following neuron network, which includes 3 input neurons, 2 hidden neurons and 1 output neurons.

Diagram

Description automatically generated

The expected output value is 1. The learning rate is 0.9

Knowing that the actual output at some neuron *j* is calculated as follows.

𝑛

𝑦𝑗(𝑝) = sigmoid[∑𝑥𝑖(𝑝) × 𝑤𝑖𝑗(𝑝) + 𝜃𝑗]

𝑖=1

where *n* is the number of inputs of neuron *j*,𝑤𝑖𝑗 is the corresponding link from a neuron *i* in the previous layer to neuron *j*, and 𝜃𝑗 is the bias at neuron *j*.

Present all calculations required to perform the backpropagation once (i.e., one forward pass and one backward pass) on the given neural network in the following cases

Step 1 – Initialization

Step 2 – Activation

At iteration p:

* Calculate the actual output from n=3 inputs of neuron j in the hidden layer:
* Calculate the actual output from k=2 inputs of neuron m in the hidden layer:

Step 3 – Weight Training:

The output layer:

* Calculate the error gradient for neuron k in the output layer:
* Calculate the weight corrections:
* Update the weights at the output neurons:

The hidden layer:

* Calculate the error gradient for neuron j in the hidden layer:
* Calculate the weight corrections:
* Update the weights at the hidden neurons:

a) Ignore all biases *(precision to 3 decimal places).*

# Ignore all biases – Forward

|  |  |
| --- | --- |
| Output at neuron 4 | 0.426 |
| Output at neuron 5 | 0.475 |
| Output at neuron 6 | 0.527 |

# Ignore all biases – Backward

|  |  |
| --- | --- |
| Error gradient at neuron 6 | 0.118 |
| Error gradient at neuron 5 | -0.006 |

|  |  |
| --- | --- |
| Error gradient at neuron 4 | -0.009 |
| Update w46 | -0.255 |
| Update w56 | -0.150 |
| Update w14 | 0.192 |
| Update w15 | -0.305 |
| Update w24 | 0.400 |
| Update w25 | 0.100 |
| Update w34 | -0.508 |
| Update w35 | 0.195 |

b) Consider all biases such that each bias is treated as a neuron and thus it will be also updated *(precision to 3 decimal places).*

# (Consider all biases – Forward

|  |  |
| --- | --- |
| Output at neuron 4 | 0.332 |
| Output at neuron 5 | 0.525 |
| Output at neuron 6 | 0.552 |

# Consider all biases – Backward

|  |  |
| --- | --- |
| Error gradient at neuron 6 | 0.111 |
| Error gradient at neuron 5 | -0.006 |
| Error gradient at neuron 4 | -0.007 |
| Update w46 | -0.267 |
| Update w56 | -0.148 |
| Update w14 | 0.193 |
| Update w15 | -0.305 |
| Update w24 | 0.400 |
| Update w25 | 0.100 |
| Update w34 | -0.507 |
| Update w35 | 0.195 |
| Update bias 6 | -0.407 |
| Update bias 5 | 0.195 |
| Update bias 4 | 0.200 |

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