

## A Three Layer Example: Working on Output Layer

In this lesson, we will work on the last and final layer, i.e., the Output Layer and calculate the final outputs of our Neural Network.

Let's crack on and calculate the combined moderated input into the final layer  $X = W.I$  just as we did before in the last two lessons. The inputs into this layer are the outputs from the second layer we just worked out  $O_{hidden}$ . And the weights are those for the links between the second and third layers  $W_{hidden\_output}$ , not those we just used between the first and second. So we have:

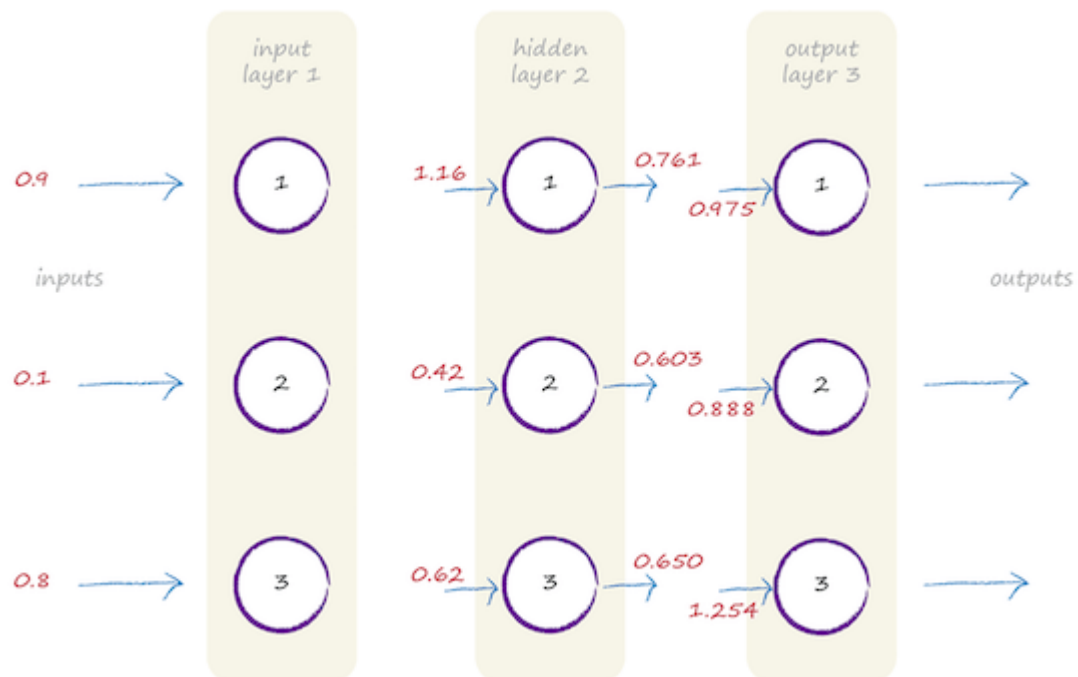
$$X_{output} = W_{hidden\_output} \cdot O_{hidden}$$

So working this out just in the same way gives the following result for the combined moderated inputs into the final output layer.

$$X_{output} = \begin{pmatrix} 0.3 & 0.7 & 0.5 \\ 0.6 & 0.5 & 0.2 \\ 0.8 & 0.1 & 0.9 \end{pmatrix} \cdot \begin{pmatrix} 0.761 \\ 0.603 \\ 0.650 \end{pmatrix}$$

$$X_{output} = \begin{pmatrix} 0.975 \\ 0.888 \\ 1.254 \end{pmatrix}$$

The updated diagram now shows our progress feeding forward the signal from the initial input right through to the combined inputs to the final layer.

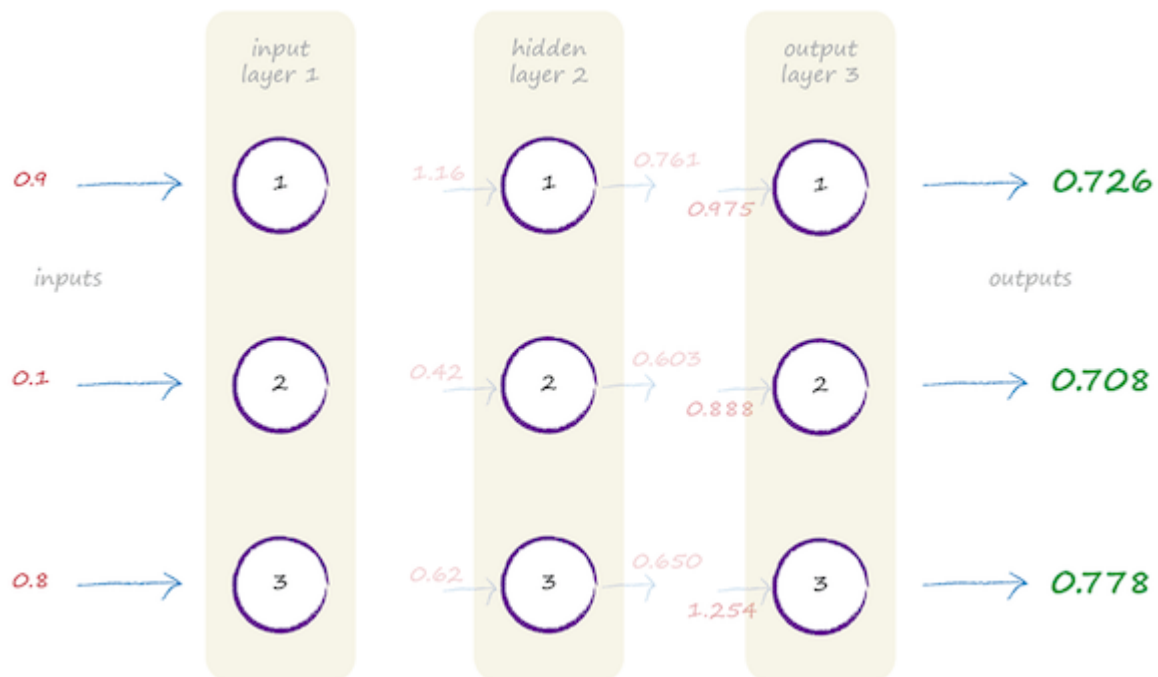


All that remains is to apply the sigmoid activation function, which is easy.

$$O_{\text{output}} = \text{sigmoid} \begin{pmatrix} 0.975 \\ 0.888 \\ 1.254 \end{pmatrix}$$

$$O_{\text{output}} = \begin{pmatrix} 0.726 \\ 0.708 \\ 0.778 \end{pmatrix}$$

That's it! We have the final outputs of the neural network. Let's show this in the diagram too.



So the final output of the example neural network with three layers is 0.726, 0.708 and 0.778. We have successfully followed the signal from its initial entry into the neural network, through the layers, and out of the final output layer. What now?

The next step is to use the output from the neural network and compare it with the training example to work out an error. We need to use that error to refine the neural network itself so that it improves its outputs. This is probably the most difficult thing to understand, so we'll take it gently and illustrate the ideas as we go.