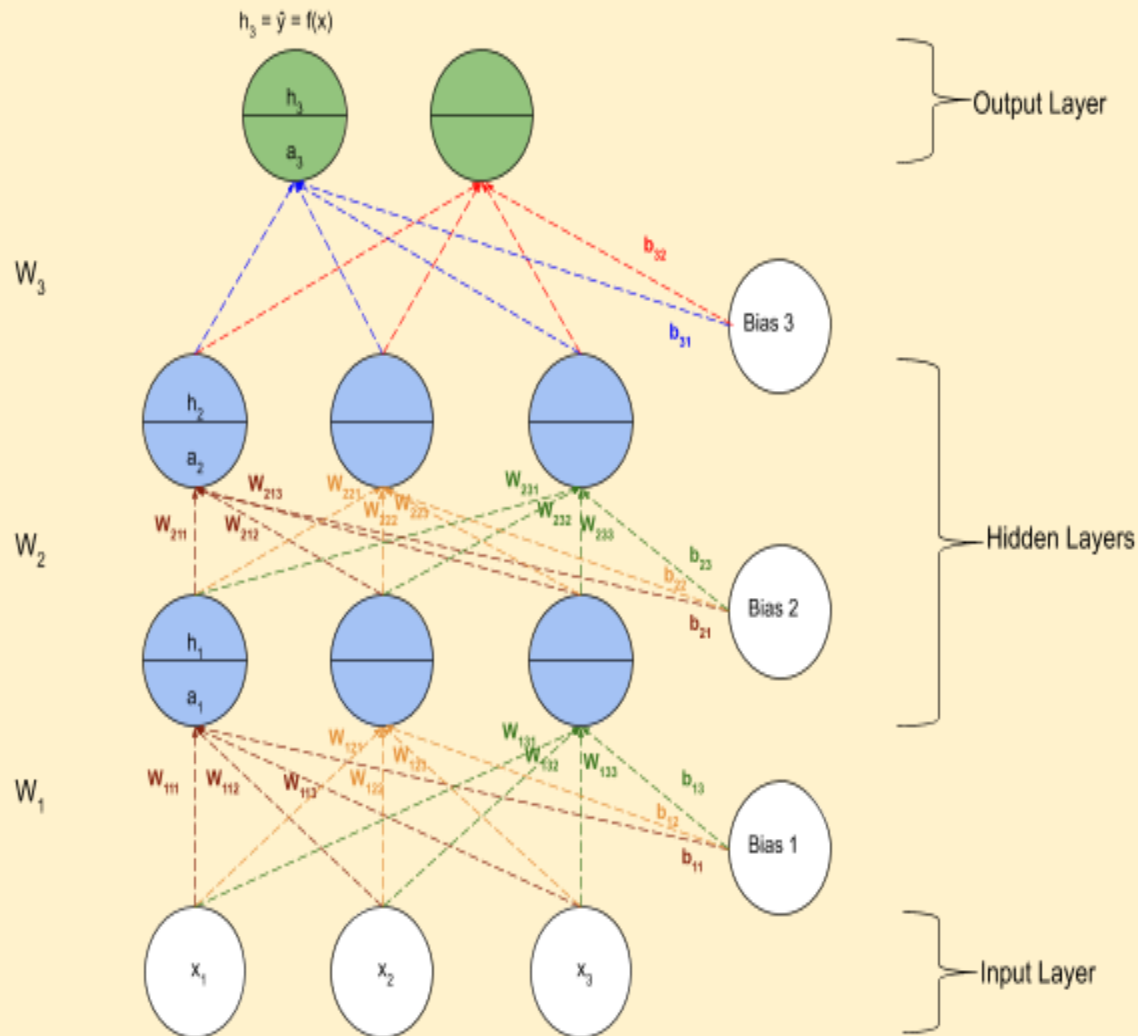


### Understanding the Computations in a Deep Neural Network

Let's look at the computations inside a DNN

1. Consider the same DNN drawn in the previous section



2. The preactivation outputs for the first layer  $a_{11}$ ,  $a_{12}$ ,  $a_{13}$ , are calculated using simple Matrix-vector multiplication

$$W_1 = \begin{bmatrix} w_{111} & w_{112} & w_{113} \\ w_{121} & w_{122} & w_{123} \\ w_{131} & w_{132} & w_{133} \end{bmatrix} \quad X = \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$

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3. Here, the preactivation values are as follows

a.  $a_{11} = w_{111} * x_1 + w_{112} * x_2 + w_{113} * x_3 + b_{11}$

b.  $a_{12} = w_{121} * x_1 + w_{122} * x_2 + w_{123} * x_3 + b_{12}$

c.  $a_{13} = w_{131} * x_1 + w_{132} * x_2 + w_{133} * x_3 + b_{13}$

d. These values are just the individual rows of the dot-product between  $W_1$  and  $X$  plus the bias vector

e. Thus  $W_1 X = a_1$  is given by

$$a_1 = \begin{bmatrix} a_{11} \\ a_{12} \\ a_{13} \end{bmatrix}$$

f. Here,  $W_1 \in \mathbb{R}^{3 \times 3}$ ,  $X \in \mathbb{R}^{3 \times 1}$ , and  $W_1 X \in \mathbb{R}^{3 \times 1}$

g.  $a_i = W_i$

4. The activation values are as follows

a.  $h_i = g(a_i)$

b. They are simply the result on applying the activation function (in this case: sigmoid) on the preactivated values

c.  $h_{11} = \frac{1}{1+e^{-(a_{11})}}$

d.  $h_{12} = \frac{1}{1+e^{-(a_{12})}}$

e.  $h_{13} = \frac{1}{1+e^{-(a_{13})}}$