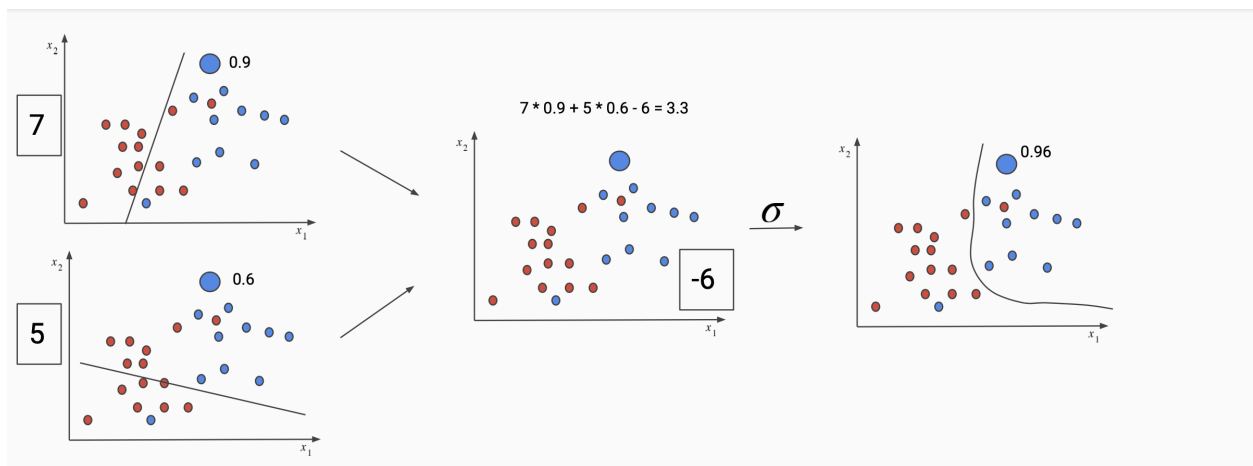


Deep Learning

Perceptron

- <https://www.ling.upenn.edu/courses/cogs501/Rosenblatt1958.pdf>

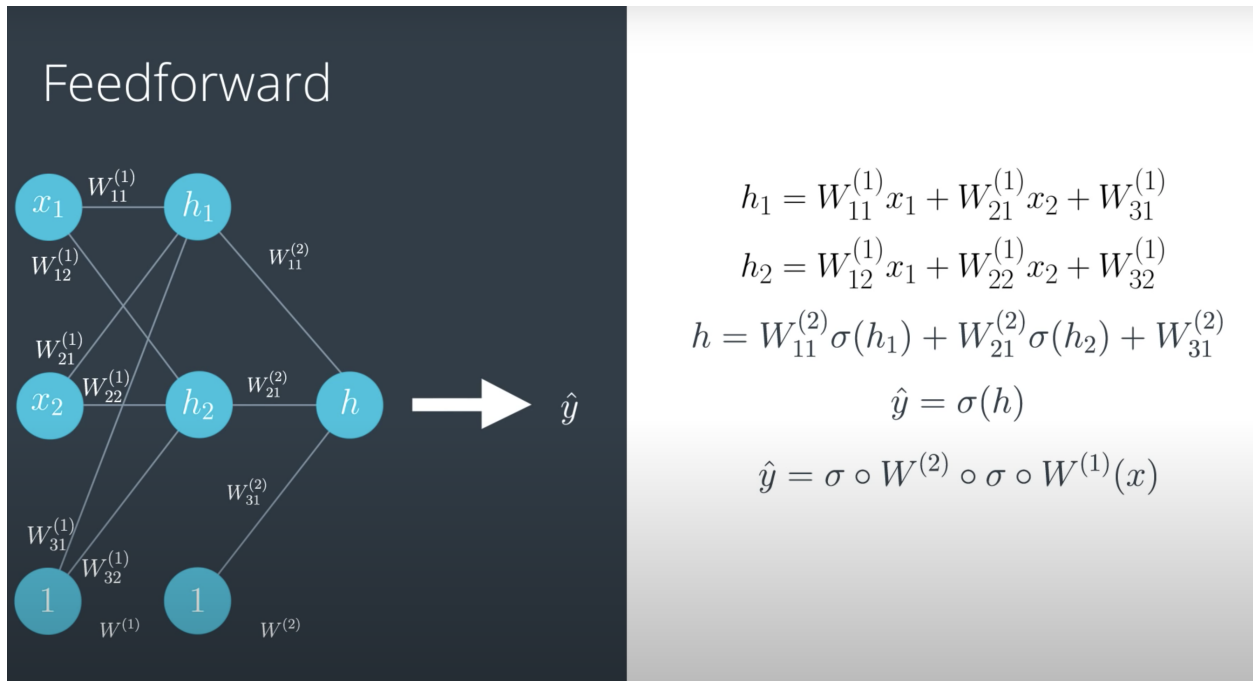
Intuition



Neural Networks Zoo

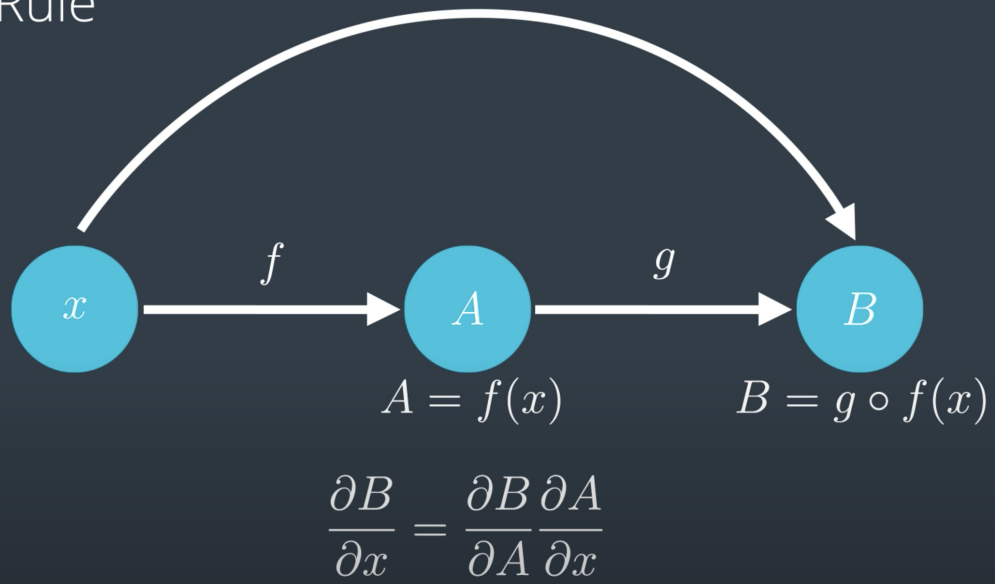
- <https://www.asimovinstitute.org/neural-network-zoo/>

Feed forward

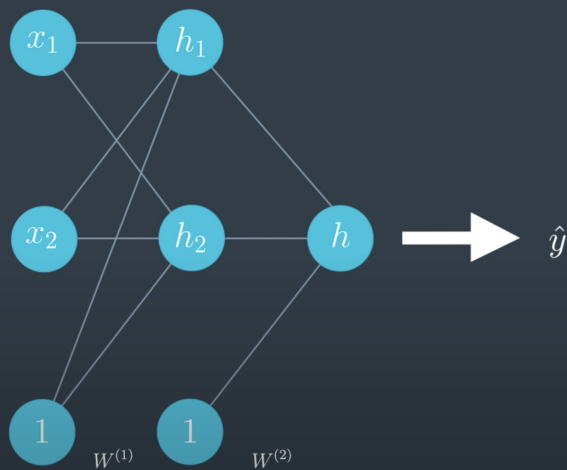


Back propagation

Chain Rule



Backpropagation



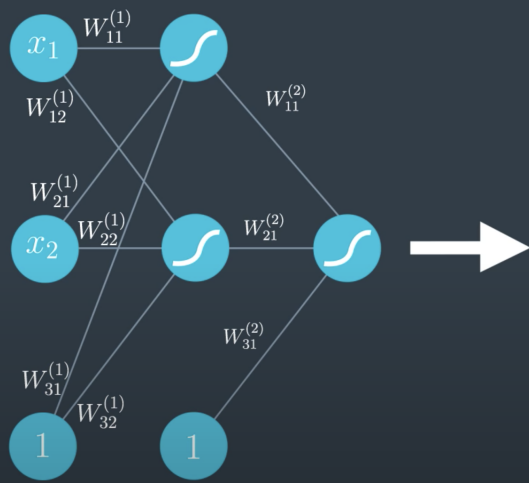
$$E(W) = -\frac{1}{m} \sum_{i=1}^m y_i \ln(\hat{y}_i) + (1 - y_i) \ln(1 - \hat{y}_i)$$

$$E(W) = E(W_{11}^{(1)}, W_{12}^{(1)}, \dots, W_{31}^{(2)})$$

$$\nabla E = \left(\frac{\partial E}{\partial W_{11}^{(1)}}, \dots, \frac{\partial E}{\partial W_{31}^{(2)}} \right)$$

$$\frac{\partial E}{\partial W_{11}^{(1)}} = \frac{\partial E}{\partial \hat{y}} \frac{\partial \hat{y}}{\partial h} \frac{\partial h}{\partial h_1} \frac{\partial h_1}{\partial W_{11}^{(1)}}$$

Backpropagation



$$\hat{y} = \sigma W^{(2)} \circ \sigma \circ W^{(1)}(x)$$

$$W^{(1)} = \begin{pmatrix} W_{11}^{(1)} & W_{12}^{(1)} \\ W_{21}^{(1)} & W_{22}^{(1)} \\ W_{31}^{(1)} & W_{32}^{(1)} \end{pmatrix} \quad W^{(2)} = \begin{pmatrix} W_{11}^{(2)} \\ W_{21}^{(2)} \\ W_{31}^{(2)} \end{pmatrix}$$

$$\nabla E = \begin{pmatrix} \frac{\partial E}{\partial W_{11}^{(1)}} & \frac{\partial E}{\partial W_{12}^{(1)}} & \frac{\partial E}{\partial W_{11}^{(2)}} \\ \frac{\partial E}{\partial W_{21}^{(1)}} & \frac{\partial E}{\partial W_{22}^{(1)}} & \frac{\partial E}{\partial W_{21}^{(2)}} \\ \frac{\partial E}{\partial W_{31}^{(1)}} & \frac{\partial E}{\partial W_{32}^{(1)}} & \frac{\partial E}{\partial W_{31}^{(2)}} \end{pmatrix}$$

$$W_{ij}'^{(k)} \leftarrow W_{ij}^{(k)} - \alpha \frac{\partial E}{\partial W_{ij}^{(k)}}$$

Derivatives

<https://betterexplained.com/articles/calculus-building-intuition-for-the-derivative/>