

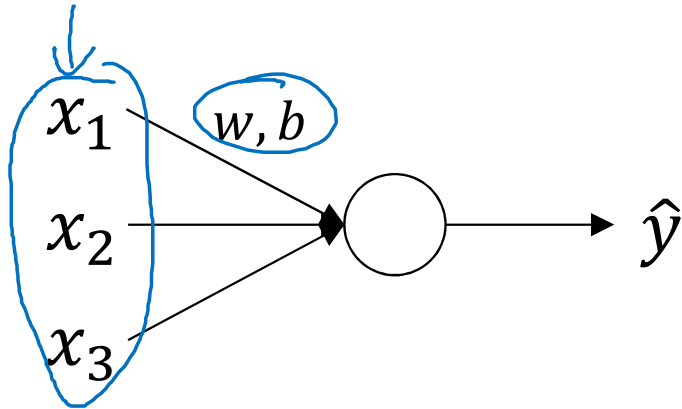


deeplearning.ai

Batch Normalization

Normalizing activations
in a network

Normalizing inputs to speed up learning

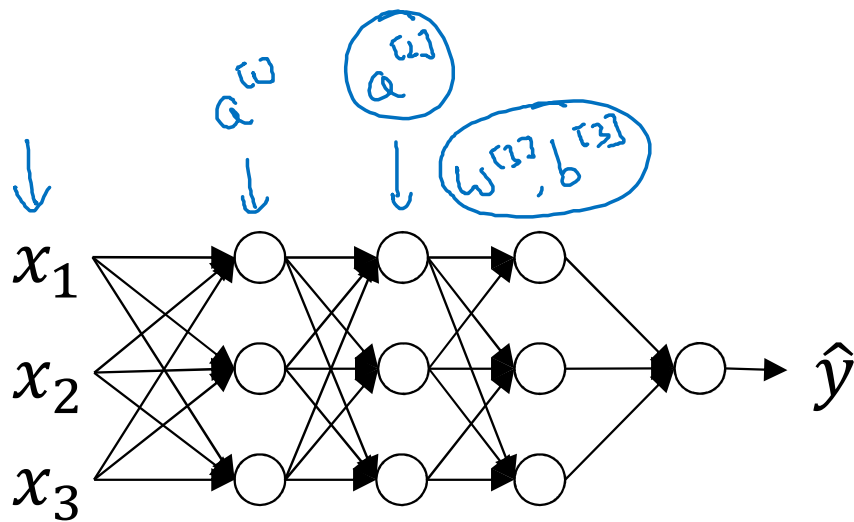
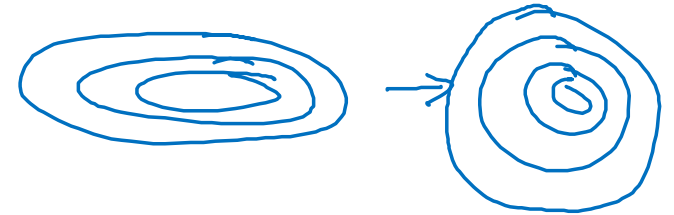


$$\mu = \frac{1}{n} \sum_i x^{(i)}$$

$$X = X - \mu$$

$$\sigma^2 = \frac{1}{n} \sum_i x^{(i)2} \quad \leftarrow \text{element-wise}$$

$$X = X / \sigma^2$$



Can we normalize $\frac{a^{[2]}}{w^{[2]}, b^{[2]}}$ so as to train faster

Normalize $z^{[2]}$

Implementing Batch Norm

Given some intermediate values in NN

$z^{(1)}, \dots, z^{(m)}$
 $z^{[l]}(i)$

$$\begin{aligned} \mu &= \frac{1}{m} \sum_i z^{(i)} \\ \sigma^2 &= \frac{1}{m} \sum_i (z^{(i)} - \mu)^2 \\ z_{\text{norm}}^{(i)} &= \frac{z^{(i)} - \mu}{\sqrt{\sigma^2 + \epsilon}} \\ \hat{z}^{(i)} &= \gamma z_{\text{norm}}^{(i)} + \beta \end{aligned}$$

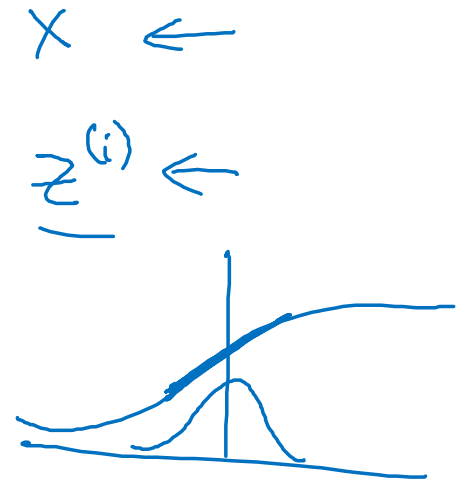
If

$$\gamma = \sqrt{\sigma^2 + \epsilon}$$

$$\beta = \mu$$

then $\hat{z}^{(i)} = z^{(i)}$

learnable parameters of model.



Use $\hat{z}^{[l]}(i)$ instead of $z^{[l]}(i)$.