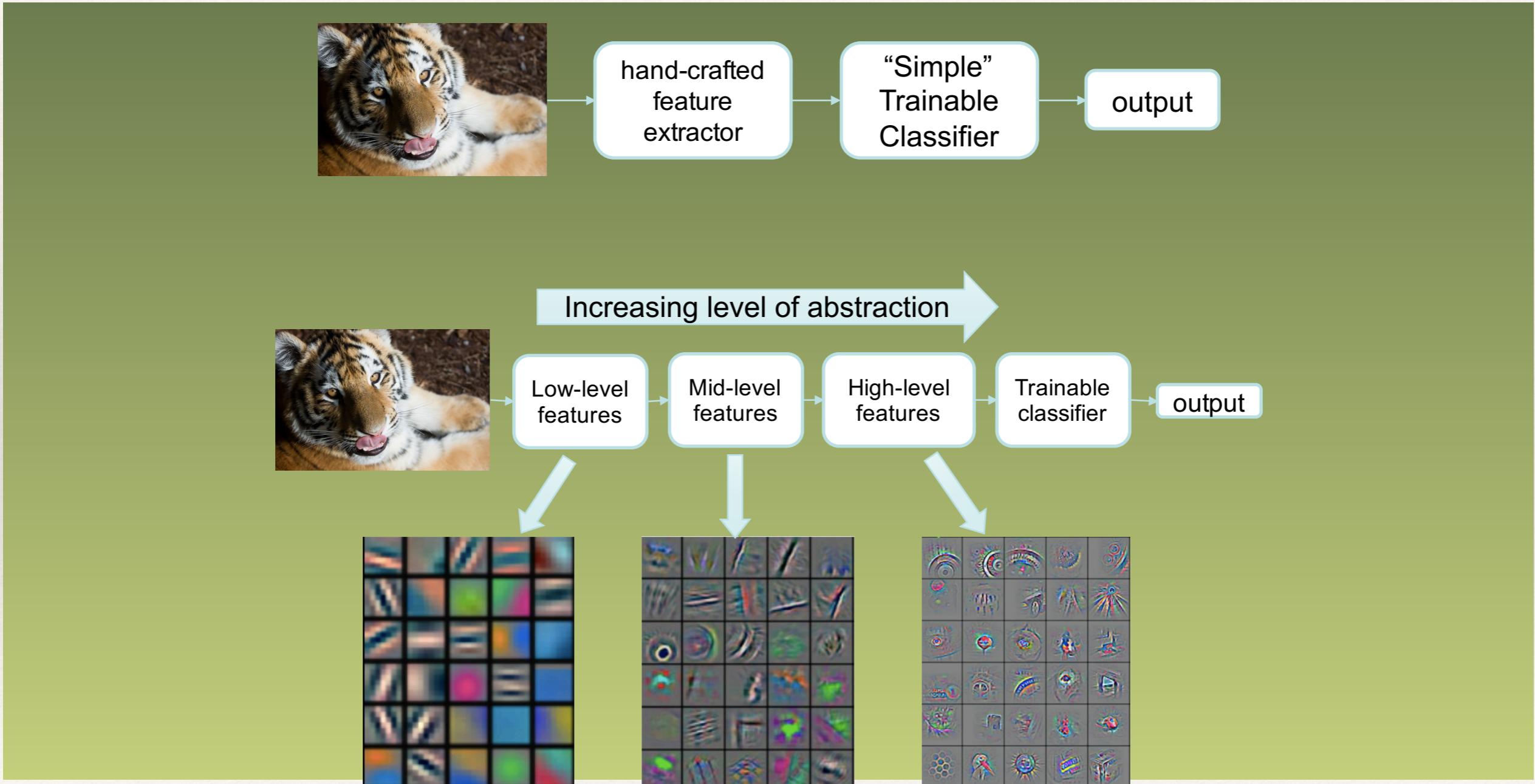


SML

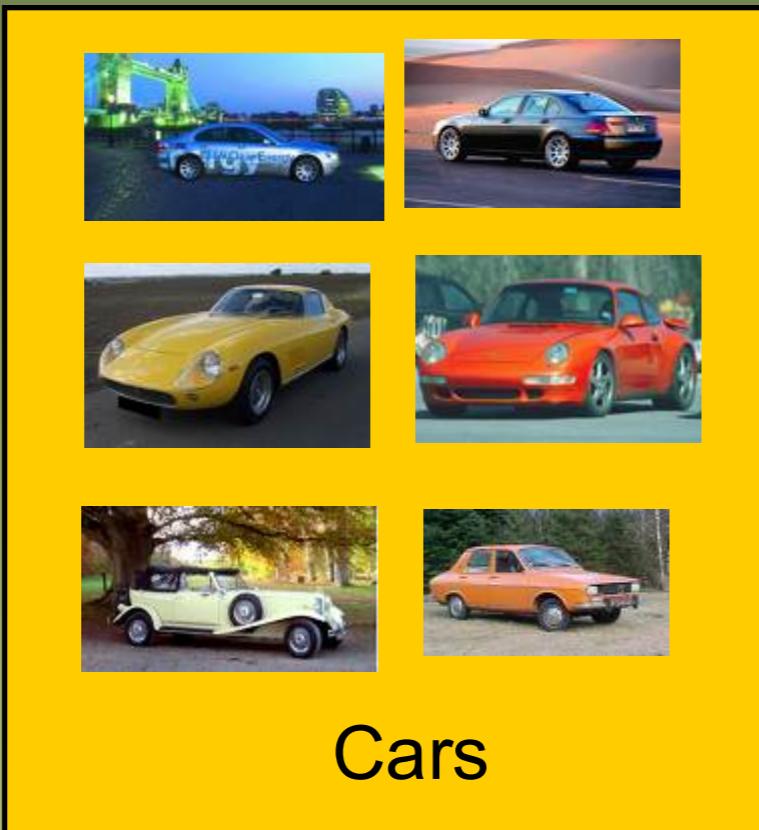
Autoencoder

Slides prepared from various
sources

Handcrafted vs Deep Learning



Learning Representations

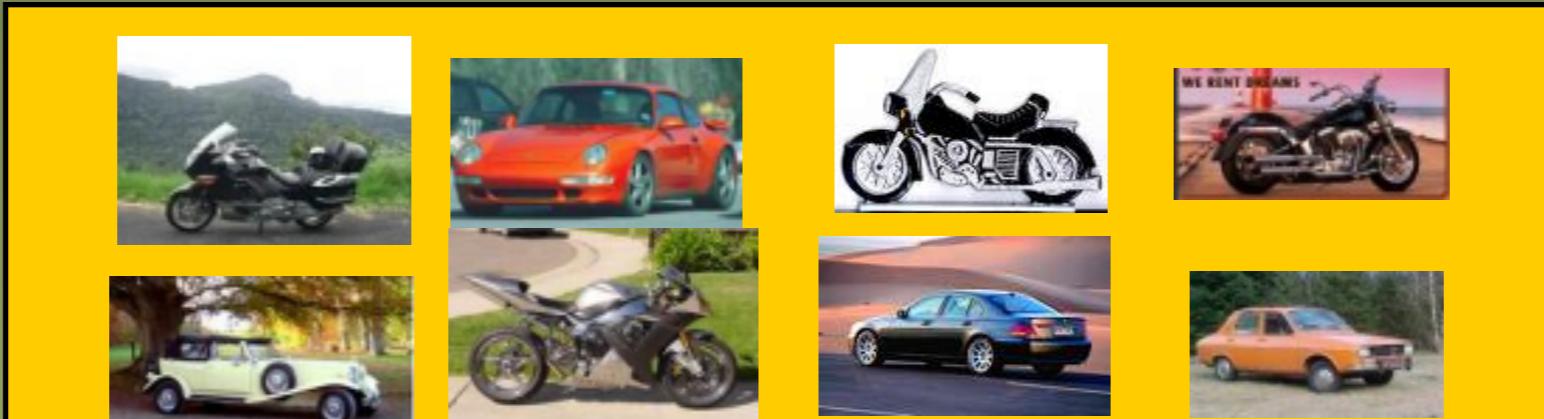


Motorcycles

Testing:
What is this?



Learning Representations



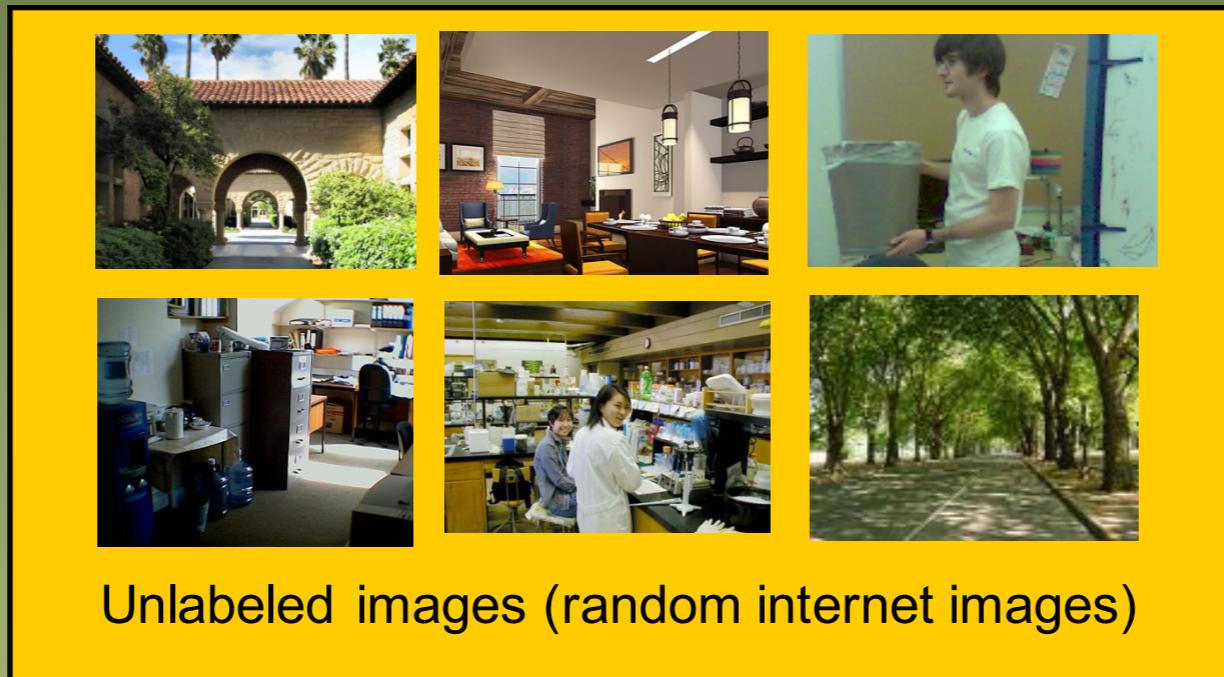
Unlabeled images (all cars/motorcycles)



Testing:
What is this?



Learning Representations



Unlabeled images (random internet images)



Car



Motorcycle

Testing:
What is this?



Multiple Models

- ❖ Most basic one (yet powerful): Autoencoder
- ❖ Similar to PCA
 - ❖ Invented by Pearson (1901) and Hotelling (1933)
 - ❖ First applied in ecology by Goodall (1954) under the name “factor analysis”

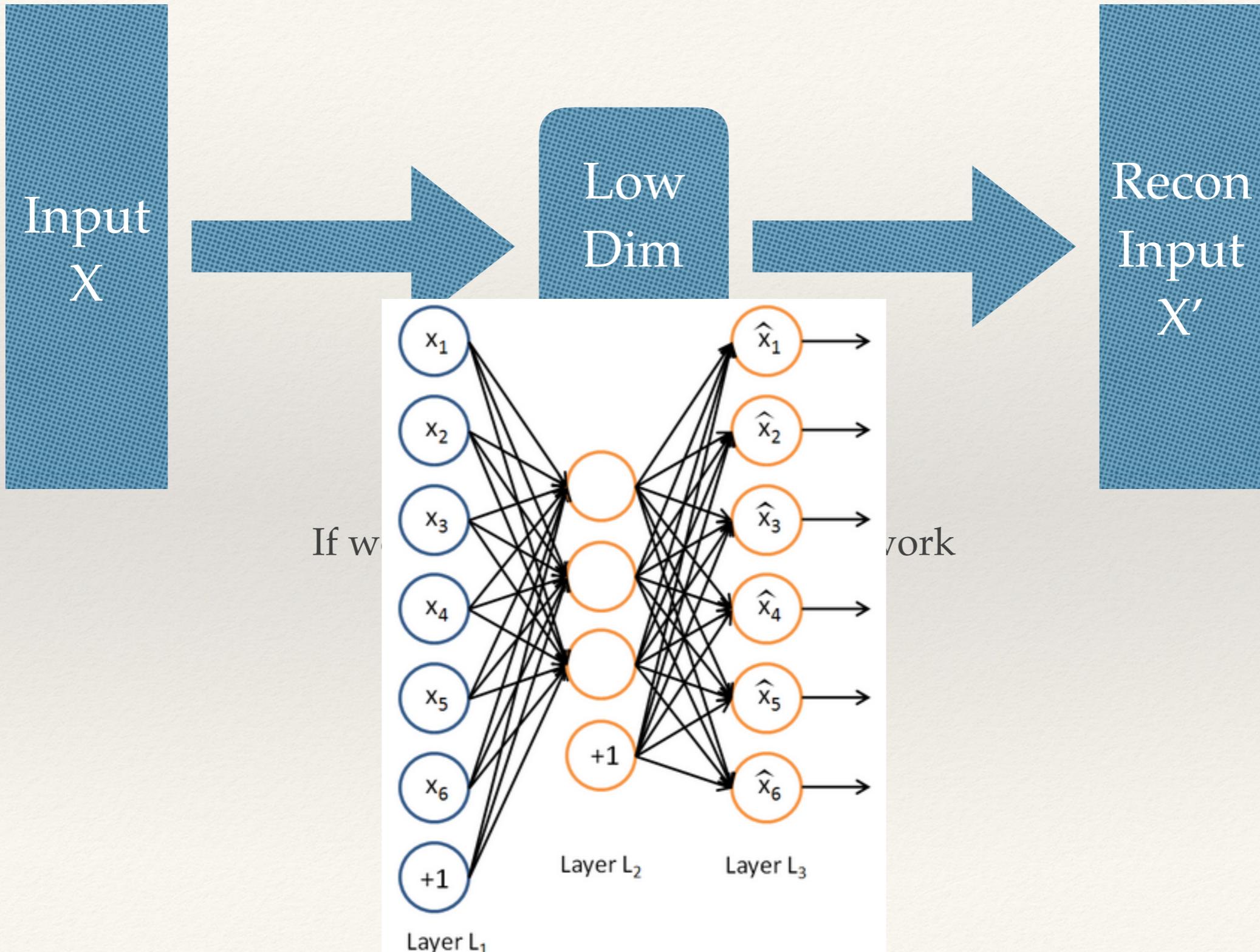
Key Property of PCA



Then,

$$\| \hat{g}_2 - \hat{g}_1 \| \approx \| \hat{x}_2 - \hat{x}_1 \|$$

Now think of PCA in Neural Network



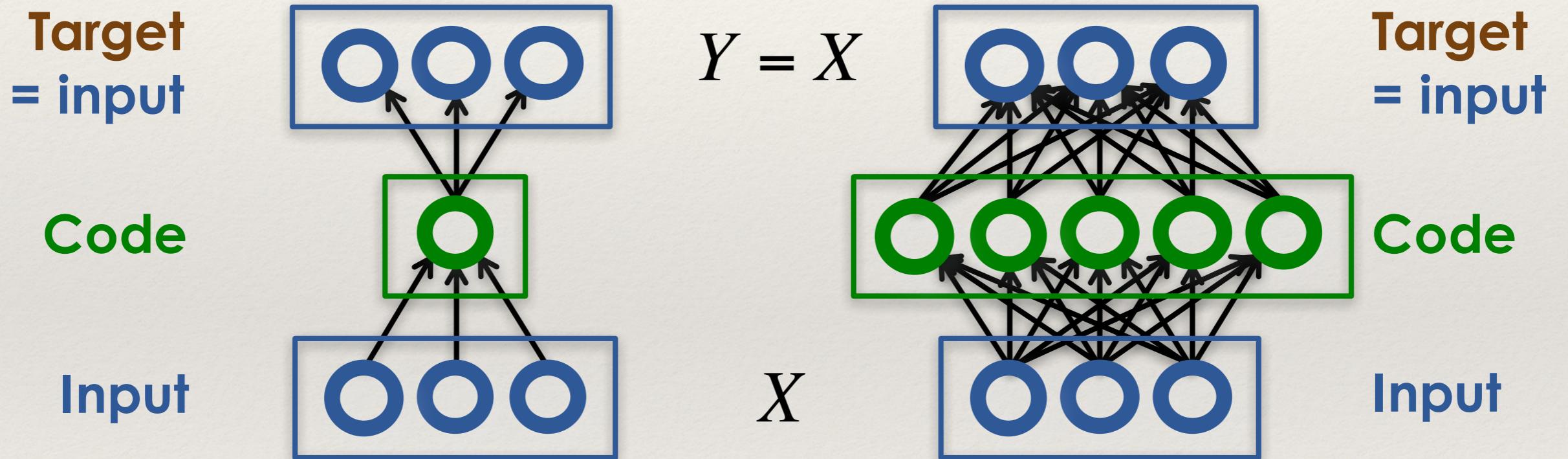
Autoencoder

- ❖ Biological motivation
- ❖ An image of size 28x28 pixels can be represented using a combination of **codes** from a **basis set**



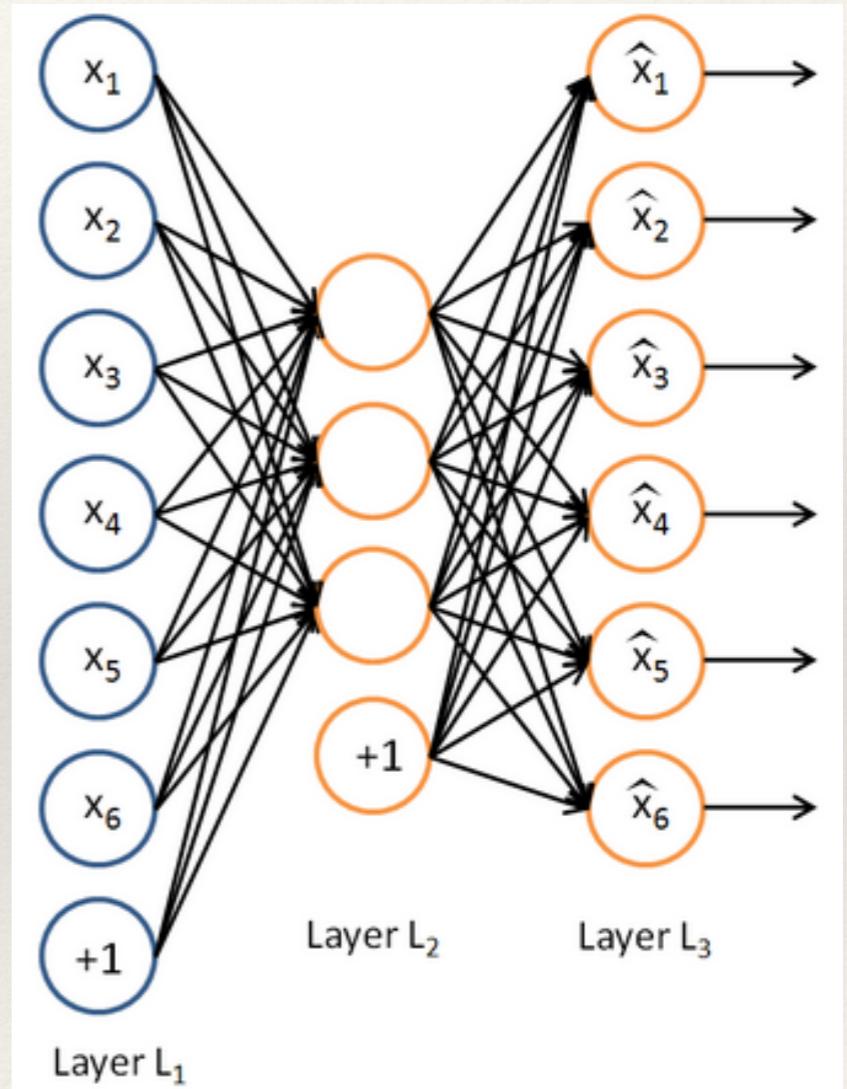
$$\boxed{7} = 1 \boxed{8} + 1 \boxed{7} + 1 \boxed{2} + 1 \boxed{9} + 1 \boxed{2} + 1 \boxed{7} + 1 \boxed{2} + 0.8 \boxed{7} + 0.8 \boxed{7}$$

Key Idea of Autoencoder



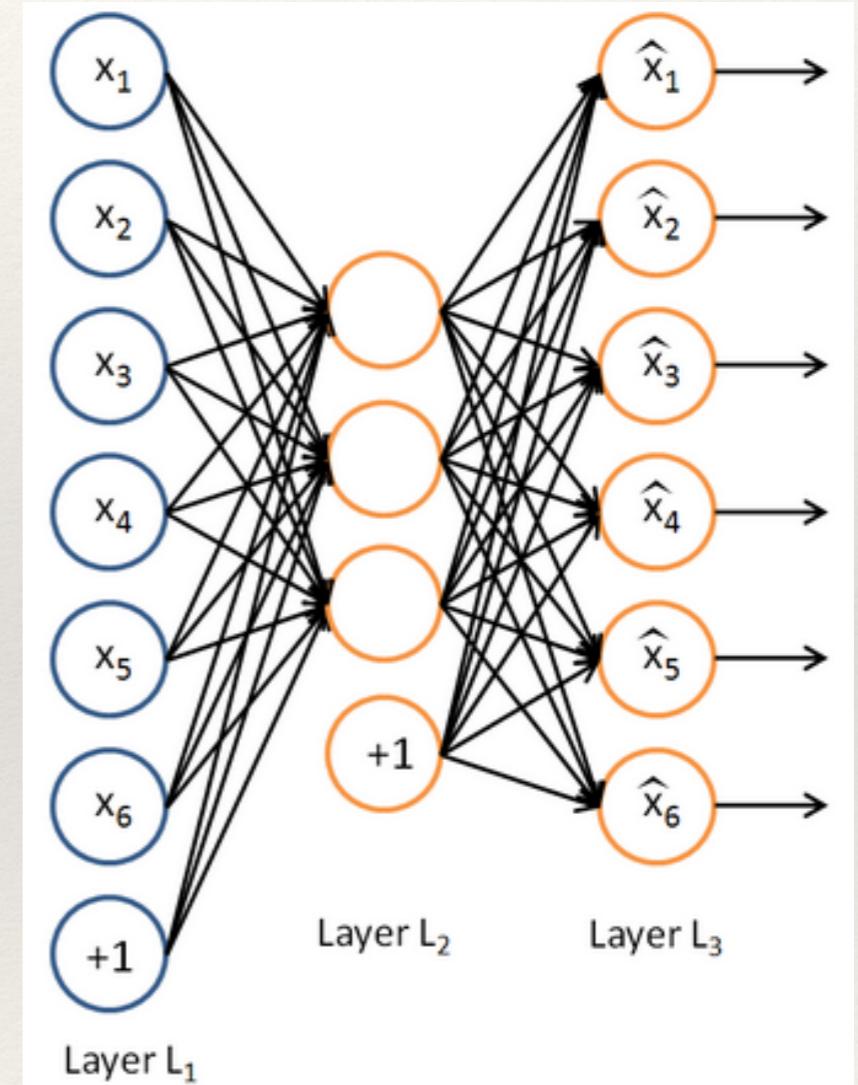
Autoencoder

- ❖ Two parts: encoding and decoding
- ❖ Input layer: raw data X
- ❖ One hidden layer (encoding): feature learner
- ❖ Output layer (decoding): reconstruct X' such that
 - ❖ $\| \| X - X' \| \|^2$ is minimum

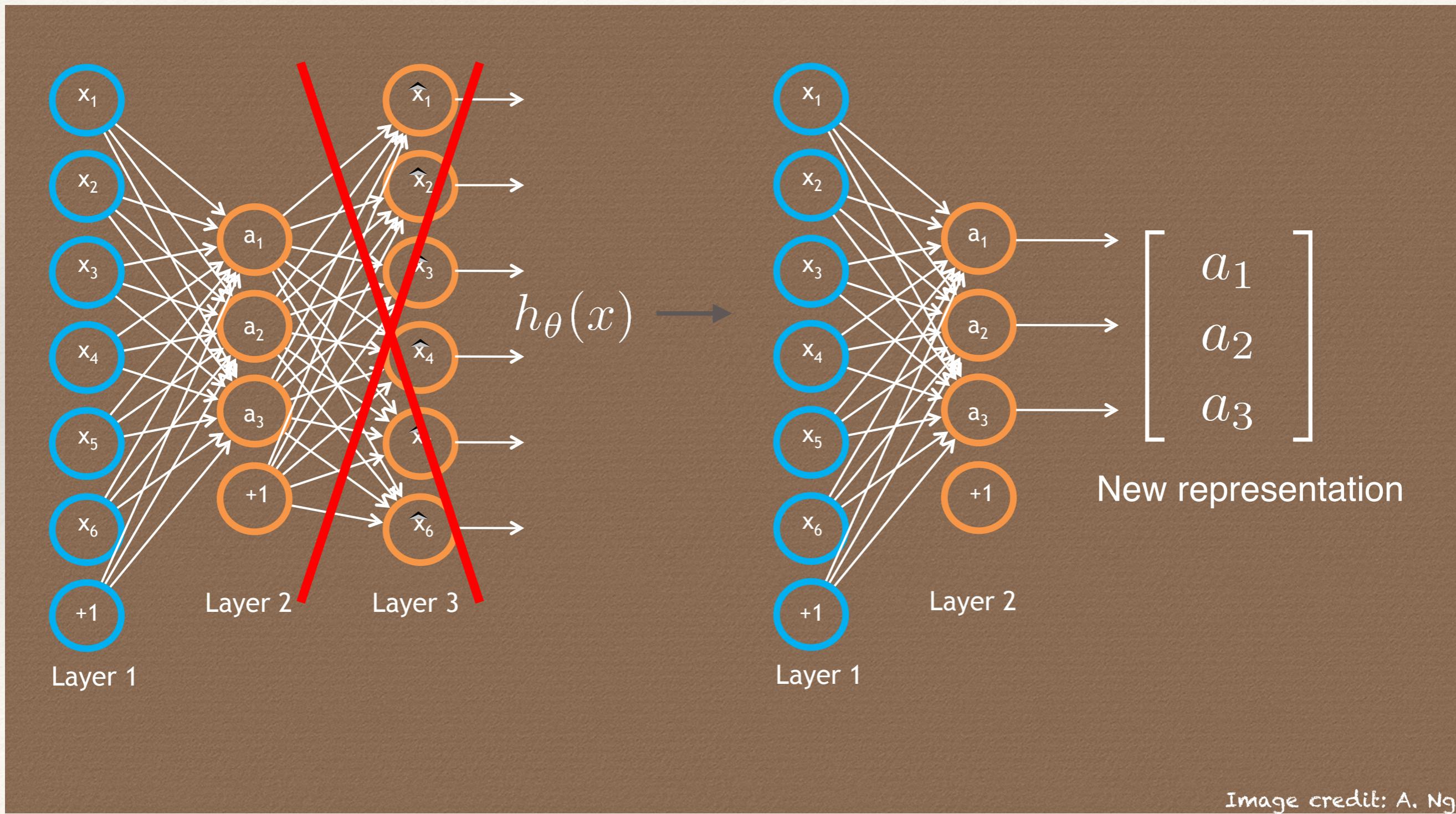


What this network is doing?

- ❖ $h_1 = \sum(w_i^* x_i)$
- ❖ $x_{cap} = \sum(w_{1i}^* h_i)$
- ❖ $x_{cap} = \sum(w_{1i}^* (\sum(w_i^* x_i)))$
- ❖ $\|x - x_{cap}\|_2$



Autoencoders



Autoencoders

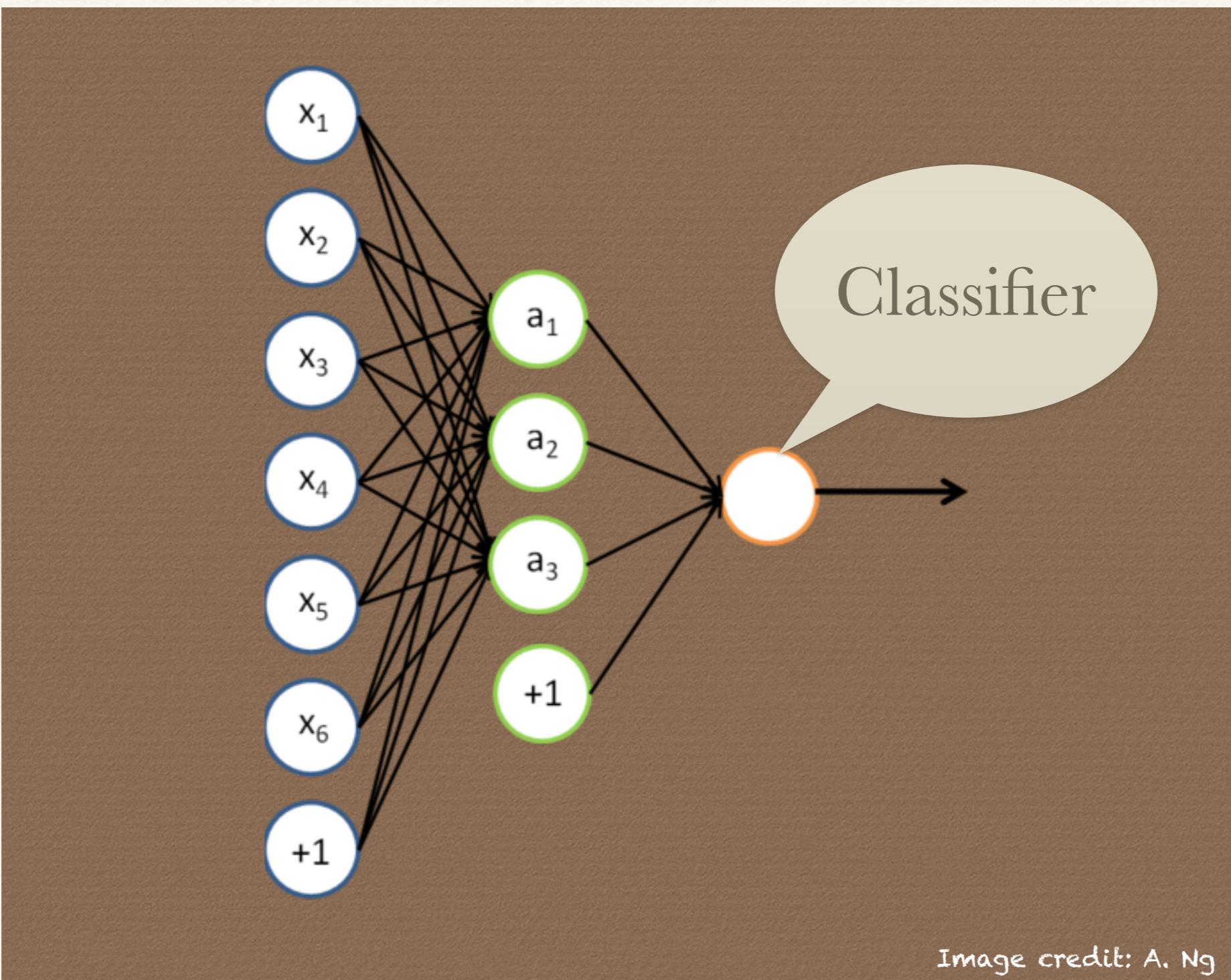
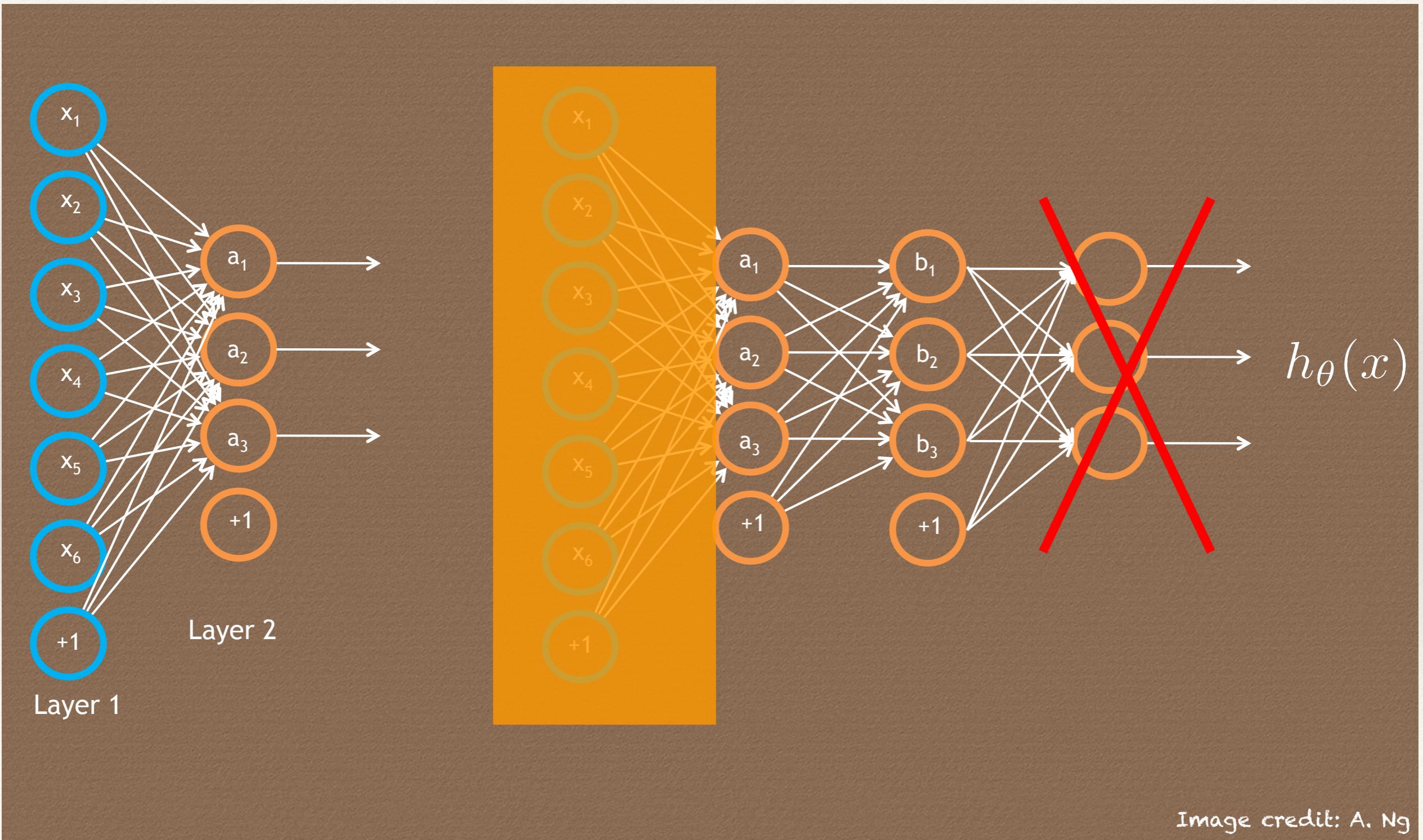
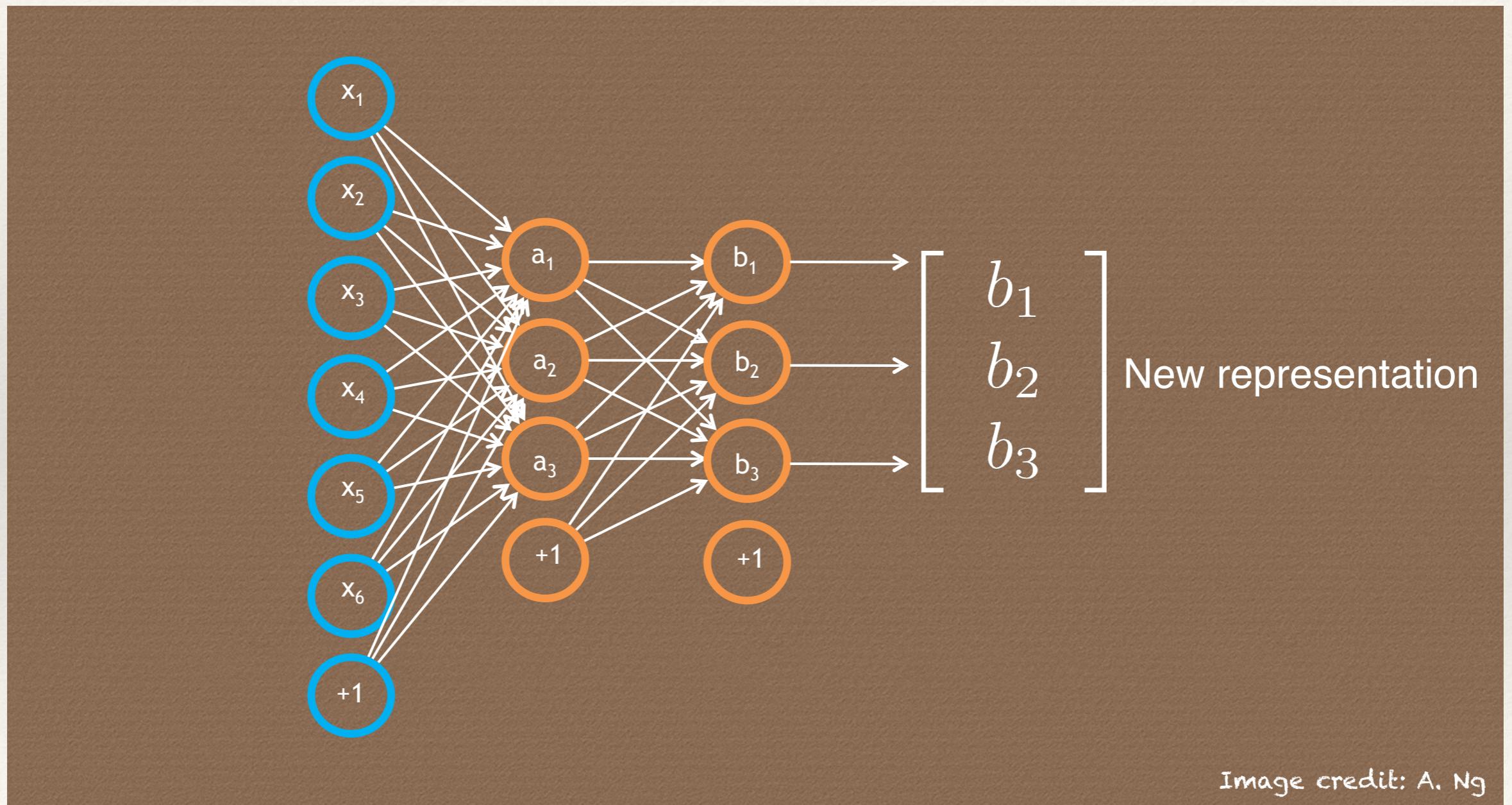


Image credit: A. Ng

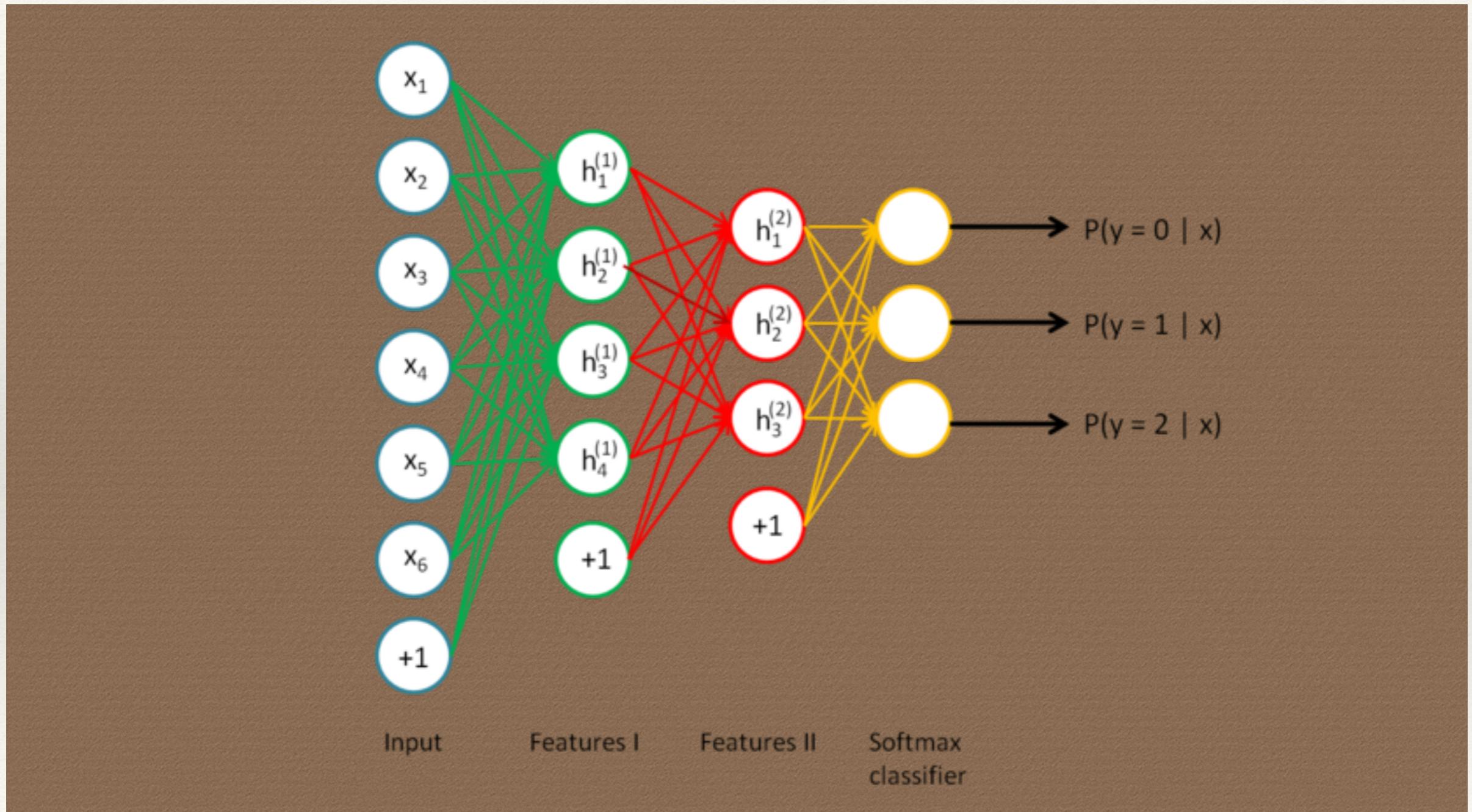
Stacked Autoencoders



Stacked Autoencoders



Stacked Autoencoder for Classification



Today's Summary

