Introduction to neural networks

Deep Neural Networks

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Contents

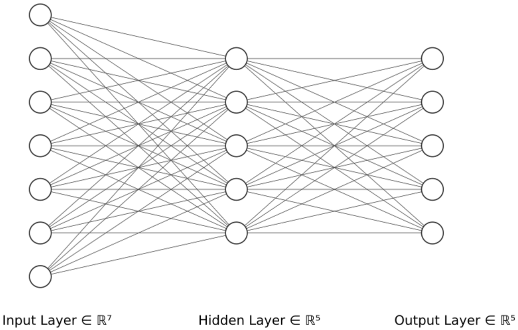
Roadmap

1. Deep fully connected networks

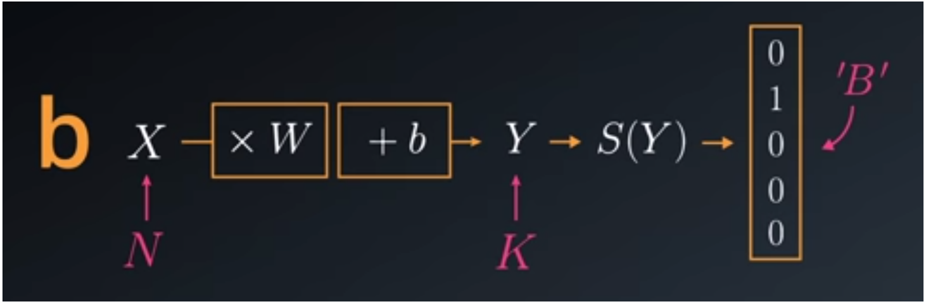
Linear model

- Multinomial regression model

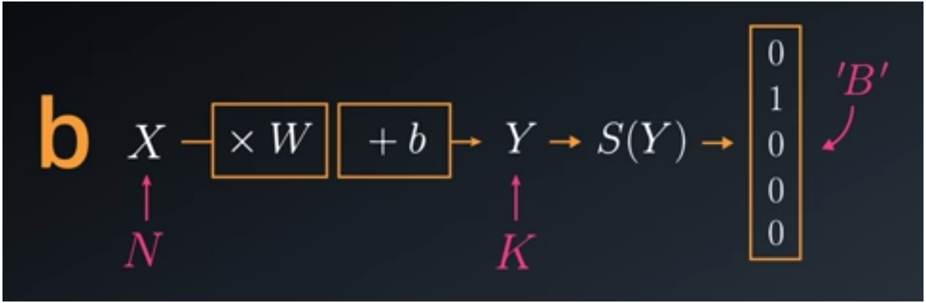
$$X \rightarrow XW + b \rightarrow f(h) \rightarrow Y \rightarrow S(Y) \rightarrow P \tag{1}$$



Linear model complexity



Linear model complexity



- Number of parameters in each layer:

$$f(n, k) = (n + 1)k \tag{2}$$

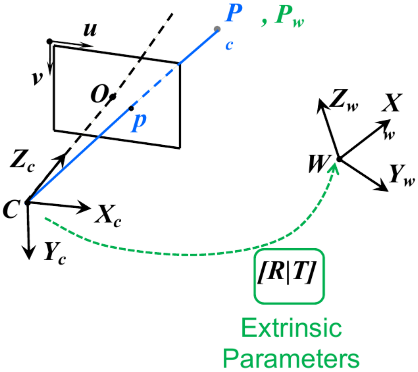
where n is the number of inputs and k the number of outputs.

Linear models advantages

- Efficiency
- Hardware available

GPU

Why are so effective?



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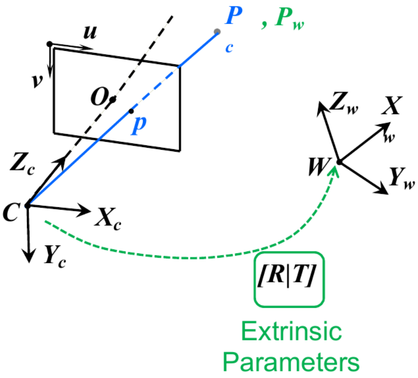

Projection Matrix

$$\lambda \begin{bmatrix} u \\ v \\ 1 \end{bmatrix} = \boxed{K\left[R|T\right]} \begin{bmatrix} X_w \\ Y_w \\ Z_w \\ 1 \end{bmatrix}$$

$$\lambda \begin{bmatrix} u \\ v \\ 1 \end{bmatrix} = \begin{bmatrix} m_{11} & m_{12} & m_{13} & m_{14} \\ m_{21} & m_{22} & m_{23} & m_{24} \\ m_{31} & m_{32} & m_{33} & m_{34} \end{bmatrix} \begin{bmatrix} X_w \\ Y_w \\ Z_w \\ 1 \end{bmatrix}$$

GPU

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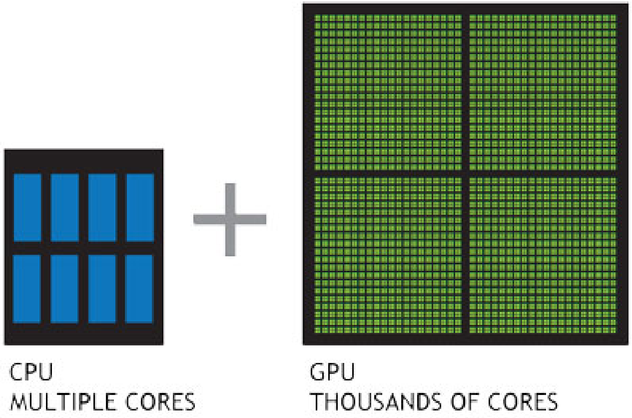

GPU

Linear models disadvantages

- Linear models are restricted to linear combinations!

$$Y = x_1 + x_2 \tag{3}$$

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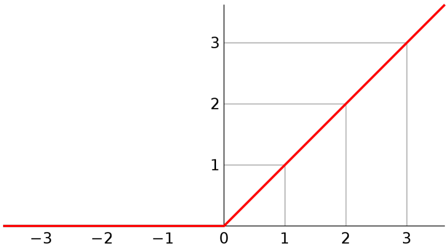
  Activation functions!

ReLU

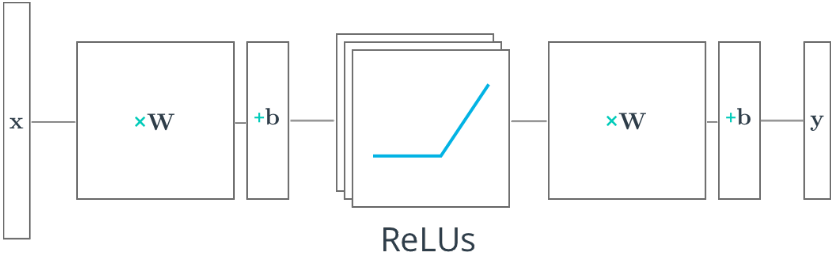
- Rectified linear unit

$$y = max(0, x)$$



- Derivative?

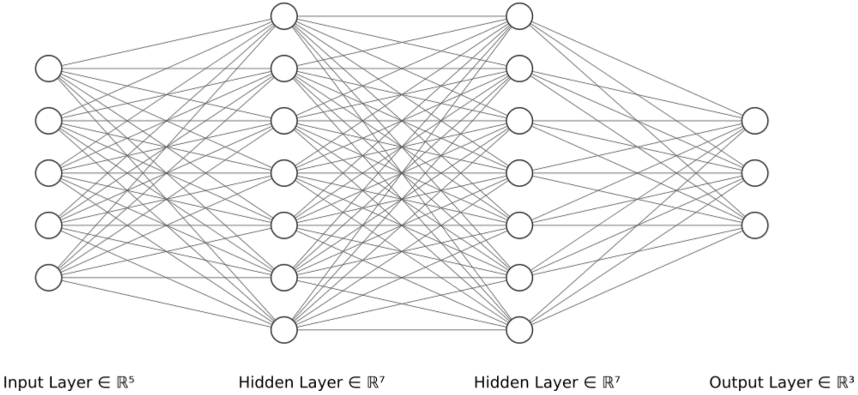
Multilayer Neural Network



- Layer 1: the set of W and b applied to X and passed through ReLUs. The output is fed to the next one, but is not observable outside the network (hidden layer).
- Layer 2: the weights and biases applied to these intermediate outputs, followed by $S(y)$.

Excercises

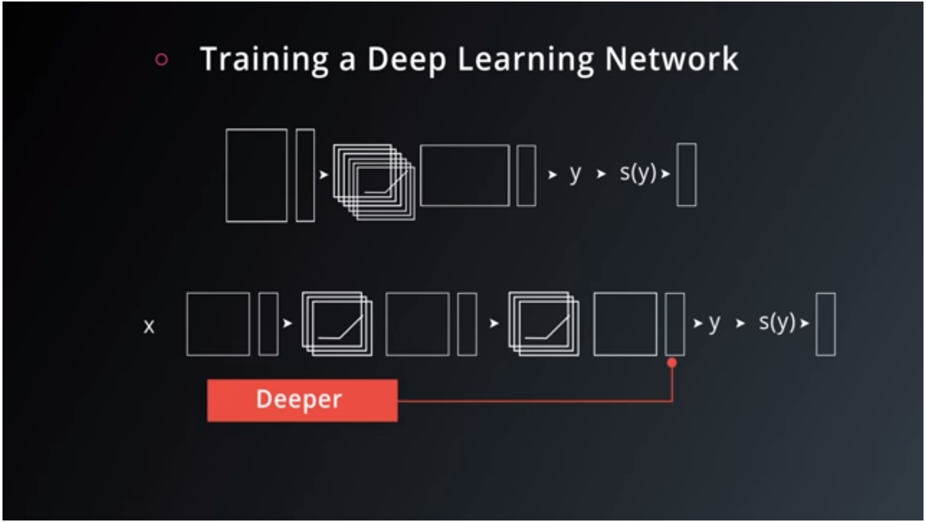
- Determine the amount of weights required in the following network:



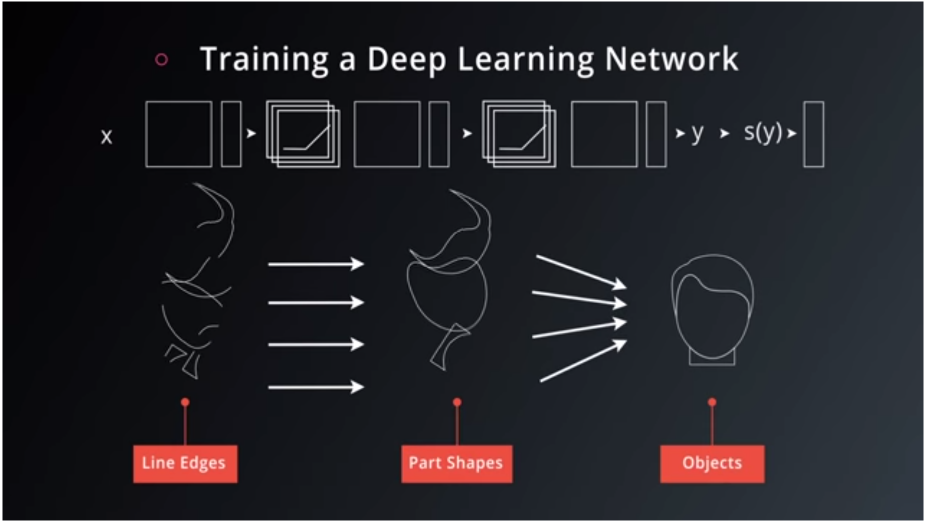
- The chain rule

$$\frac{\partial f(g(x))}{\partial x} = \frac{\partial f}{\partial g}\frac{\partial g}{\partial x} \tag{4}$$

Training a DNN



Training a DNN



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