Introduction to the basics of AI - S7

Z. TAIA-ALAOUI

Outline for today’s course

- Revision Of Deep Learning Principles
- Convolutional Neural Networks
- Implementation

Vocabulary

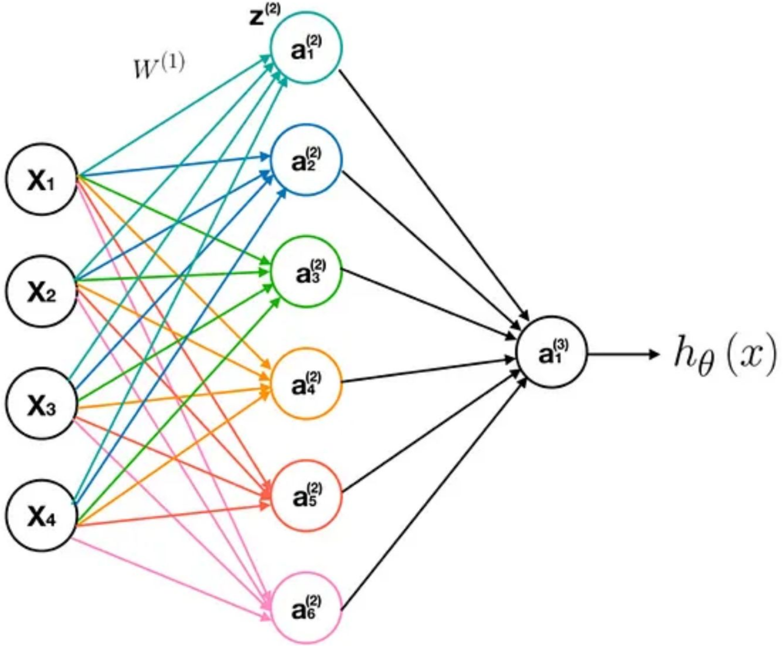
Learning:

A computer program is said to learn from **experience E** with respect to some class of **tasks T** and **performance measure P**, if its performance at tasks in T, as measured by P, improves with experience E. [Tom Mitchell] (link)

Learning

- Forward Propagation

$$W^T X = \begin{bmatrix} \theta_{11}{}^{(1)} & \theta_{12}{}^{(1)} & \theta_{13}{}^{(1)} & \theta_{14}{}^{(1)} \\ \theta_{21}{}^{(1)} & \theta_{22}{}^{(1)} & \theta_{23}{}^{(1)} & \theta_{24}{}^{(1)} \\ \theta_{31}{}^{(1)} & \theta_{32}{}^{(1)} & \theta_{33}{}^{(1)} & \theta_{34}{}^{(1)} \\ \theta_{41}{}^{(1)} & \theta_{42}{}^{(1)} & \theta_{43}{}^{(1)} & \theta_{44}{}^{(1)} \\ \theta_{51}{}^{(1)} & \theta_{52}{}^{(1)} & \theta_{53}{}^{(1)} & \theta_{54}{}^{(1)} \\ \theta_{61}{}^{(1)} & \theta_{62}{}^{(1)} & \theta_{63}{}^{(1)} & \theta_{64}{}^{(1)} \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \\ X_3 \\ X_4 \end{bmatrix} = \begin{bmatrix} z_1{}^{(1)} \\ z_2{}^{(1)} \\ z_3{}^{(1)} \\ z_4{}^{(1)} \\ z_5{}^{(1)} \\ z_6{}^{(1)} \end{bmatrix} = Z^{(2)}$$



Loss Function

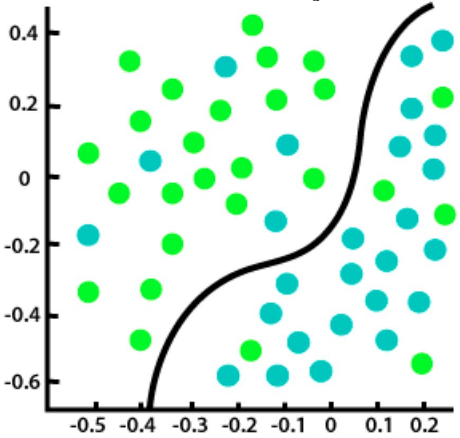
- Output Estimate: $\widehat{y} = \sigma(w^T x + b)$

Mean Absolute Error

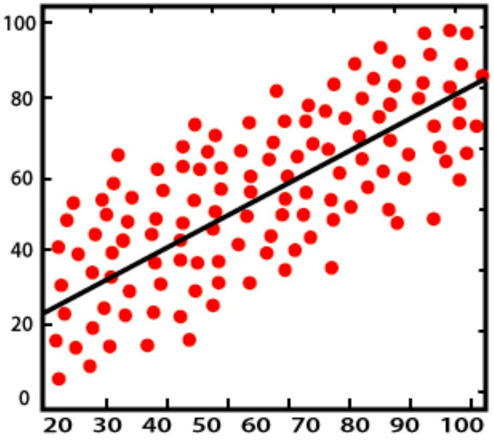
$$MAE = \frac{1}{N}\sum_{i=1}^{N}|y_i - \hat{y}_i|$$

Cross-Entropy

$$H(p,q) = -\sum_i p_i \log q_i = -y\log\hat{y} - (1-y)\log(1-\hat{y})$$



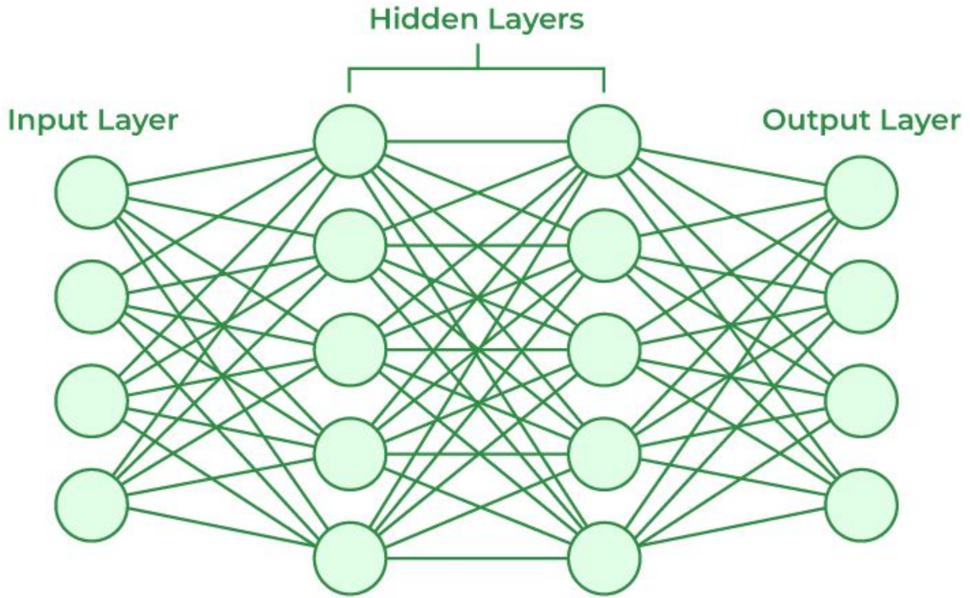
$p \in \{y, 1-y\}$ and $q \in \{\hat{y}, 1-\hat{y}\}$



Classification

Regression

Deep Networks



$$\mathbf{z} = \mathbf{W}^{(1)}\mathbf{x}$$

$$\mathbf{h} = \phi(\mathbf{z})$$

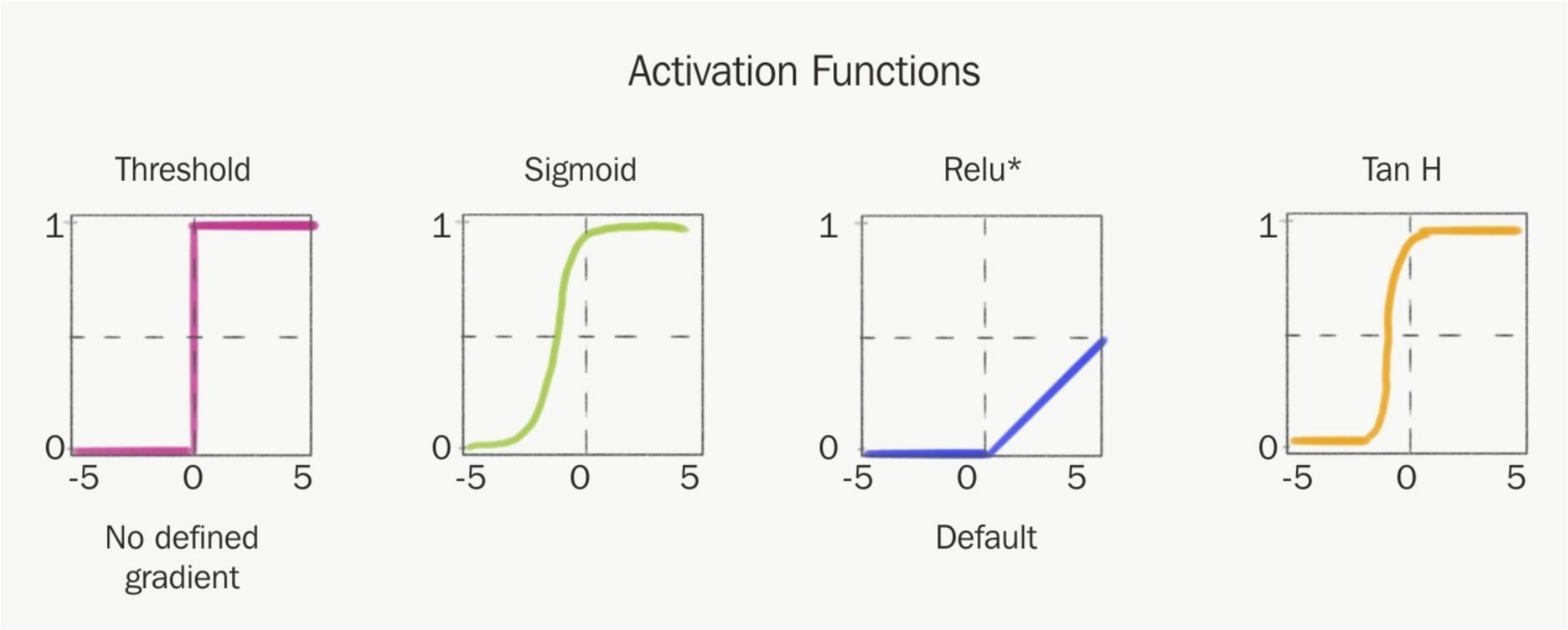
$$\mathbf{o} = \mathbf{W}^{(2)}\mathbf{h}$$

Loss

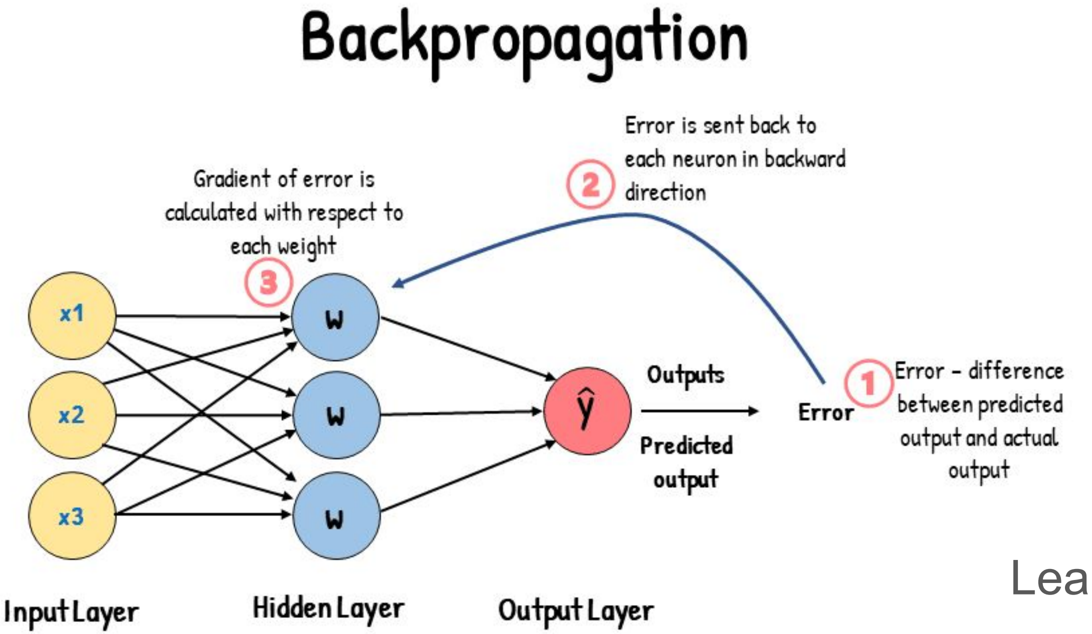
$$L = l(\mathbf{o}, y)$$

$$\hat{o} = \sigma(w^T x + b)$$

Activation Functions



Learning with Gradient Descent



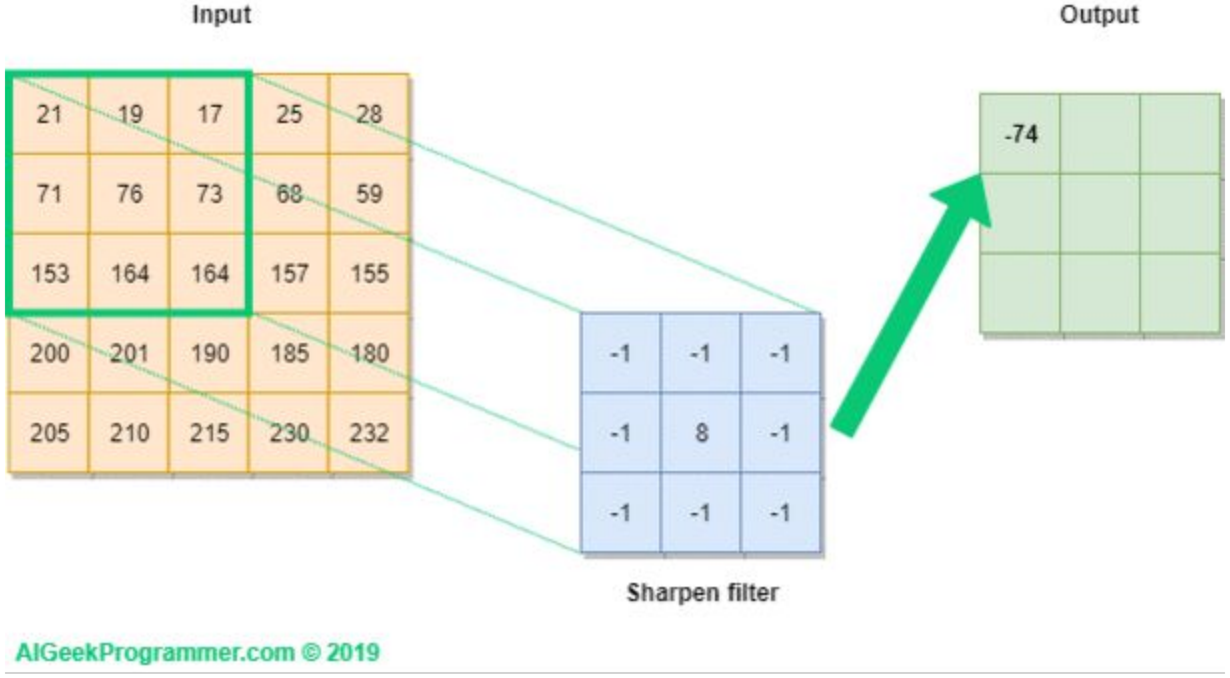
$$w_{ij}^{(k)} = w_{ij}^{(k)} - \eta \frac{\partial L}{\partial w_{ij}^{(k)}}$$

$$b_{i}^{(k)} = b_{i}^{(k)} - \eta \frac{\partial L}{\partial b_{i}^{(k)}}$$

Learning Rate

Convolutional Neural Networks

- Convolution

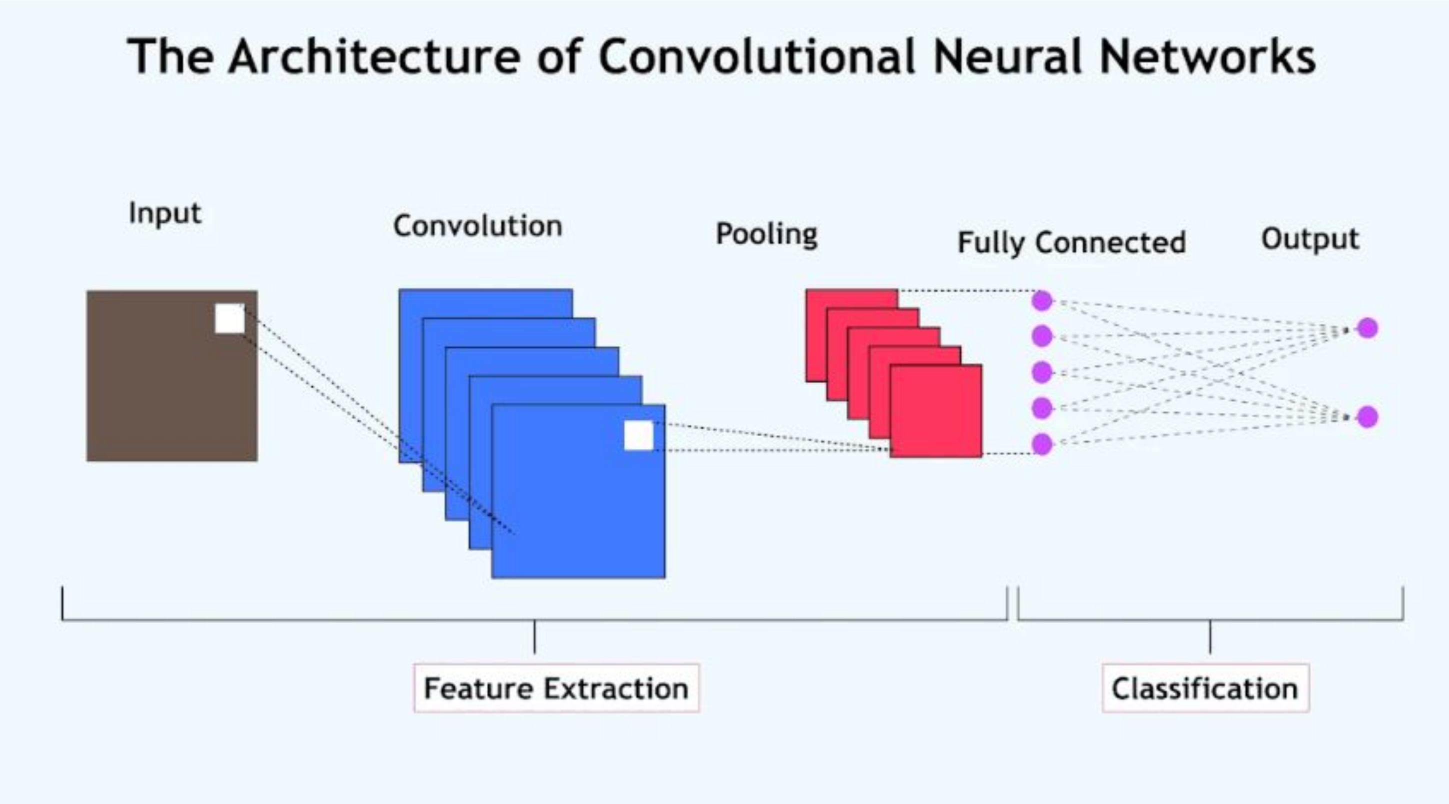


Convolutional Neural Networks

- Convolution Filters = Kernels

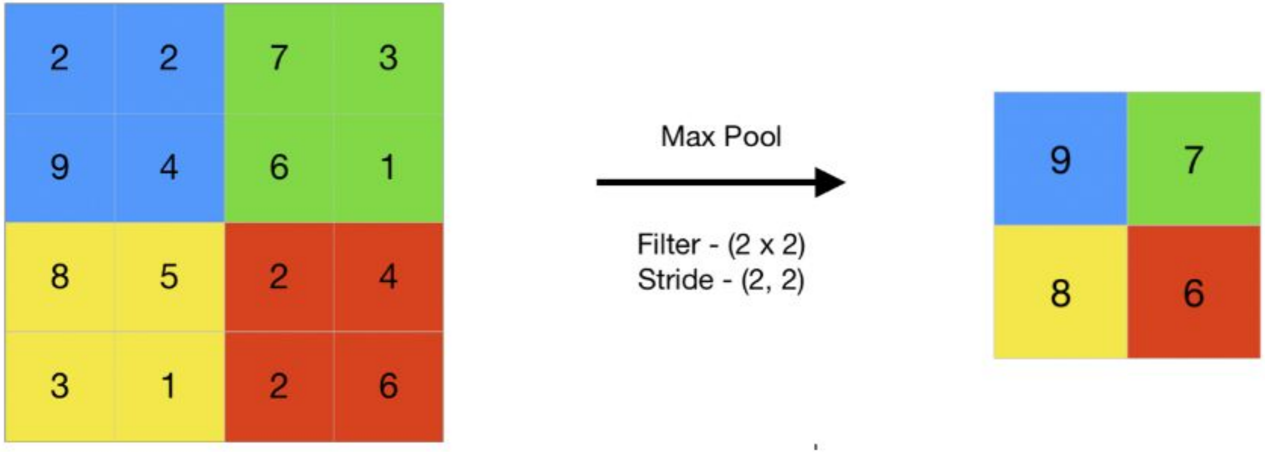
Original	*Gaussian Blur*	*Sharpen*	*Edge Detection*
$\begin{bmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix}$	$\frac{1}{16}\begin{bmatrix} 1 & 2 & 1 \\ 2 & 4 & 2 \\ 1 & 2 & 1 \end{bmatrix}$	$\begin{bmatrix} 0 & -1 & 0 \\ -1 & 5 & -1 \\ 0 & -1 & 0 \end{bmatrix}$	$\begin{bmatrix} -1 & -1 & -1 \\ -1 & 8 & -1 \\ -1 & -1 & -1 \end{bmatrix}$
			

Convolutional Neural Networks



Convolutional Neural Networks

- Pooling
  - Dimensionality Reduction
  - Prevents Overfitting
  - Feature Extraction



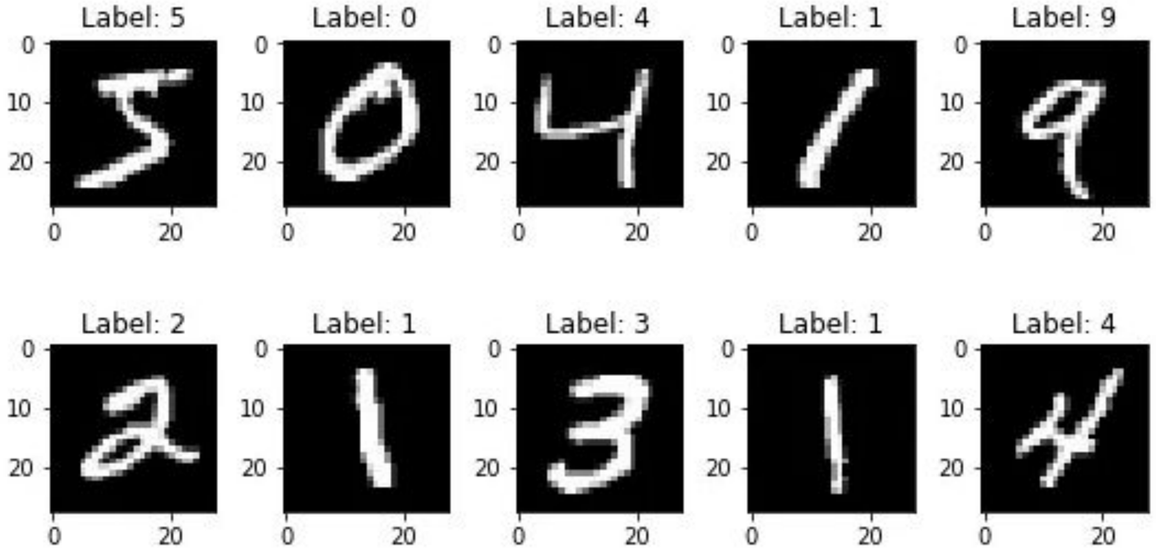
Convolutional Neural Networks

- How to Train a CNN according to your problem ?

  - What is the nature of your data ? is it sequential or not ? If not, should you impose an order in the variables ?
  - What is the optimal size for the filters ?
  - How many Layers ?

- Bibliography is the key to answering these questions !

Time for Coding



Resources

https://botpenguin.com/glossary/deep-neural-network

https://fidle.cnrs.fr/done/02-CNN-MNIST==K3MNIST2.done==.html

https://www.geeksforgeeks.org/cnn-introduction-to-pooling-layer/

https://medium.com/dataseries/visualizing-the-feature-maps-and-filters-by-convolutional-neural-networks-e1462340518e

https://machinelearningmastery.com/how-to-develop-a-convolutional-neural-network-from-scratch-for-mnist-handwritten-digit-classification/