Deep Learning and Neural Network

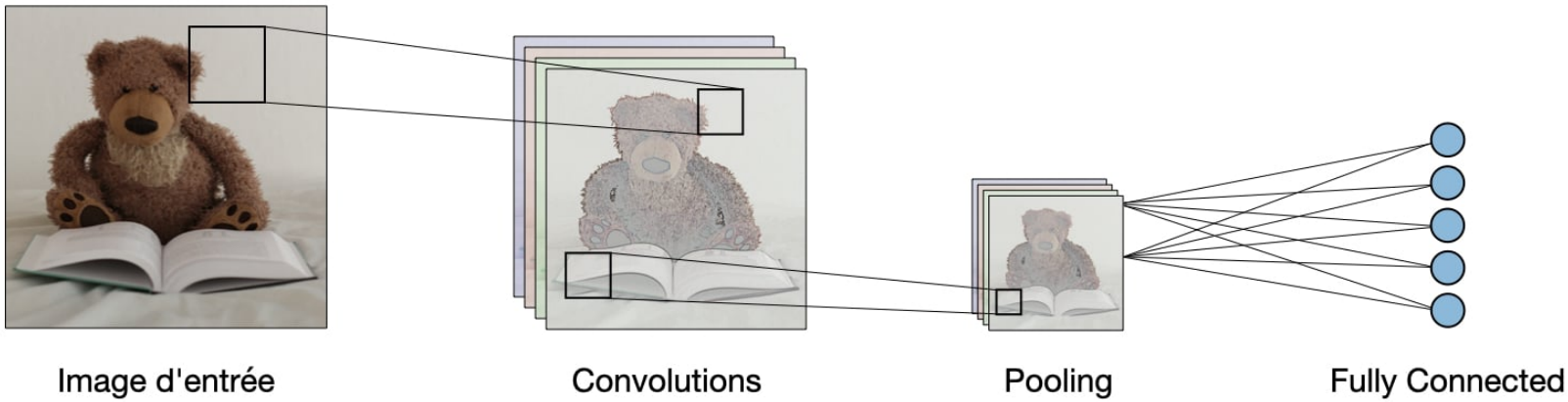
Marie Beurton-Aimar, LE Van Linh

December 10, 2020

Convolutional Neural Network

Introduction

- In CNN we identify :
  - Input data that has to be transform.
  - Convolutional layers
  - Pooling layer(s)
  - Fully connected layer.



Convolutional Neural Network

Goal

- Extract features of the input volume.
- Need to set the size of each filter on the layers. Could be different for each layer.

1	1	1	0	0
0	1	1	1	0
0	0	1	1	1
0	0	1	1	0
0	1	1	0	0

Input

1	0	1
0	1	0
1	0	1

Filter / Kernel

Convolutional Neural Network

Goal

- Extract features of the input volume.
- Need to set the size of each filter on the layers. Could be different for each layer.

1x1	1x0	1x1	0	0
0x0	1x1	1x0	1	0
0x1	0x0	1x1	1	1
0	0	1	1	0
0	1	1	0	0

Input x Filter

4		

Feature Map

Convolutional Neural Network

Goal

- Extract features of the input volume.
- Need to set the size of each filter on the layers. Could be different for each layer.

1	1x1	1x0	0x1	0
0	1x0	1x1	1x0	0
0	0x1	1x0	1x1	1
0	0	1	1	0
0	1	1	0	0

Input x Filter

4	3	

Feature Map

Convolutional Neural Network

Goal

- Extract features of the input volume.
- Need to set the size of each filter on the layers. Could be different for each layer.

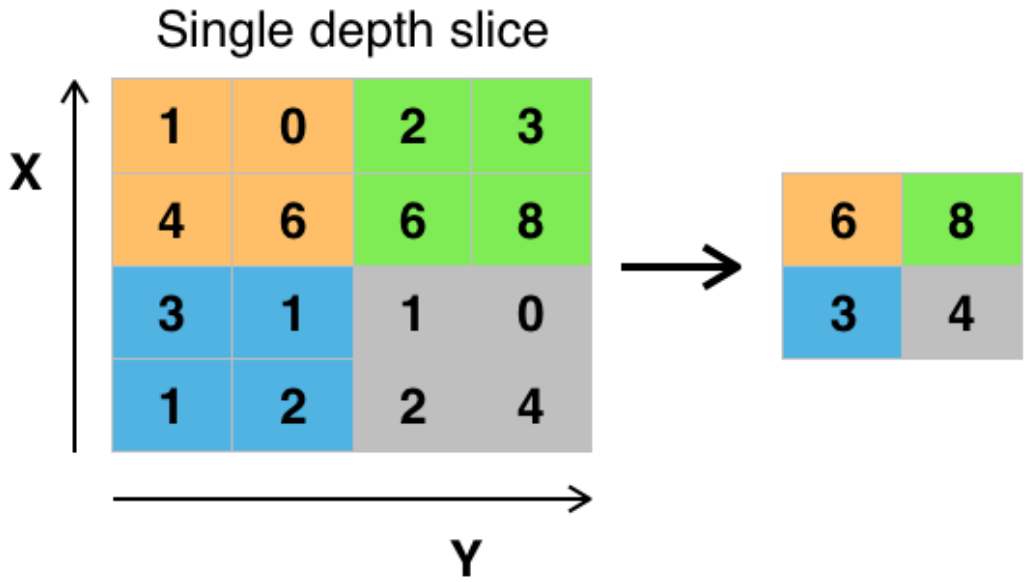
1	1	1	0	0
0	1	1	1	0
0	0	1x1	1x0	1x1
0	0	1x0	1x1	0x0
0	1	1x1	0x0	0x1

4	3	4
2	4	3
2	3	4

Convolutional Neural Network

Pooling Layer

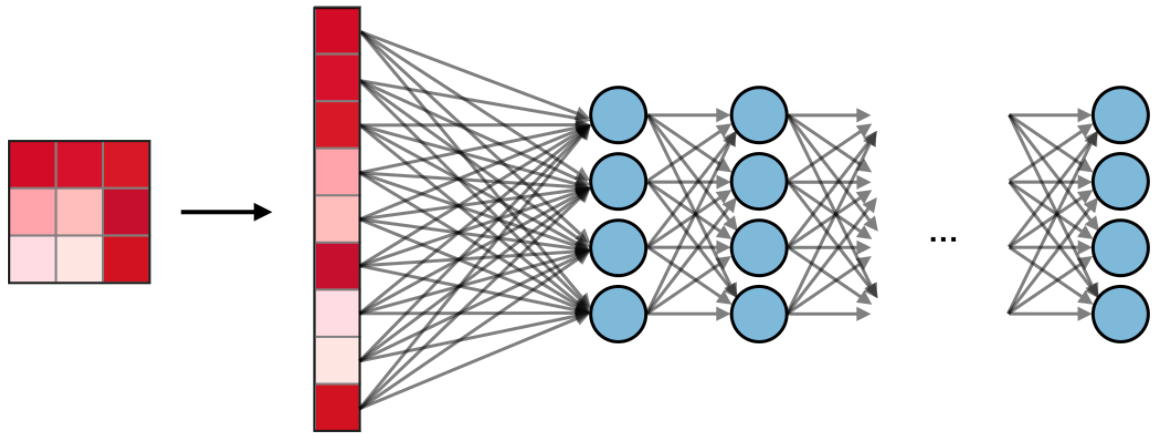
- Pooling layer reduces the spatial dimensions of the input.
- Allows to control **overfitting**.
- Several functions are available: max pooling, average pooling, L2-norm ....



Convolutional Neural Network

Fully Connected Layer

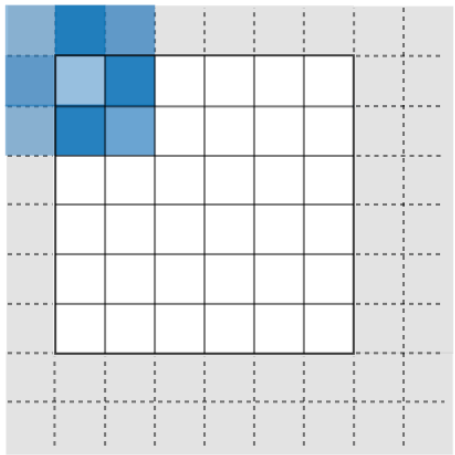
- Use as input a vector where each data is connected to a neurone.
- Main goal is to achieve the task - classification, scores...



Convolutional Neural Network

Parameters

- Stride : pixel number of the sliding window for convolution or pooling.
- Zero-padding : adding value to adjust image/matrix size.



Convolutional Neural Network

Parameters

- Batch size : define the number of samples to work through before updating the internal model parameters.
- Learning rate : control how much to change the model in response to the estimated error each time the model weights are updated.
- Epochs number : define the number times that the learning algorithm will work through the entire training datase.

Convolutional Neural Network

Evaluation - Metric

- Loss value : evaluate how the madel is training - produced from the loss function that estimates the loss of the model so that the weights can be updated to reduce the loss on the next evaluation.
- Accuracy : a metric to measure the algorithm performance at the end.
- Mean Average Precision : compute the average precision value for recall value over 0 to 1. Seee Precision/Recall.
- F1 Score : combine precision and recall relative to a specific positive class. It is a weighted average of the precision and recall, where an F1 score reaches its best value at 1 and worst at 0

Activation Functions

ReLU Layer[a]

[a] Relu Module http://cs231n.github.io/convolutional-networks/

- Layer to correct data - take into account the non-linearity of the process of classification.
- One example of Relu fonction $f(x) = max(0, x)$

SoftMax

- Use a score vector as inputs.
- Produce a vector of probabilities as response (output).

Using a Deep Network

Data organisation

- Training and Validation data set are rebuild at each epoch.
- Don't miss to shuffle at each epoch.
- Usual parameters are 80% for training and 20% for validation.
- Test data has to be kept apart and never seen before the test step.

Re-using a model

- Saving the model to apply to test data or to fine-tune another CNN.
- Transfert learning or fine-tuning: re-use a training model to feed another one for another task - and another data set.

CNN Architecture

AlexNet

- Creating in 2010 for the ILSVRC challenge, won in 2012 with an error-rate of 15.3%.
- Original paper : ImageNet Classification with Deep Convolutional Neural Networks by Alex Krizhevsky et al.
- Imagenet dataset : 22 000 classes and 15 millions of images.
- 8 Layers - including Dropout layer. producing 60 millions of parameters.
- Replace `tanh` function by Rectified Linear Units (ReLU), fastest computing.
- Able to use multiple GPU.
- Special pooling with overlap.
- Data augmentation : 2048 times.

CNN Architecture

VGG Family

- Creating in 2014 for the ILSVRC challenge.
- VGG16: 16 convolutional layers. 138 millions of parameters.
- 13 convolutional layers, Reduce the size filter to 3X3.
- 3 fully connected layers.
- Original paper : Very Deep Convolutional Networks for Large Scale Image Recognition by Karen Simonyan et al.