

Réseaux de neurones et apprentissage profond

Une brève introduction, partie 2

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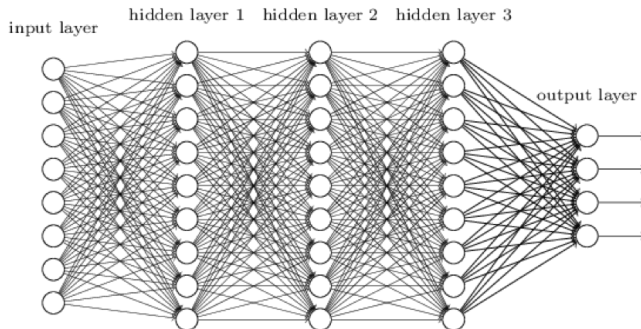
L2TI
Université Paris 13

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Plan du cours

- Architecture d'un réseau multicouche (MLP)
- Apprentissage d'un réseau
- Outils logiciels
- Outils de calcul
- Implémentation en PyTorch

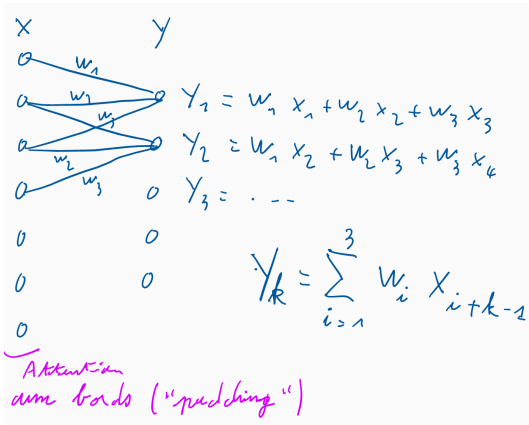
Couches complètement connectées



Chaque cellule est connectée à toutes les cellules de la couche précédente. La couche réalise un produit de matrice.

Couche à convolution

Exemple en une dimension :



Couche à convolution (2d)

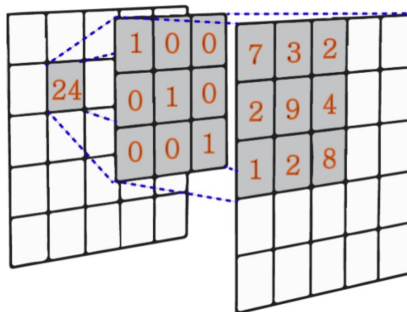
$$y[i, j] = (x * w)[i, j] \quad \text{Cross-Correlation in 2D}$$

$$= \sum_{n=-\infty}^{\infty} \sum_{m=-\infty}^{\infty} x[m-i, n-j] w[m, n]$$

Output (y)

Kernel (w)

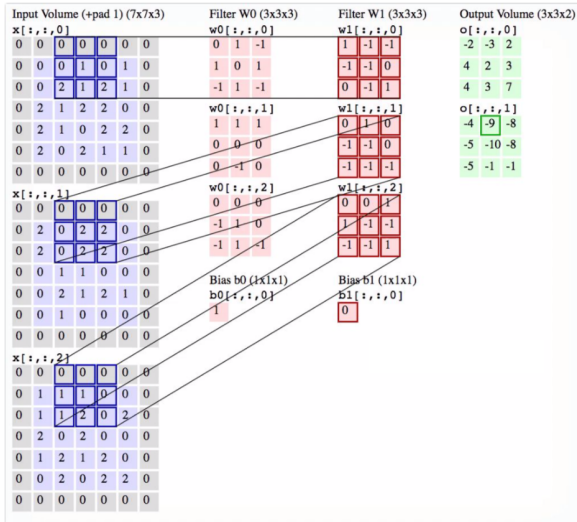
Input (x)



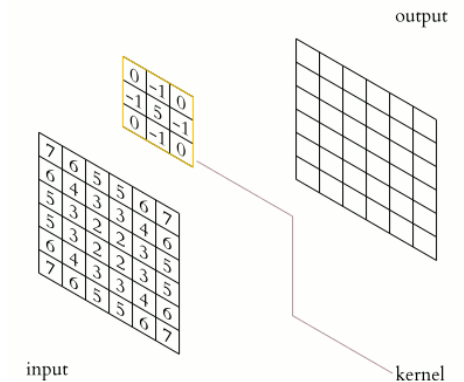
Filtres appris



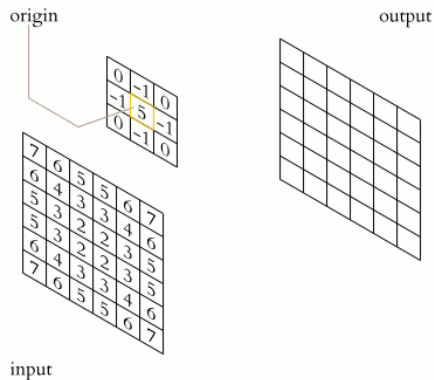
Exemple : convolution 2D sur 3 canaux



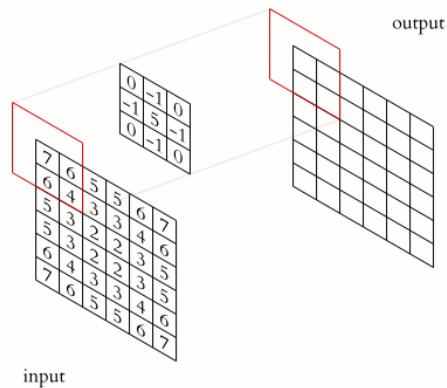
Exemple



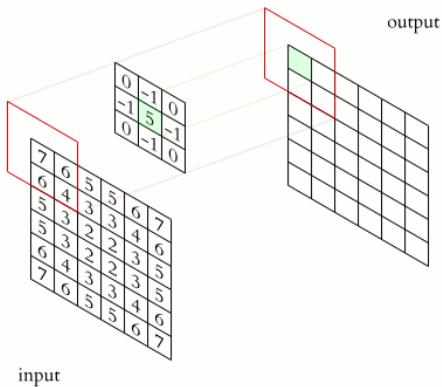
Exemple



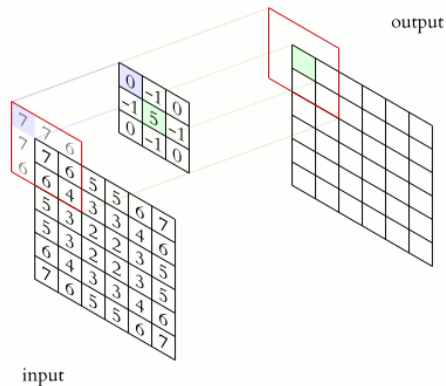
Exemple



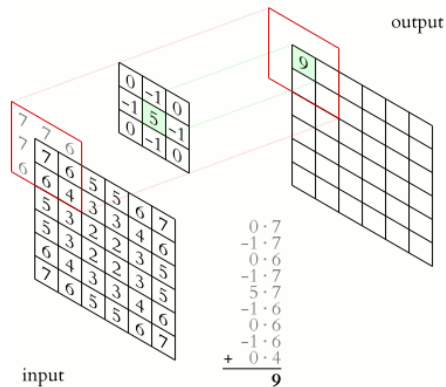
Exemple



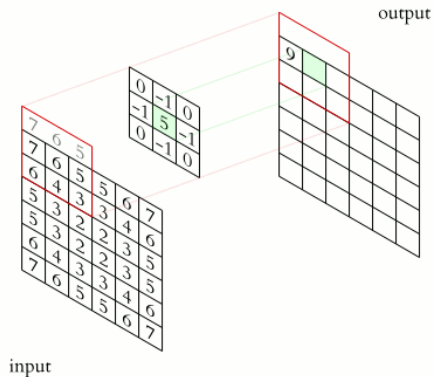
Exemple



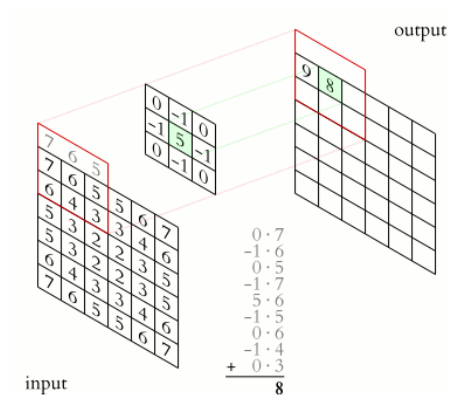
Exemple



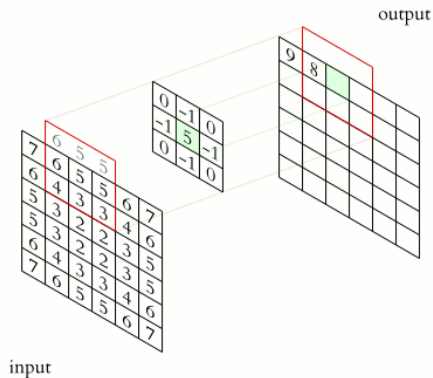
Exemple



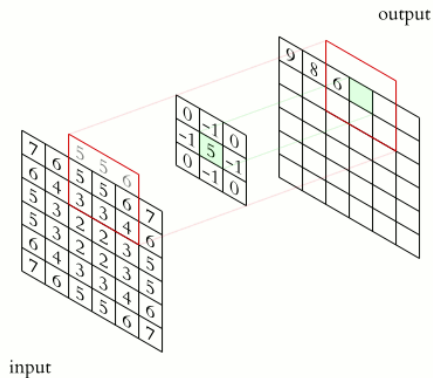
Exemple



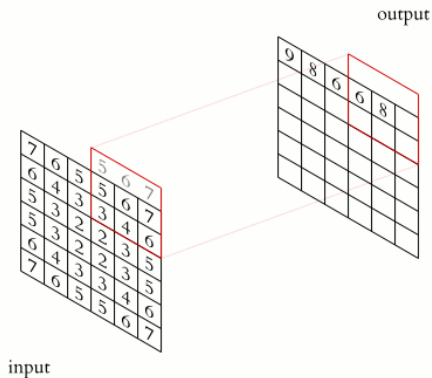
Exemple



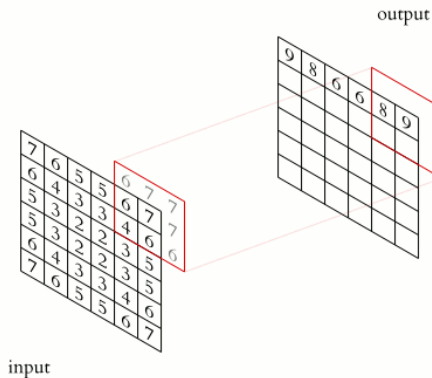
Exemple



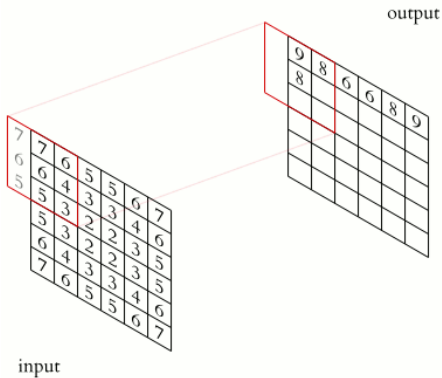
Exemple



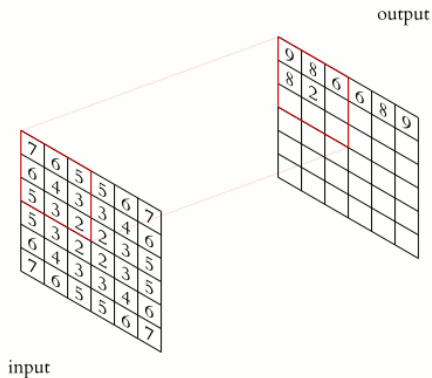
Exemple



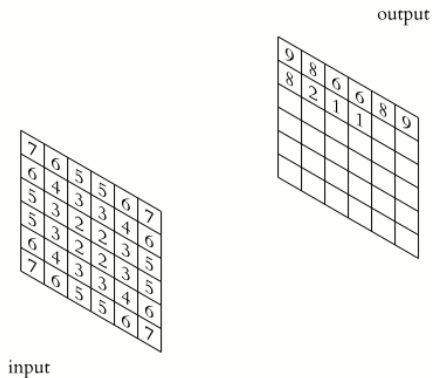
Exemple



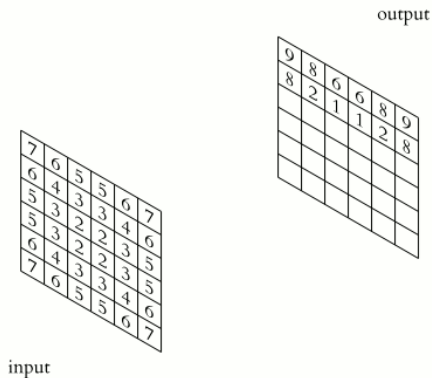
Exemple



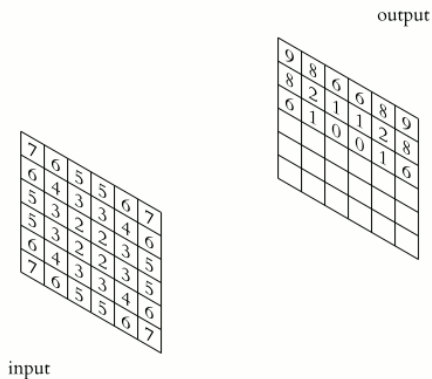
Exemple



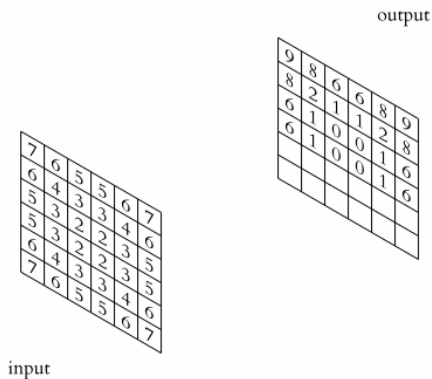
Exemple



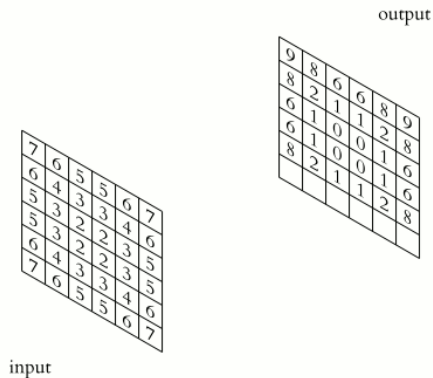
Exemple



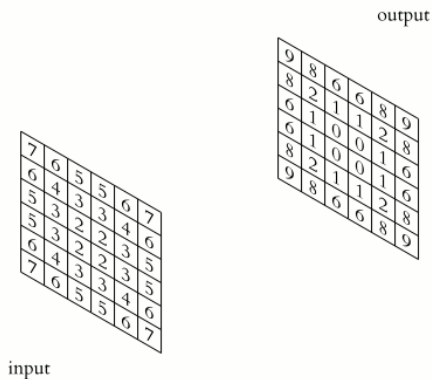
Exemple



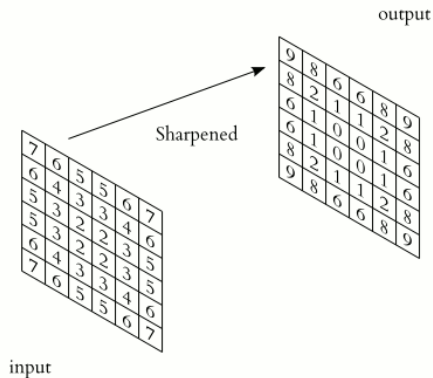
Exemple



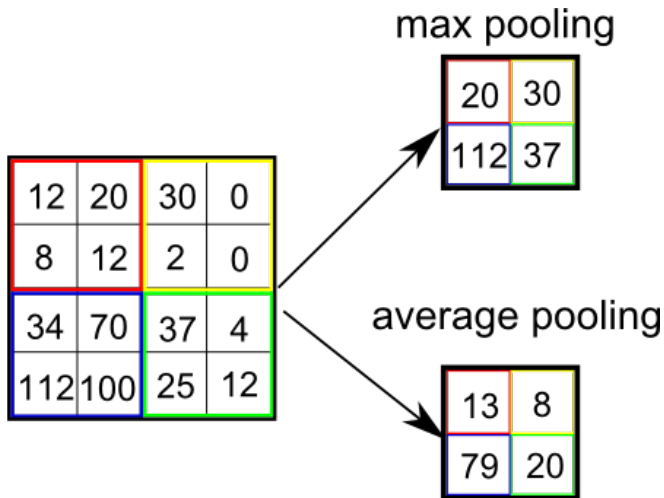
Exemple



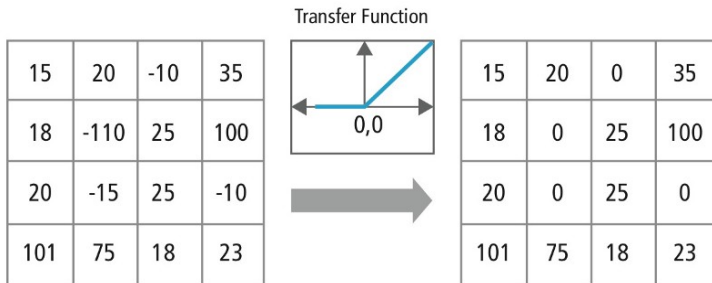
Exemple



Couches de *pooling*

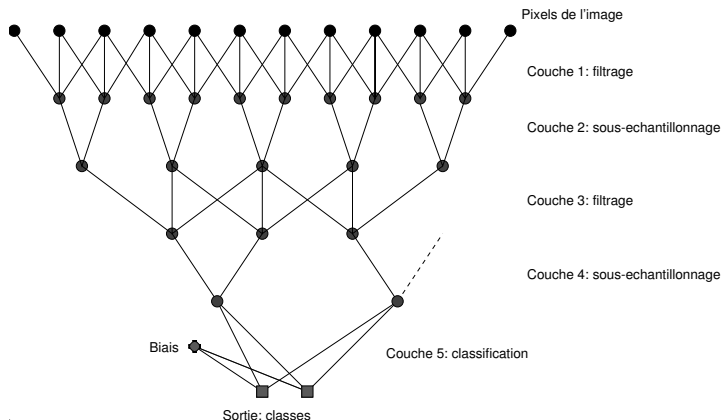


Couche ReLU (rappel)

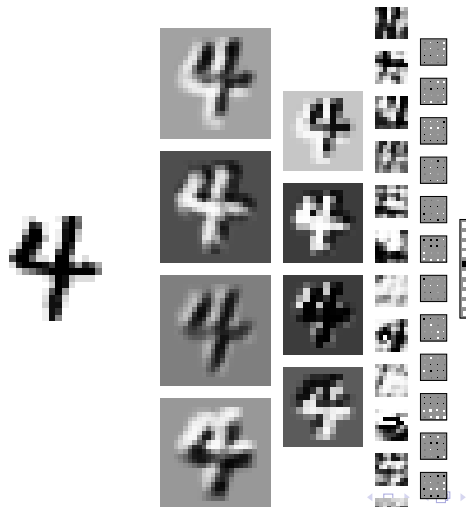


Architecture multicouche

alternance de convolutions et de pooling

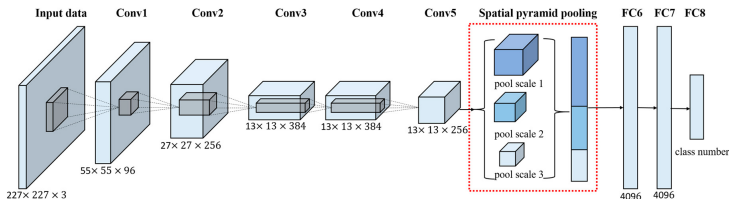


LeNet (1990)



AlexNet (2012)

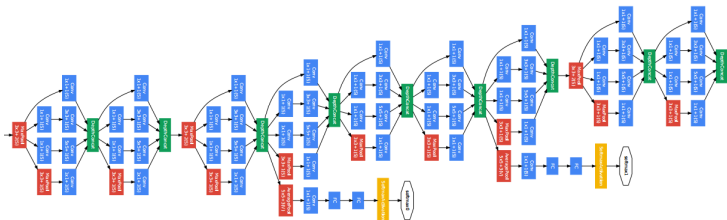
Reconnaissance d'images, *ImageNet classification with deep convolutional neural networks*, Alex Krizhevsky, Ilya Sutskever, Geoffrey E. Hinton, 2012



Source: [figure : Han et al. 2017](#)

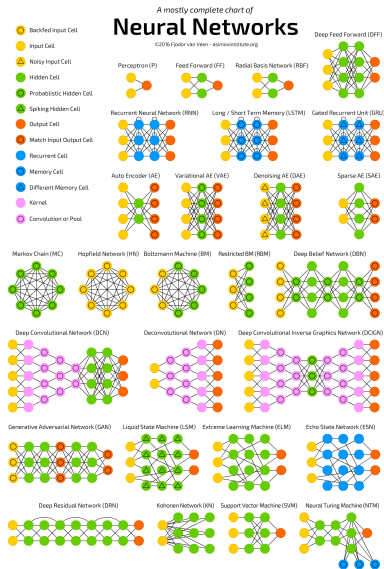
Exemple : GoogleLeNet

Reconnaissance d'images, *Going Deeper with Convolutions*, C. Szegedy et al., 2014



22 couches.

Neural Network Zoo



Source: [van Veen, 2016](#)

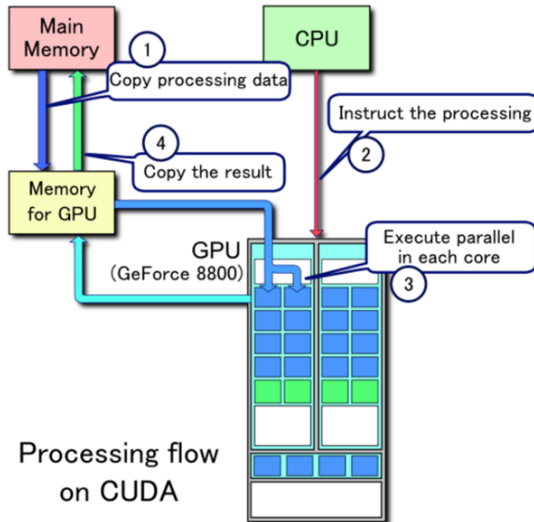
Techniques d'apprentissage

- Descente stochastique du gradient (SGD)
- Stochastique vs **mini-batch** vs batch ?
- momentum
- batch normalization
- Critère d'arrêt, *early stopping*

Outils logiciels

- Tensor Flow (Google)
- Keras
- PyTorch (Facebook research)
- Caffe (2013)
- Theano (U. Montreal, 2007)

GPU



Processing flow
on CUDA

Source: [Wikipedia](https://en.wikipedia.org/wiki/CUDA)

Création d'un réseau en PyTorch (rappel)

N1 = 2

N2 = 2

```
class Net(nn.Module):  
    def __init__(self):  
        super(Net, self).__init__()  
        self.fc1 = nn.Linear(2, N1)  
        self.fc2 = nn.Linear(N1, N2)  
        self.fc3 = nn.Linear(N2, NbClass)  
  
    def forward(self, x):  
        x = F.relu(self.fc1(x))  
        x = F.relu(self.fc2(x))  
        x = self.fc3(x)  
        return x
```