TRAITEMENT D'IMAGES

Partie Introductive

Frédéric Cointault
Institut Agro Dijon
Responsable Equipe ATIP
UMR Agroécologie
26 Bd Dr Petitjean
21000 Dijon
+33 3 80 77 27 54
frederic.cointault@agrosupdijon.fr

MEMBRE DE

L'INSTITUT NATIONAL D'ENSEIGNEMENT SUPÉRIEUR POUR L'AGRICULTURE, L'ALIMENTATION ET L'ENVIRONNEMENT

VIII – Introduction au Deep Learning

Systèmes intelligents

Artificial Intelligence (AI ou IA)

Machine Learning (ML)

Artificial Neural Network (ANN ou NN)

Deep Neural Network (DNN)

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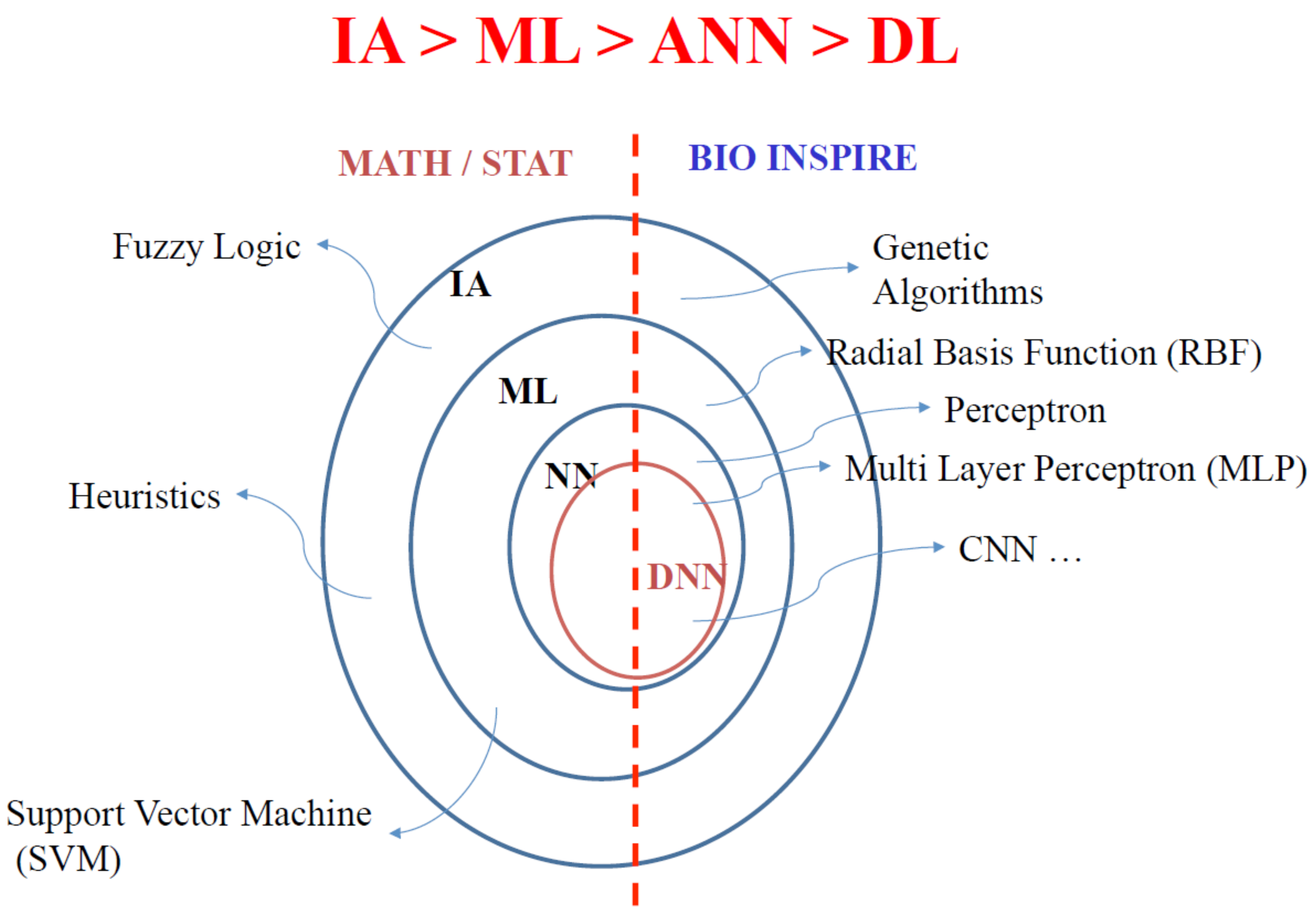

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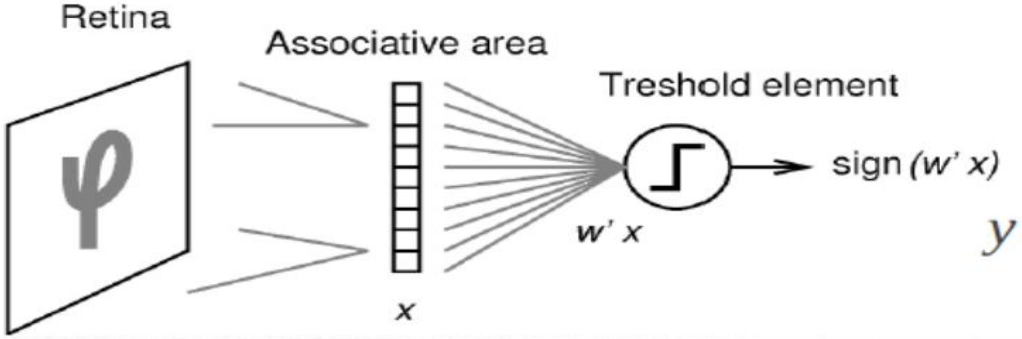
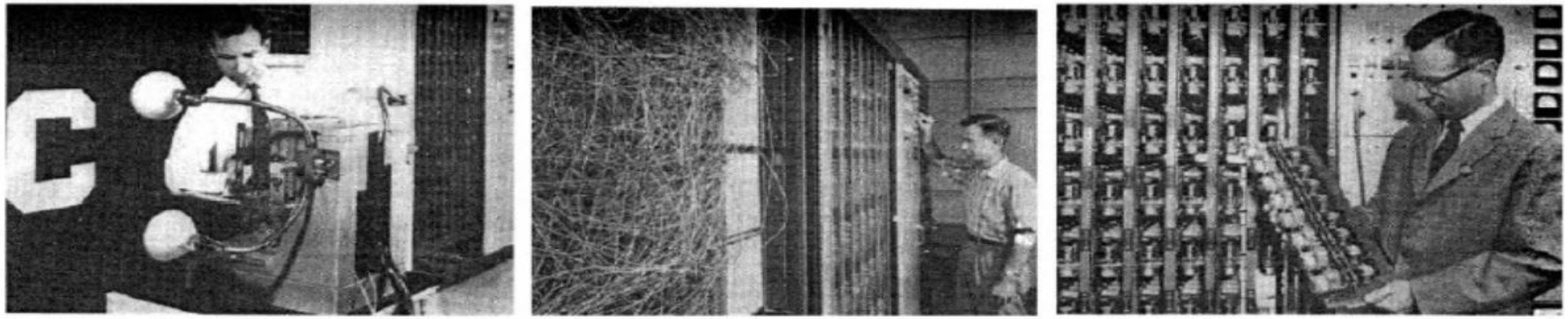
Perceptron (Rosenblatt 1957)

- A simple simulated neuron with adaptive “synaptic weights”
  - Computes a weighted sum of inputs
  - Output is +1 if the weighted sum is above a thresold, -1 otherwise.



$$y = sign\left(\sum_{i=1}^{N} W_i X_i + b\right)$$



(cf Y.Lecun - Collège de France – 2016)

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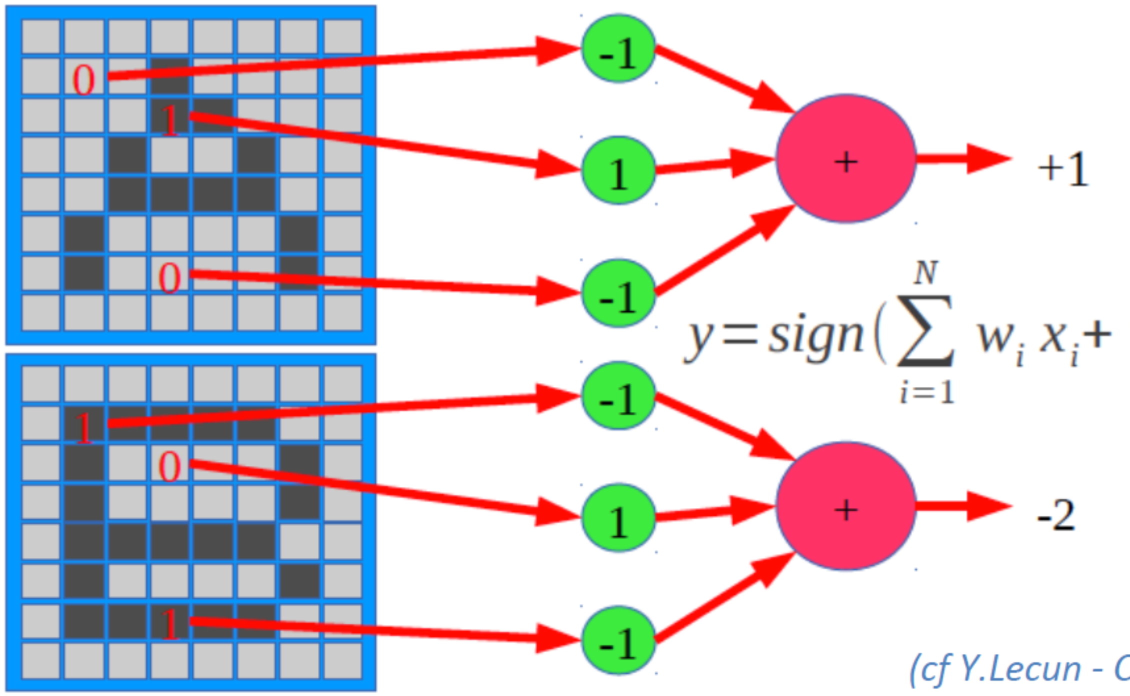
- Example: classifying letters "A" from "B"
- Learning: find the weight values that produce +1 for A and -1 for B
- Training set: $(X^1,Y^1),(X^2,Y^2),\ldots\ldots,(X^P,Y^P)$
- Example: (**A**,+1),(**B**,-1),(**A**,+1),(**B**,-1),(**A**,+1),(**B**,-1),......

Supervised Learning



$$y=sign\left(\sum_{i=1}^{N} w_i\, x_i + w_0\right)=sign(W'X)$$

(cf Y.Lecun - Collège de France – 2016)

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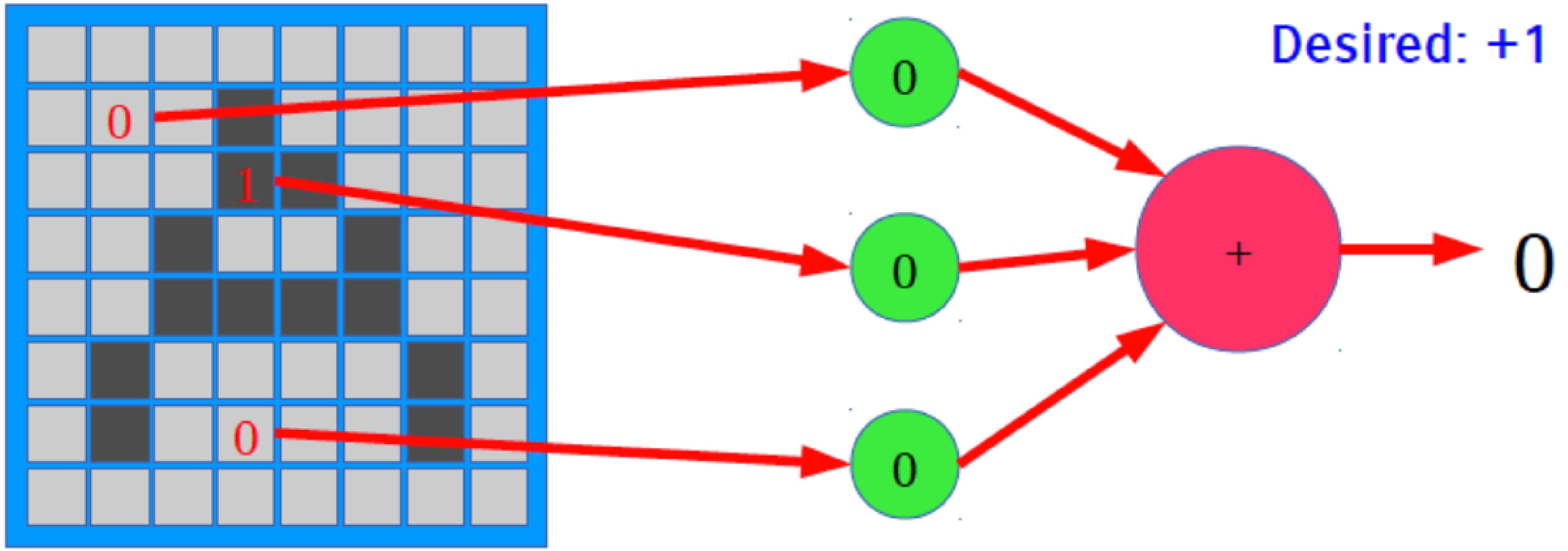
Apprentissage des poids synaptiques

- Learning: adjusting the weights so as to obtain the desired result
  - Initially, the weights are 0.



(cf Y.Lecun - Collège de France – 2016)

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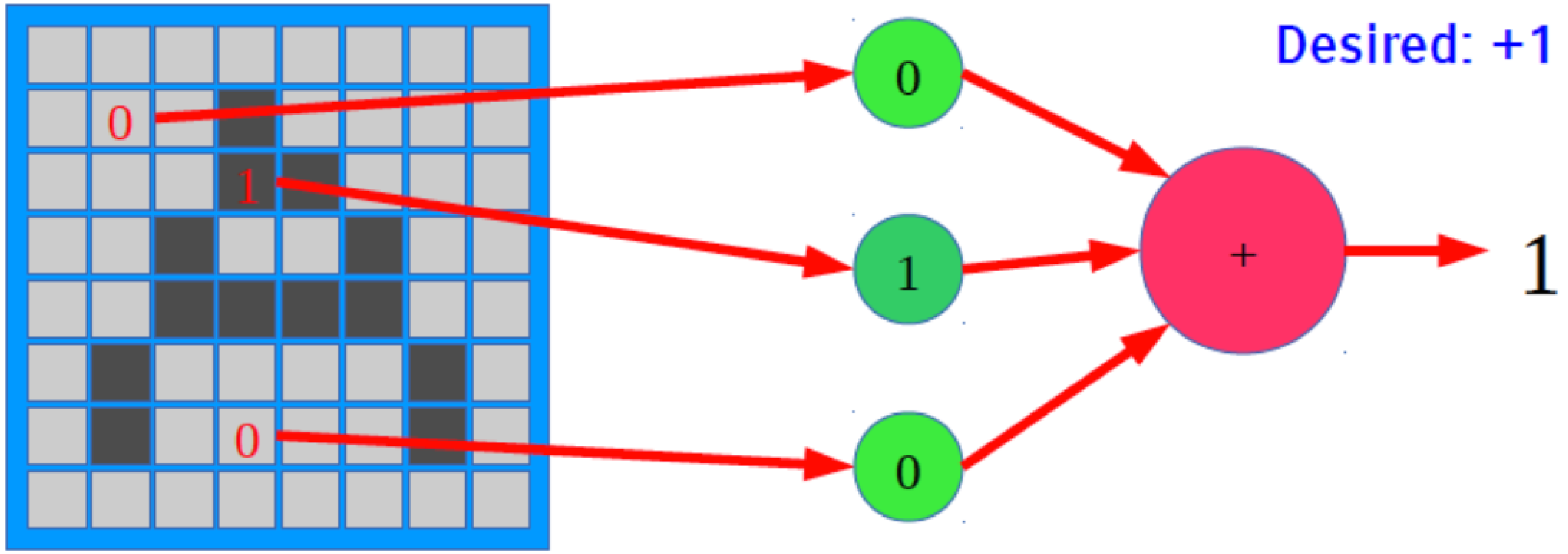
- Adjusting the weights when the the output is incorrect
  - If the desired output is +1, add pixel values to the weights (Hebbian learning)

Apprentissage des poids synaptiques



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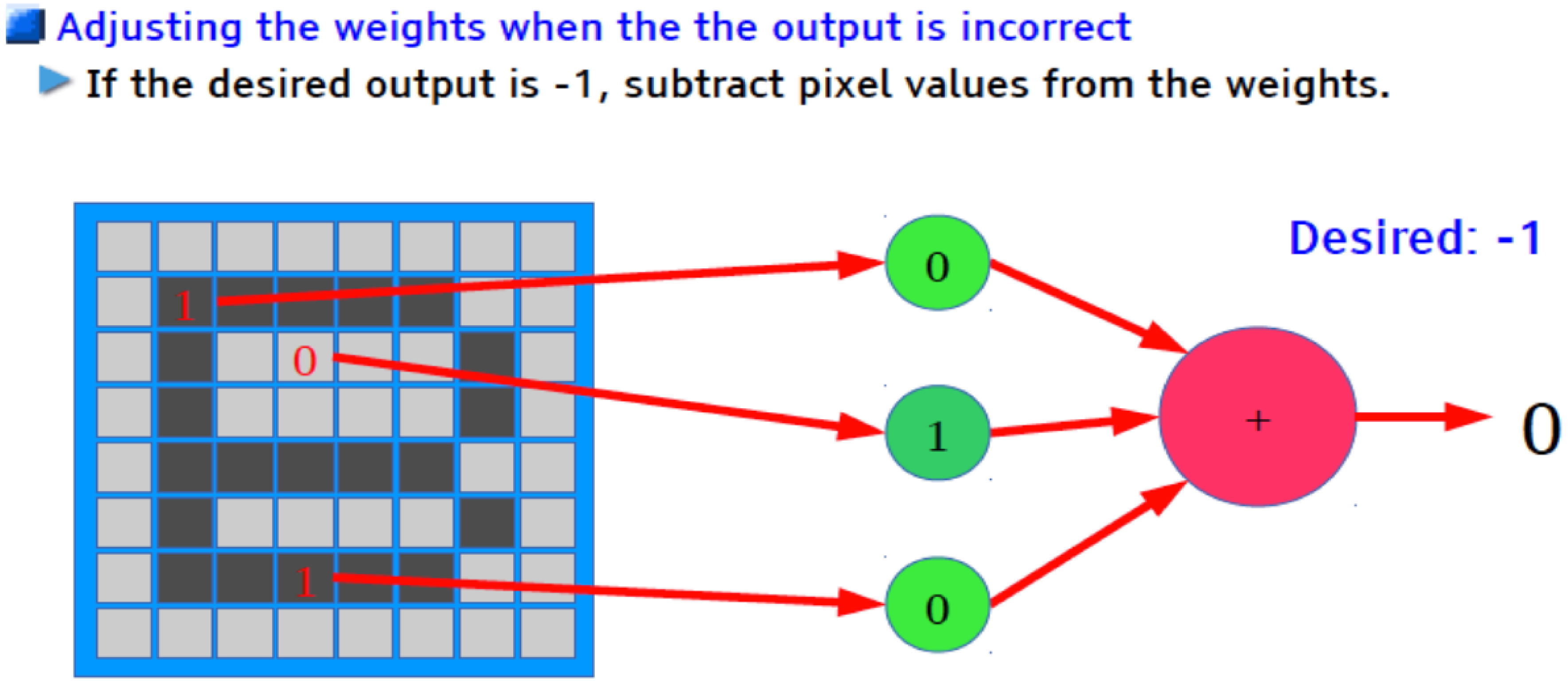
Apprentissage des poids synaptiques



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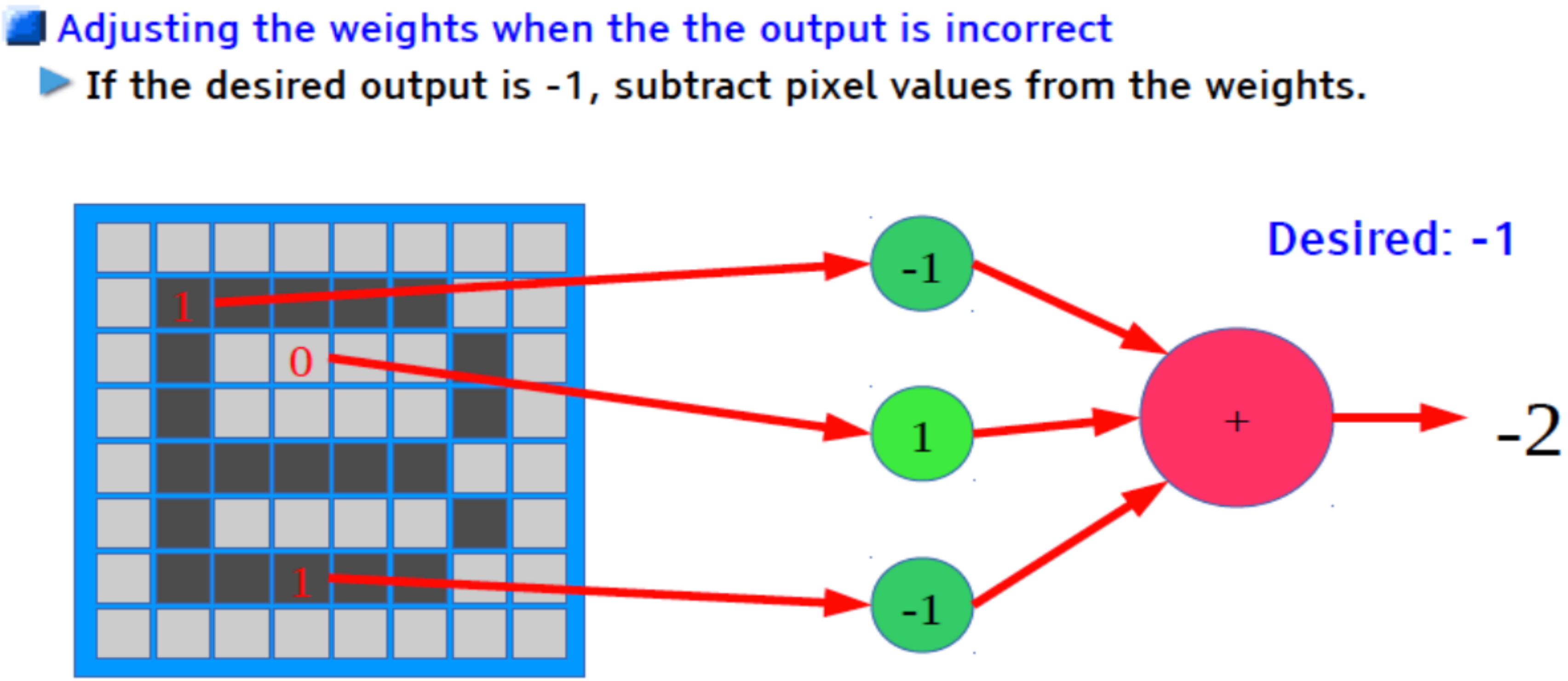
Apprentissage des poids synaptiques



(cf Y.Lecun - Collège de France – 2016)

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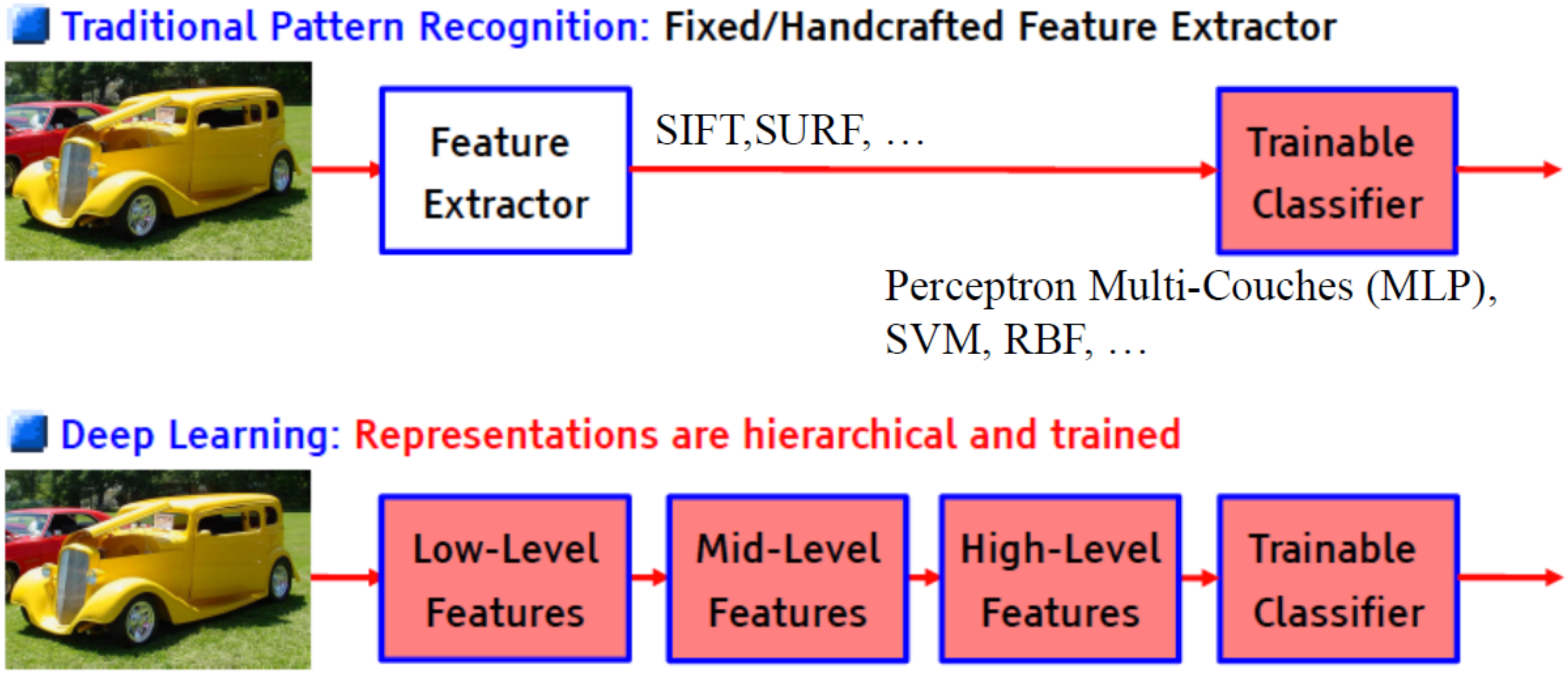
Modèles de vision artificielle



(cf Y.Lecun - Collège de France – 2016)

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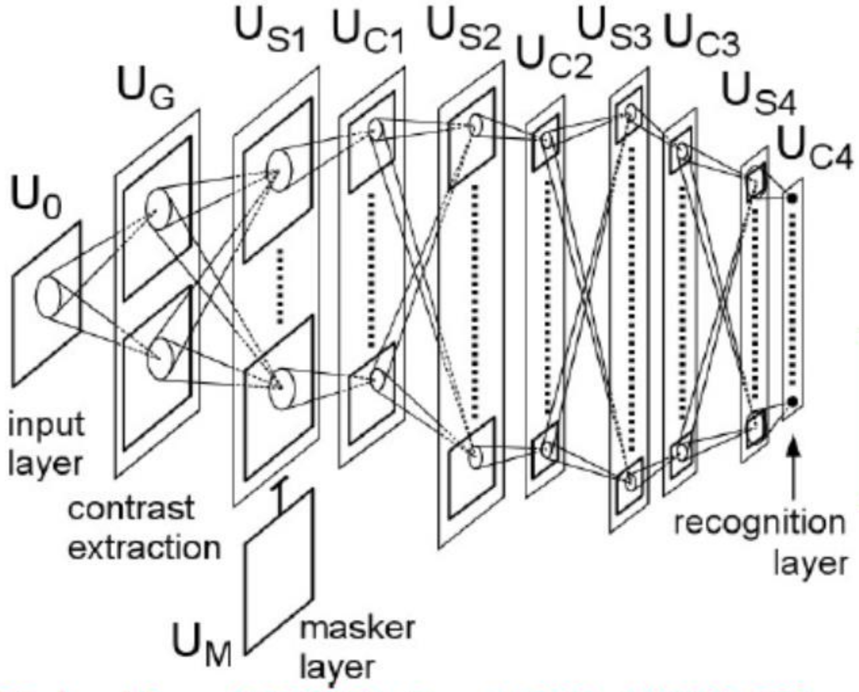
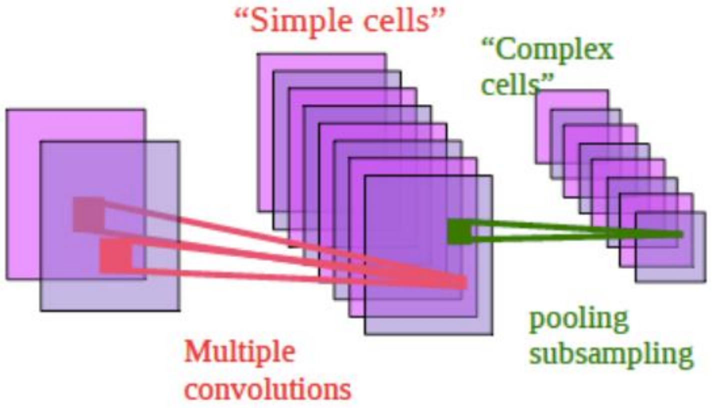
L’apprentissage profond : >50 ans

- [Hubel & Wiesel 1962]:
  - simple cells detect local features
  - complex cells “pool” the outputs of simple cells within a retinotopic neighborhood.





[Fukushima 1982][LeCun 1989, 1998],[Riesenhuber 1999]......

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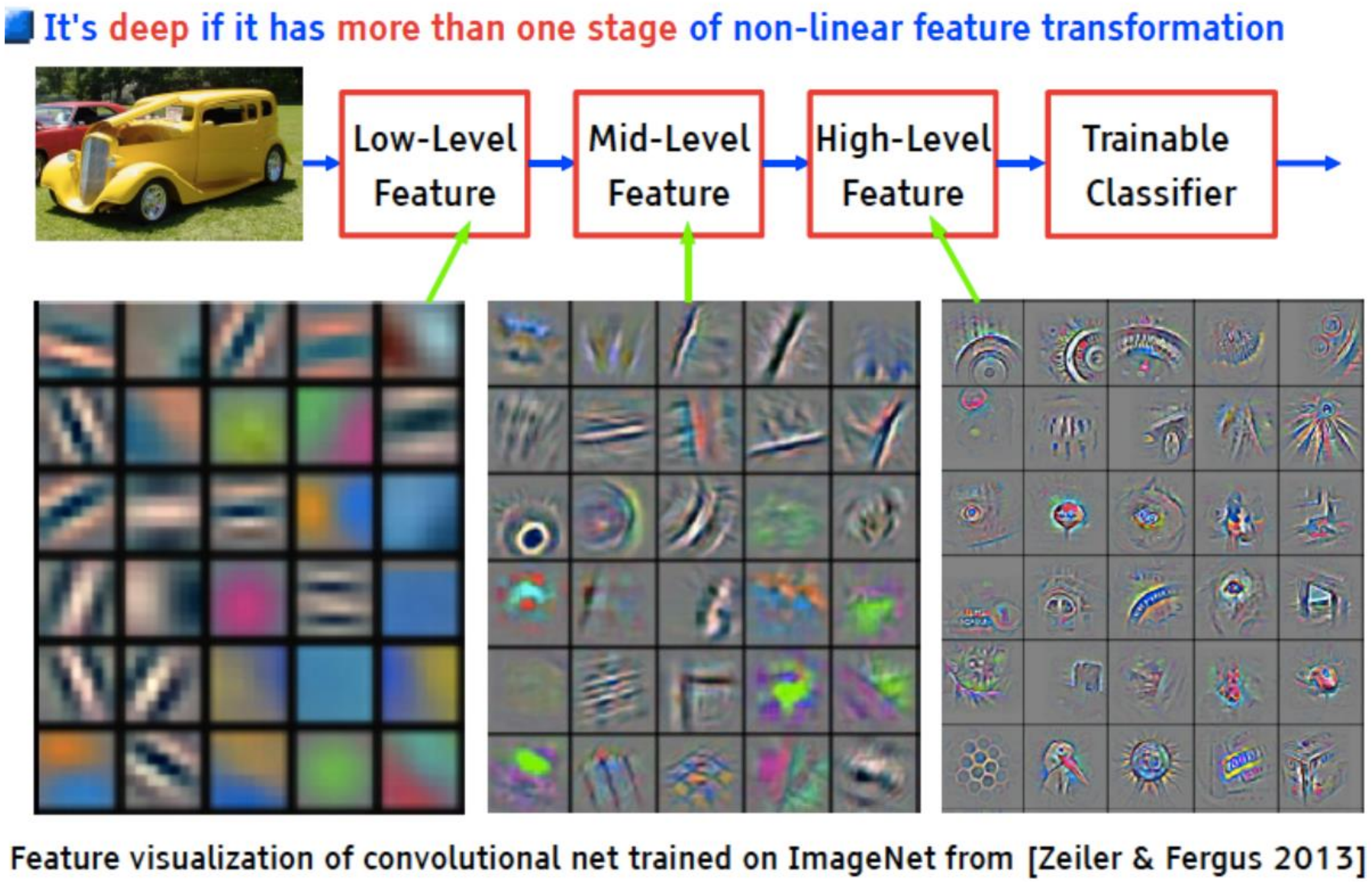

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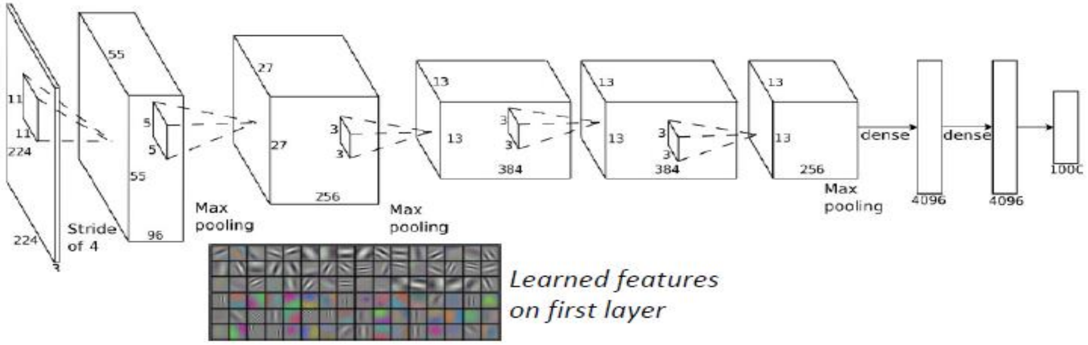
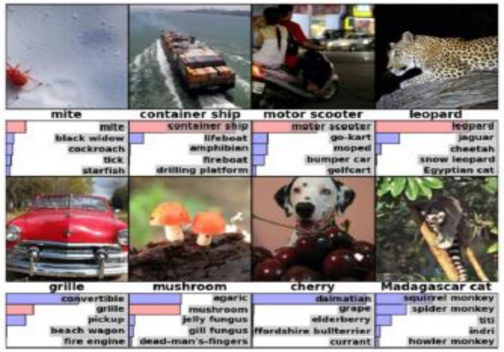
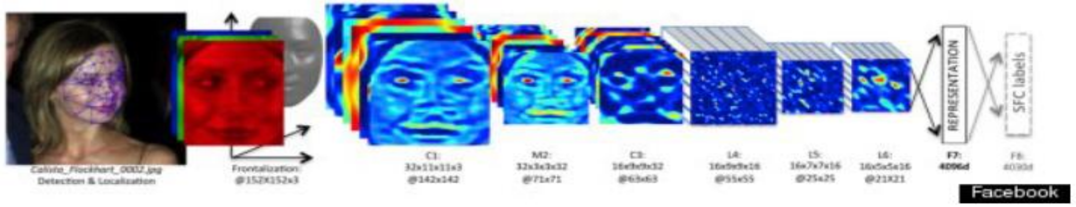
Modèles récents de DNN

- ImageNet classification (Hinton's team, hired by Google)
  - 1.2 million high res images, 1,000 different classes
  - Top-5 17% error rate (huge improvement)

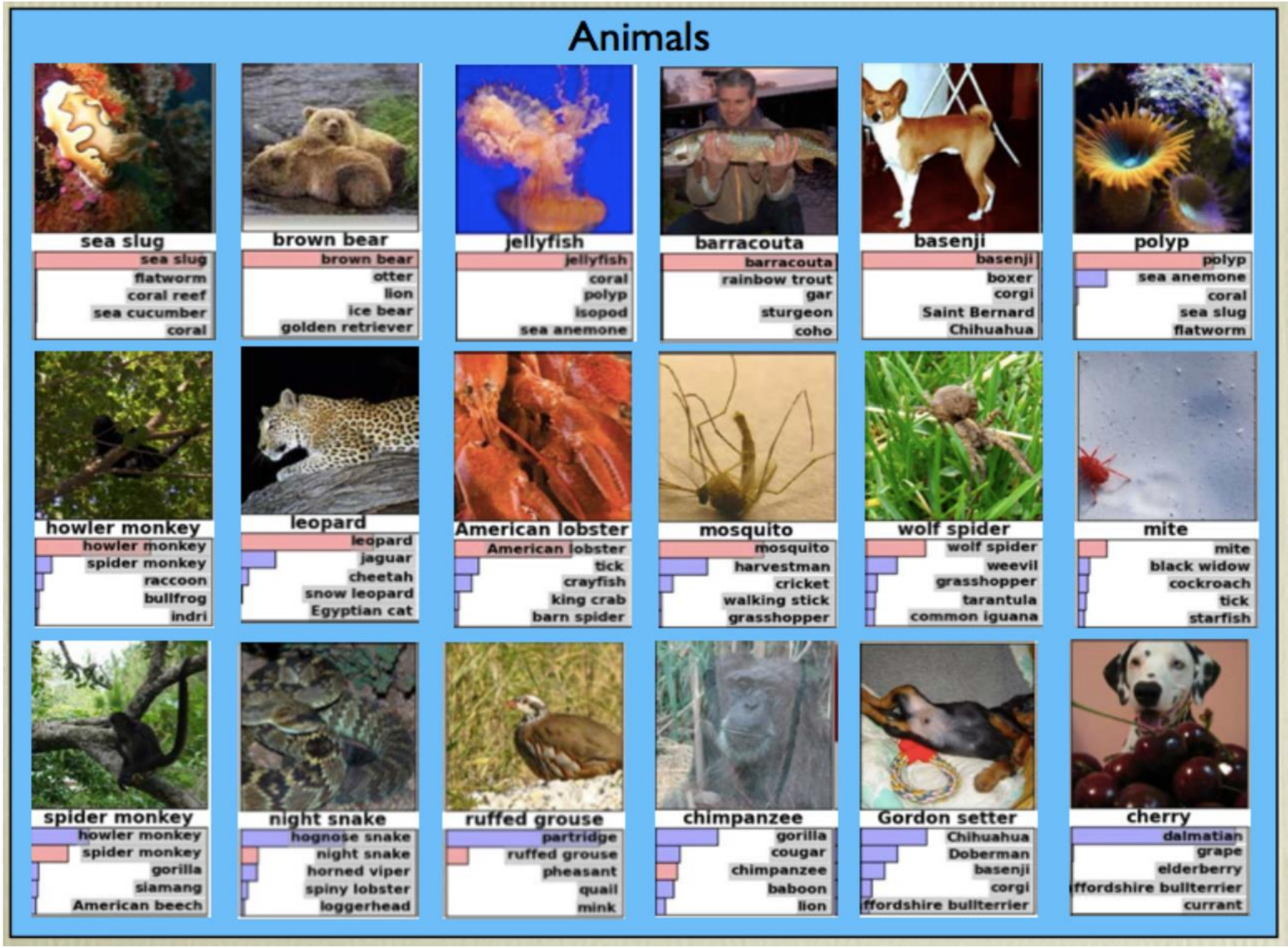




- Facebook's 'DeepFace' Program (labs head: Y. LeCun)
  - 4 million images, 4,000 identities
  - 97.25% accuracy, vs. 97.53% human performance



VIII – Int



Supervision par DNNs

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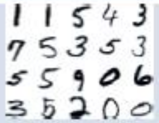
Etat de l'art dans la reconnaissance

Database		# Images	# Classes	Best score
MNIST *Handwritten digits*		60,000 + 10,000	10	99.79% [3]
GTSRB *Traffic sign*		~ 50,000	43	99.46% [4]
CIFAR-10 *airplane, automobile, bird, cat, deer, dog, frog, horse, ship, truck*		50,000 + 10,000	10	91.2% [5]
Caltech-101		~ 50,000	101	86.5% [6]
ImageNet	IMAGENET	~ 1,000,000	1,000	Top-5 83% [1]
DeepFace		~ 4,000,000	4,000	97.25% [2]

INCREASING COMPLEXITY

- **State-of-the-art are Deep Neural Networks *every time***

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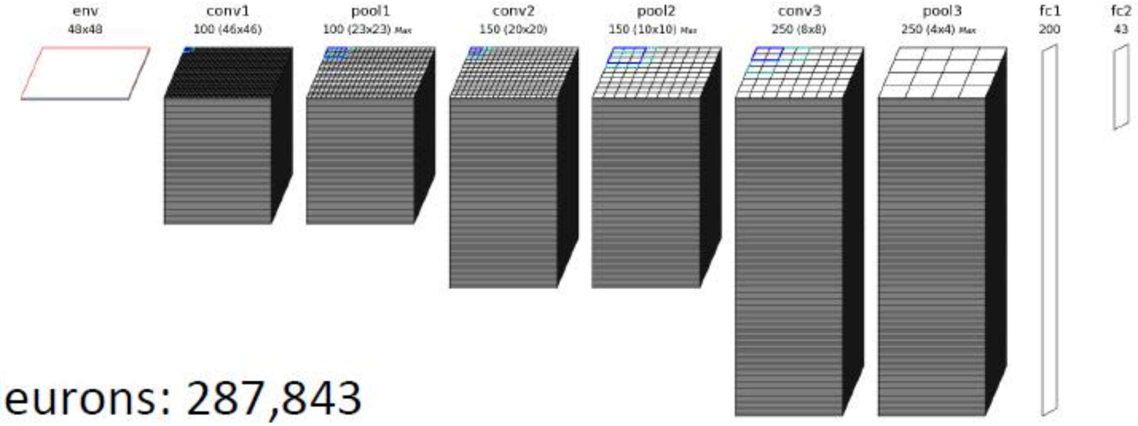
Etat de l’art ex de CNNs

The German Traffic Sign Recognition Benchmark (GTSRB)

43 traffic sign types
> 50,000 images



- Neurons: 287,843
- Synapses: 1,388,800
  - Total memory: 1.5MB (with 8 bits synapses)
- Connections: 124,121,800

Near human recognition (> 98%) [3]

[3] D. Ciresan, U. Meier, J. Masci, J. Schmidhuber, Multi-column deep neural network for traffic sign classification, Neural Networks (32), pp. 333-338, 2012

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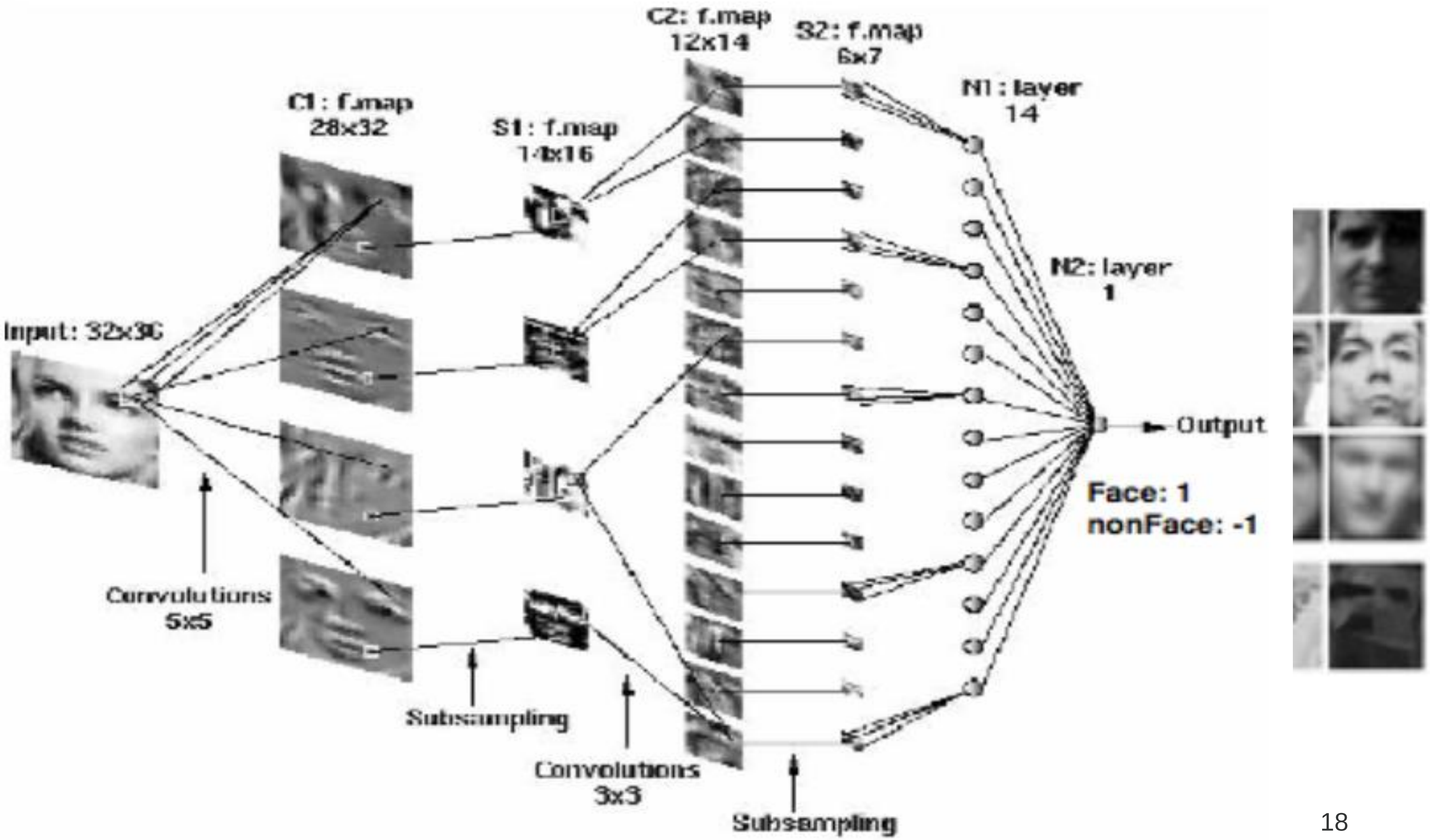
Adaptation des CNNs pour les visages



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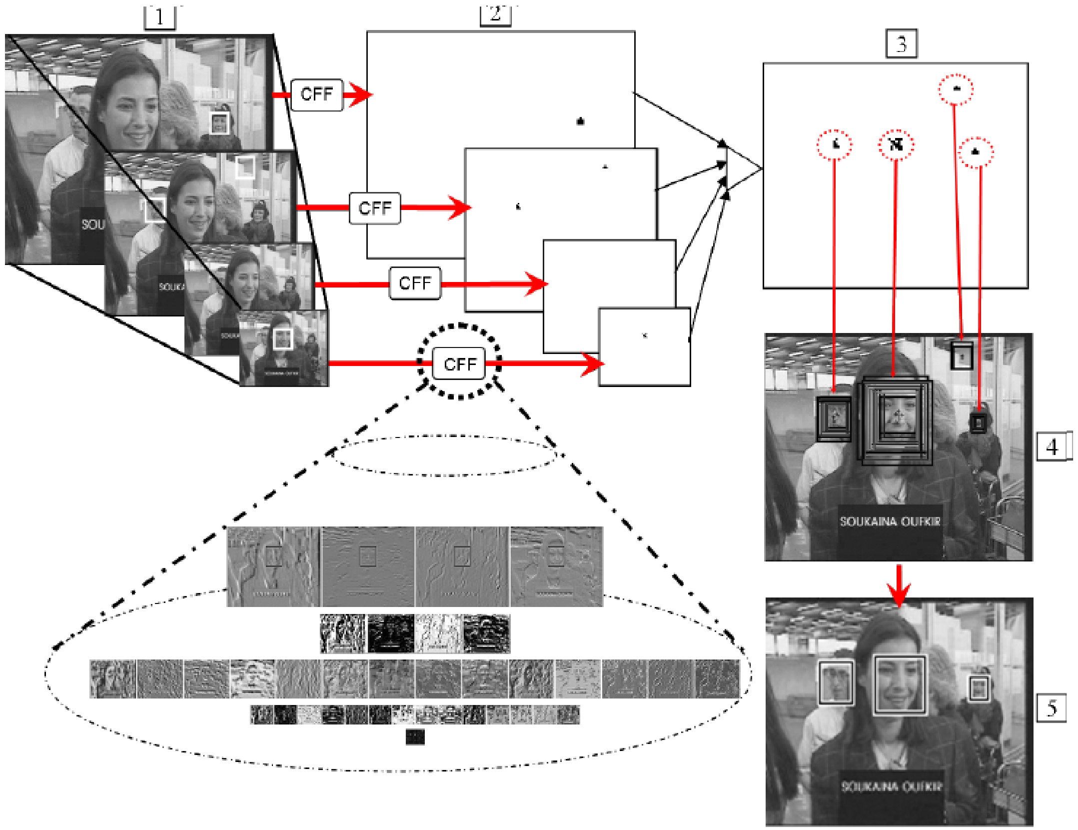
Système de détection CFF

1. Construire une pyramide d'images (facteur 1.2)
2. Appliquer CFF sur chaque image de la pyramide
   → Positions des visages candidates
3. Projeter et fusionner les positions candidates dans l'image originale
4. Appliquer CFF autour des positions candidates (position et échelle)
5. Filtrer les résultats en fonction du «volume» des réponses positives (*ThrVol*)



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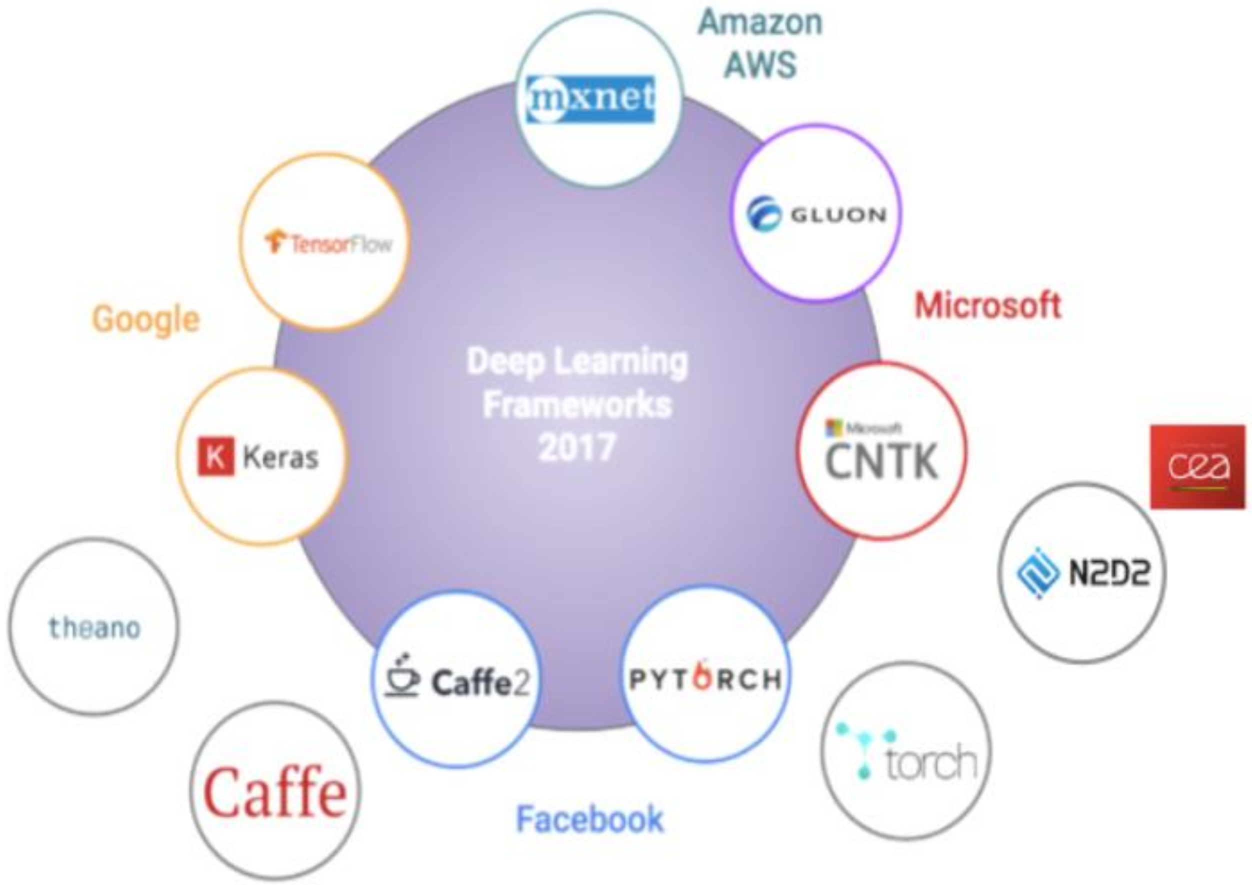
Frameworks pour développer des Deep Networks:

Numerous frameworks

- Most popular ones are open source
- Some are powered by “GAFAM”



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Utilisation de Keras:

Why use Keras…

- **Keras prioritizes developer experience**
- **Keras has broad adoption in the industry and the research community**
- **Keras makes it easy to turn models into products**
  - On iOS, via Apple's CoreML (Keras support officially provided by Apple).
  - On Android, via the TensorFlow Android runtime.
  - In the browser, via GPU-accelerated JavaScript runtimes such as Keras.js and WebDNN.
  - On Google Cloud, via TensorFlow-Serving.
  - In a Python webapp backend (such as a Flask app).
  - On the JVM, via DL4J model import provided by SkyMind.
  - On Raspberry Pi (direct Keras installation).

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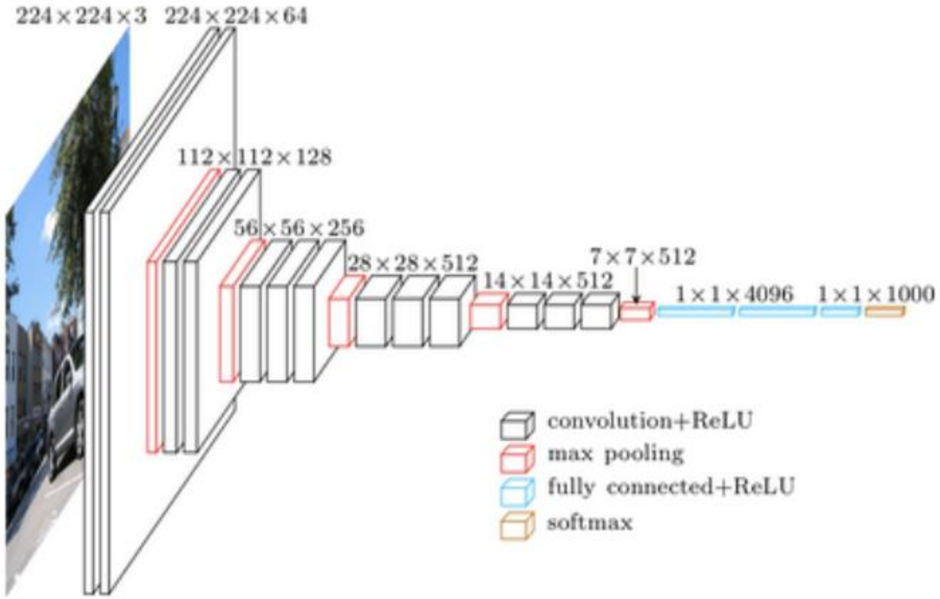
Ex de Deep Network

VGG-16



Simonyan, Karen, and Zisserman. "Very deep convolutional networks for large-scale image recognition." (2014)