

# Réseaux de neurones artificiels et apprentissage machine appliqués à la compréhension de la vision

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# Principes de la Vision

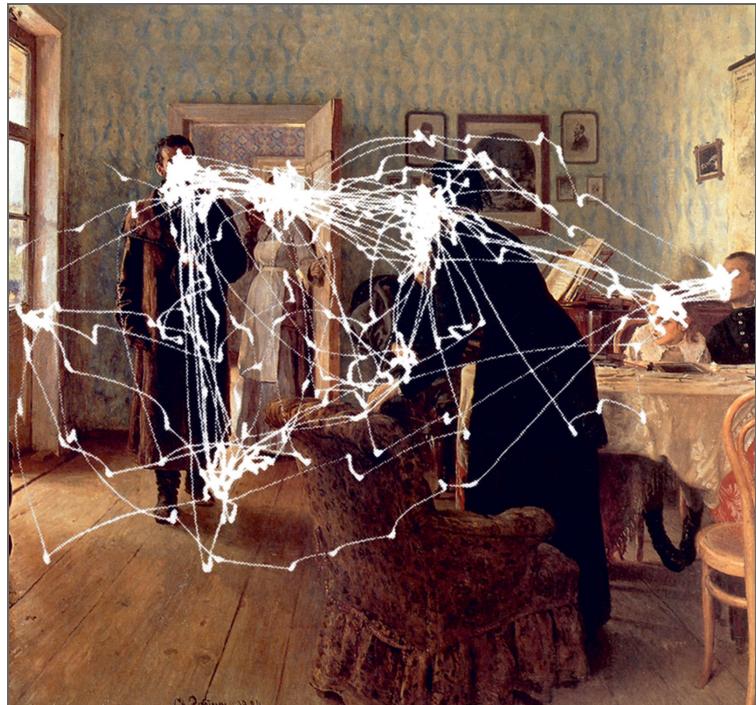


# À quoi sert la vision?



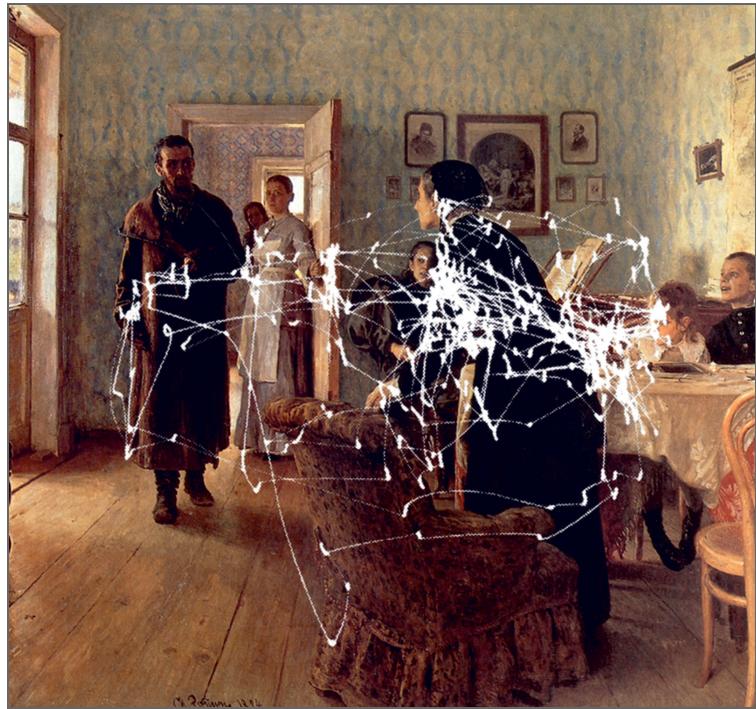
An Unexpected Visitor (Ilya Repin, 1884).

# À quoi sert la vision?



**An Unexpected Visitor (Yarbus, 1965)**

À quoi sert la vision?



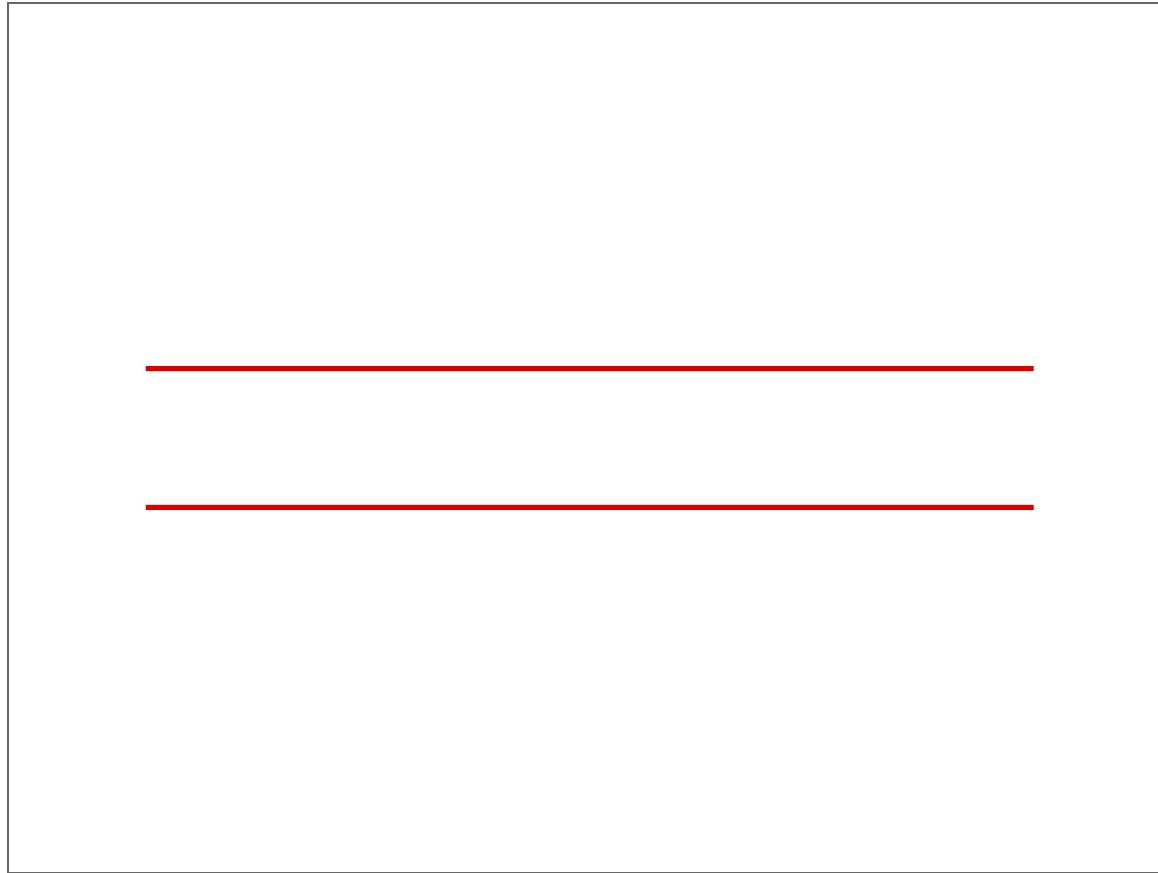
**An Unexpected Visitor - Age? (Yarbus, 1965)**

À quoi sert la vision?



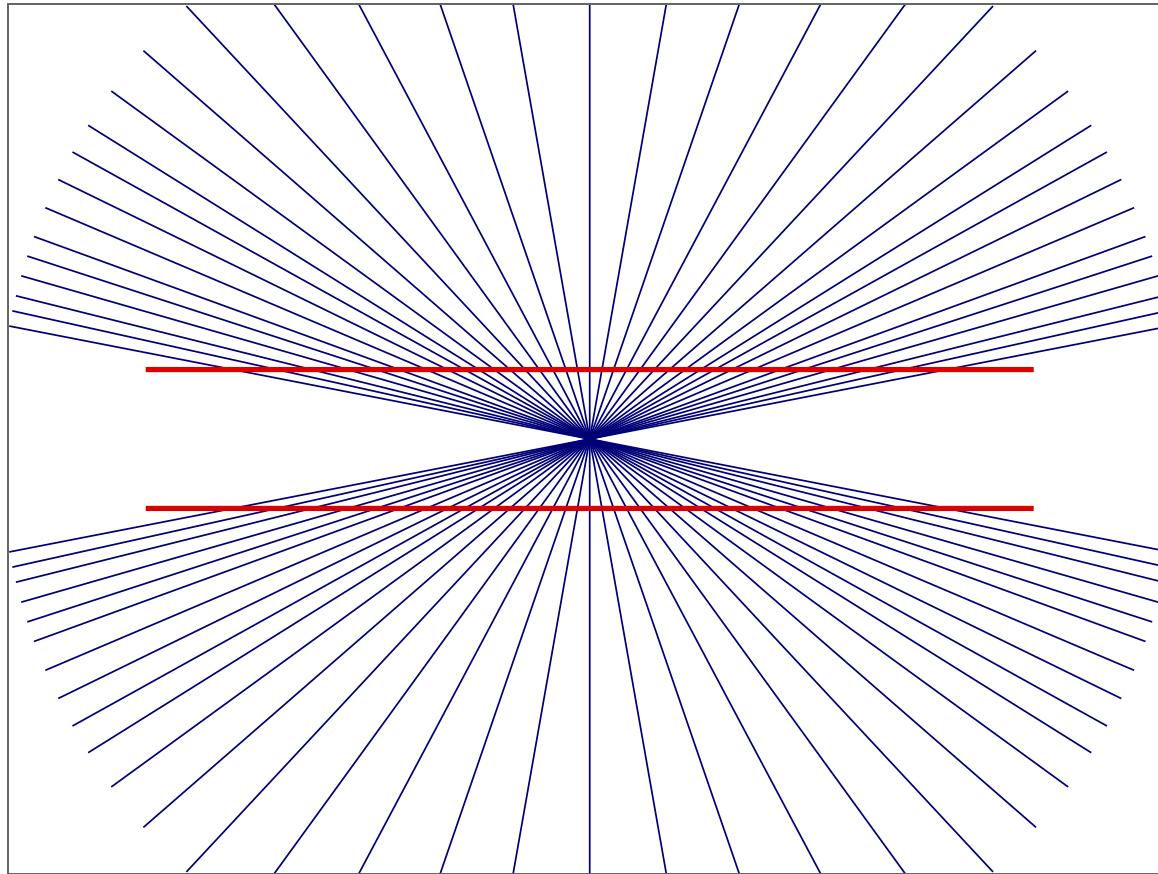
**An Unexpected Visitor - *How long?* (Yarbus, 1965)**

## Les illusions visuelles



## Hering illusion

## Les illusions visuelles



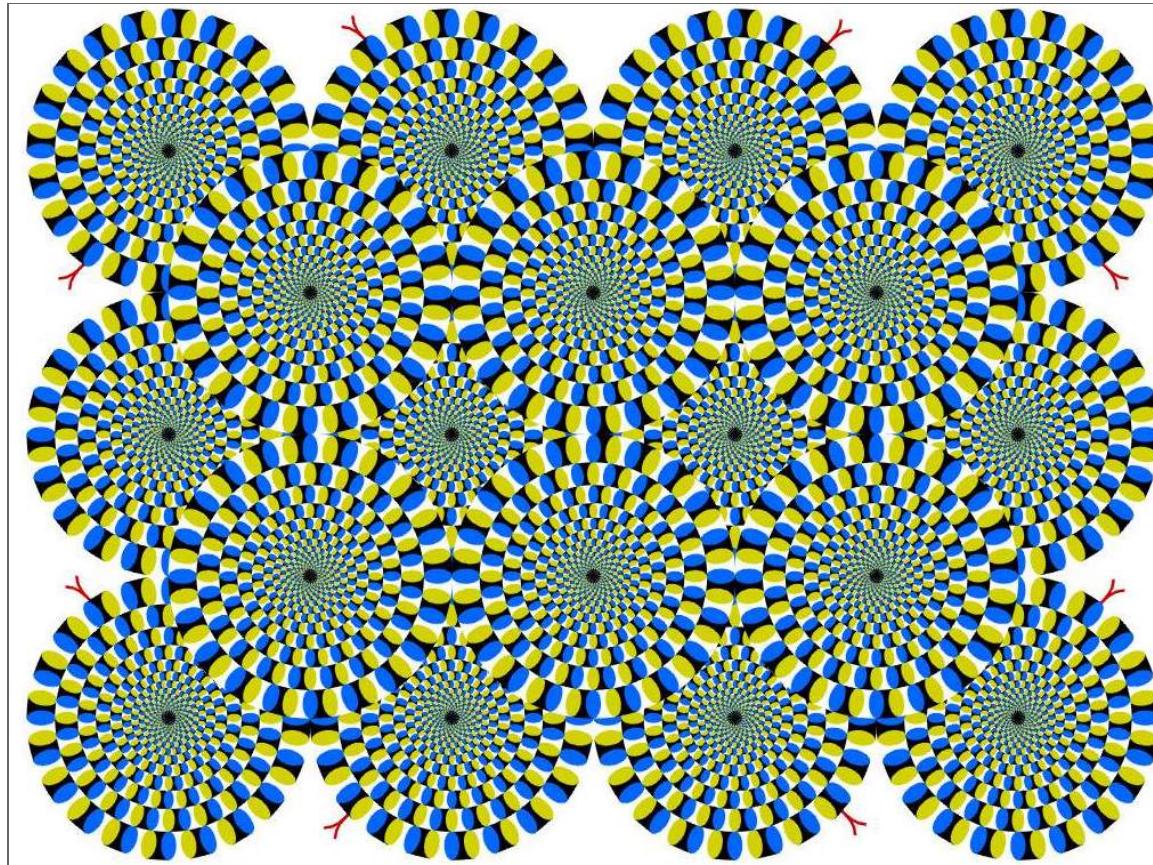
## Hering illusion

# Les illusions visuelles

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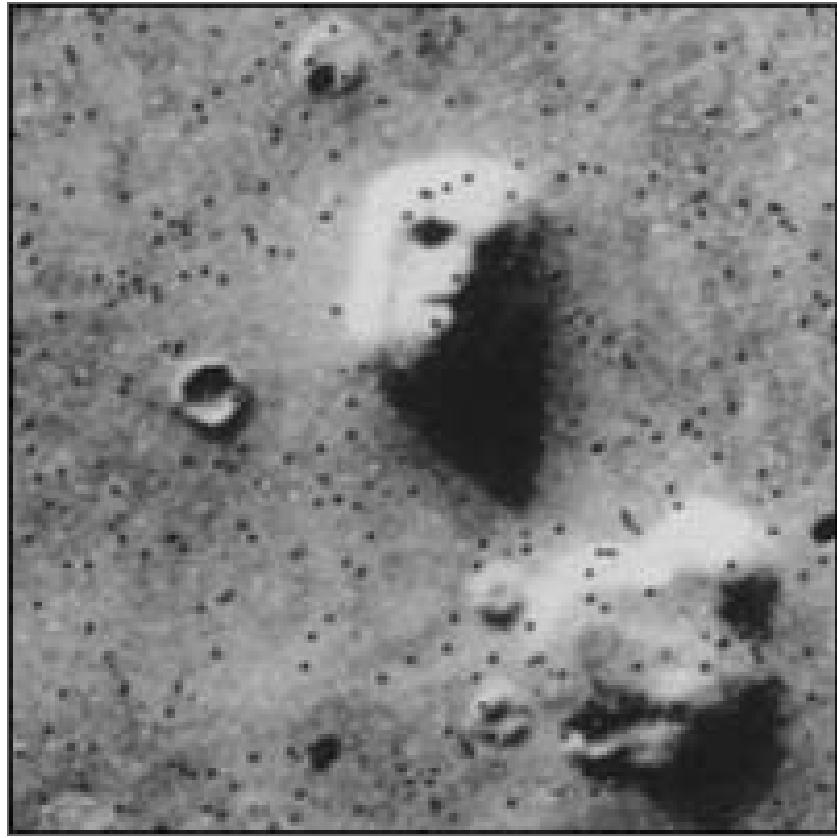
Illusions of brightness or lightness Akiyoshi KITAOKA

## Les illusions visuelles



Rotating Snakes Akiyoshi KITAOKA

## Les illusions visuelles : Paréidolie



Cydonia Mensae (1976) *Viking Orbiter image*

## Les illusions visuelles : Paréidolie



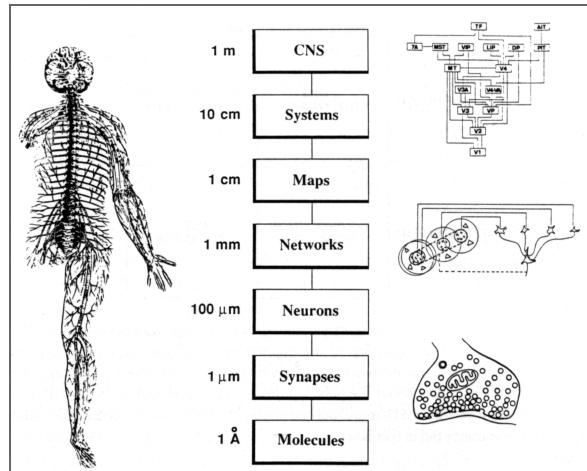
Cydonia Mensae (2007) Mars Global Surveyor

## Les illusions visuelles : Paréidolie



Cydonia Mensae (2007) Mars Global Surveyor

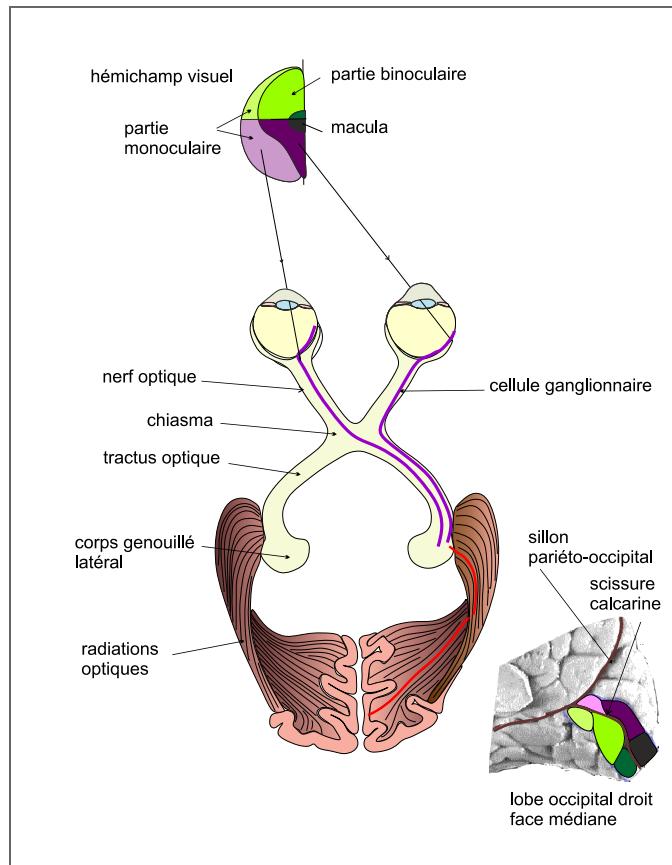
# Les neurosciences computationnelles



[Sejnowski, Koch & Churchland (1998)]

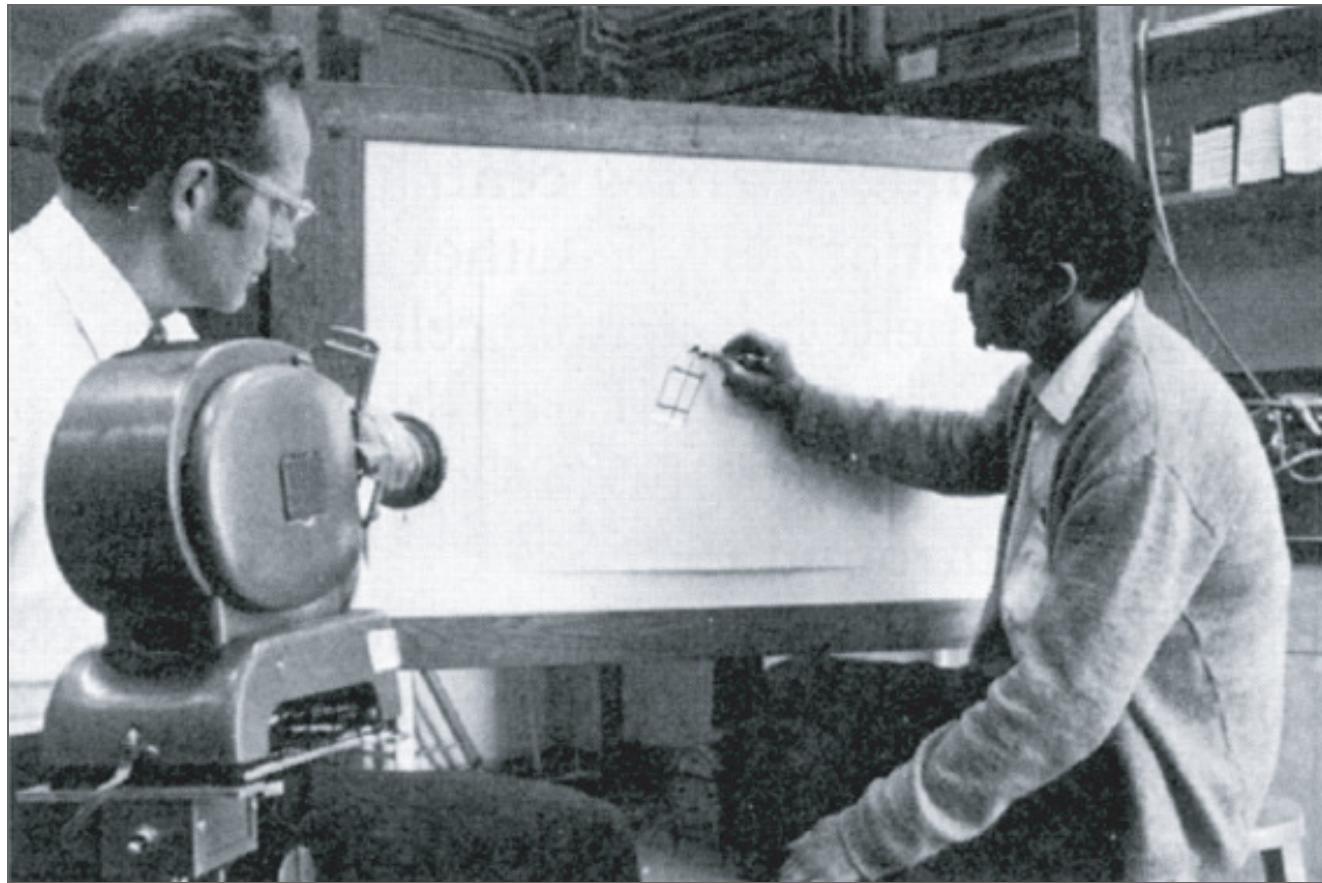
# De V1 aux réseaux convolutionnels

# Le système visuel



Système visuel humain (Wikipedia).

## Le cortex visuel primaire



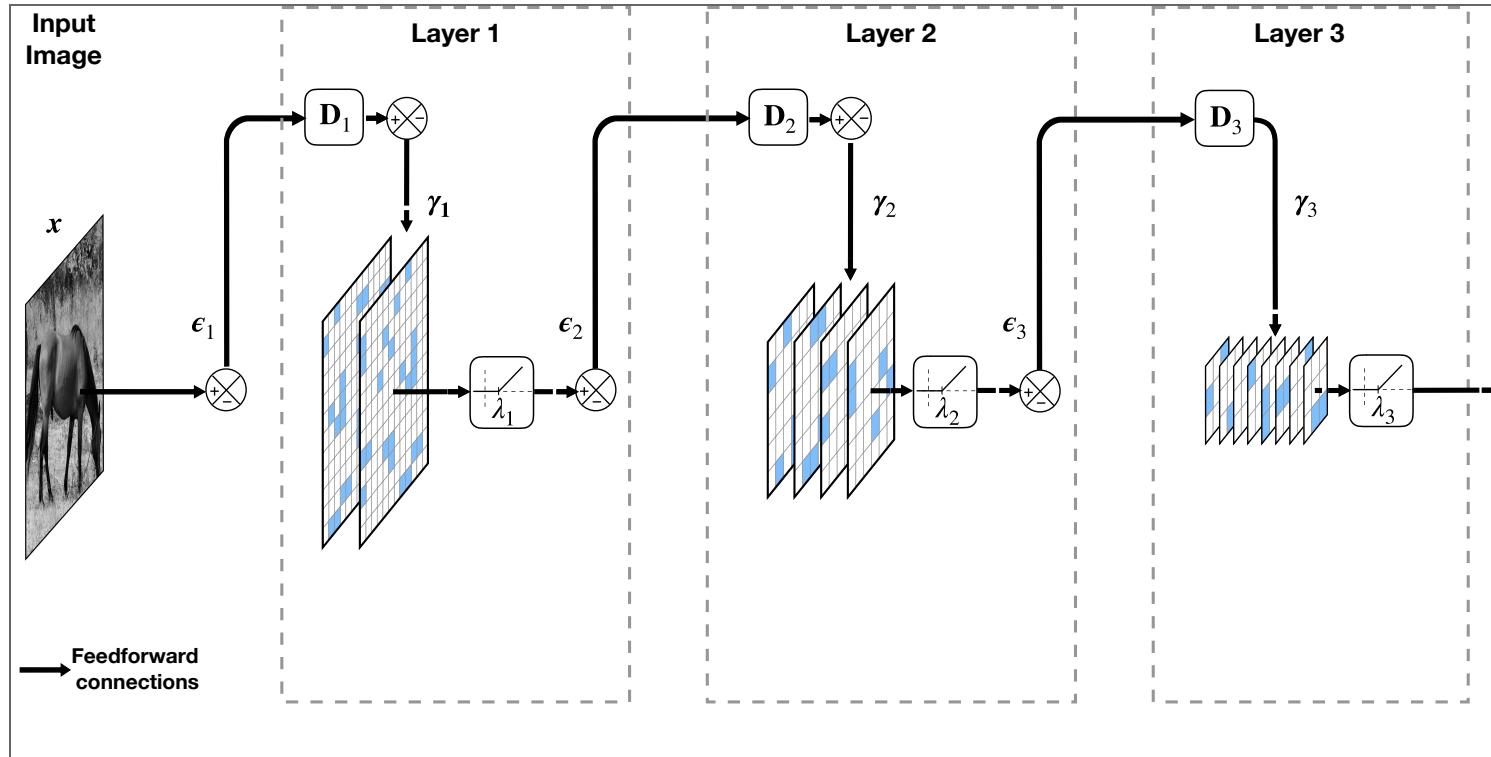
[Hubel & Wiesel, 1962]

# Hubel & Wiesel

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[Hubel & Wiesel, 1962]

# Réseaux convolutionnels : hiérarchie



[Boutin et al, 2021]

## Réseaux convolutionnels : Math

- Convolution discrète uni-dimensionnelle (eg dans le temps) avec un noyau  $f$  de rayon  $K$ :

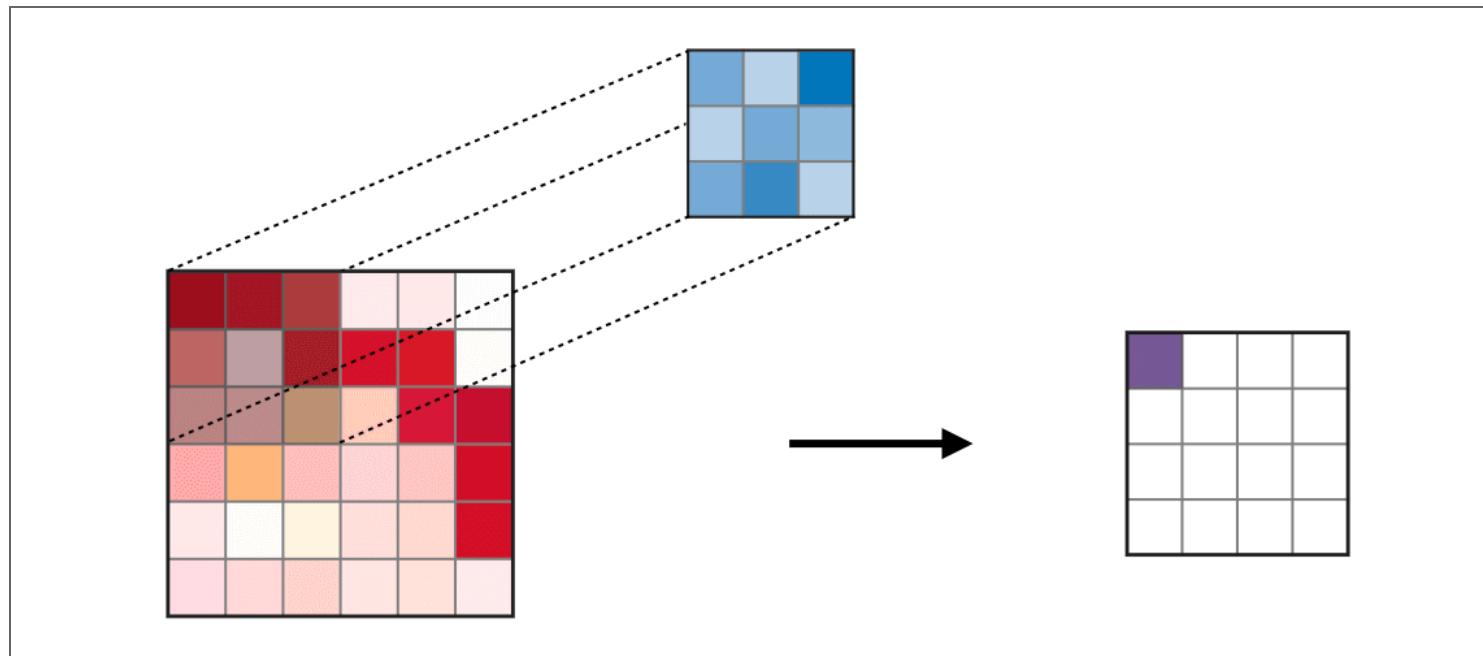
$$(f * g)[n] = \sum_{m=-K}^K f[m]g[n-m]$$

## Réseaux convolutionnels : Math

- Convolution discrète d'une image (bi-dimensionnelle):

$$(f * g)[x, y] = \sum_{i=-K}^K \sum_{j=-K}^K f[i, j]g[i - x, j - y]$$

# Réseaux convolutionnels : l'opération de convolution



**[Amidi & Amidi]**

## Réseaux convolutionnels : Math

- Convolution discrète d'une image sur plusieurs canaux de sortie:

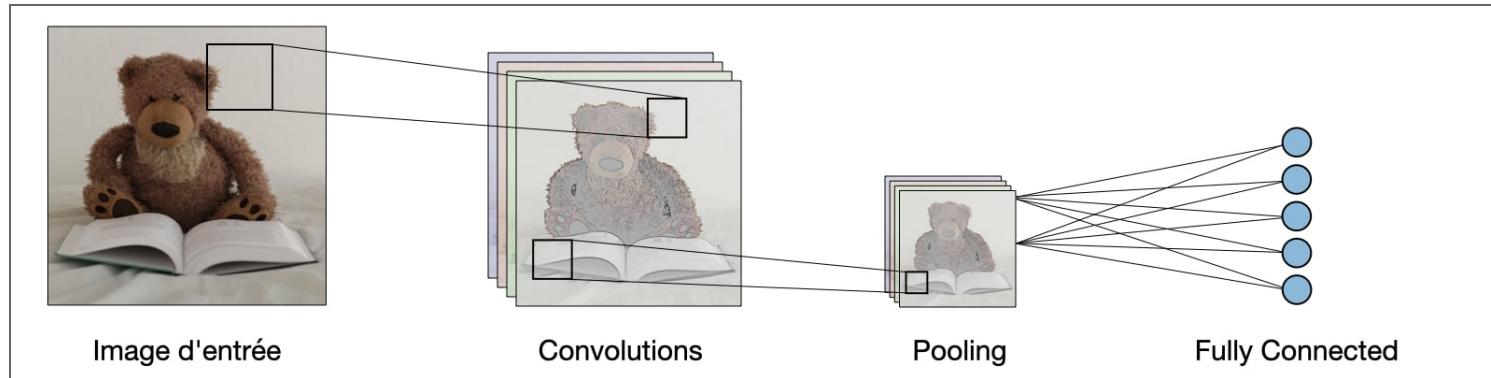
$$(f * g)[x, y, k] = \sum_{i=-K}^K \sum_{j=-K}^K f[k, i, j, k]g[i - x, j - y]$$

## Réseaux convolutionnels : Math

- Convolution discrète d'une image multi-canaux (eg. RGB) sur plusieurs canaux de sortie (noter l'ordre des indices):

$$(f * g)[x, y, k] = \sum_{i=-K}^K \sum_{j=-K}^K \sum_{c=1}^C f[k, c, i, j]g[i - x, j - y, c]$$

# Réseaux convolutionnels : CNN



**[Amidi & Amidi]**

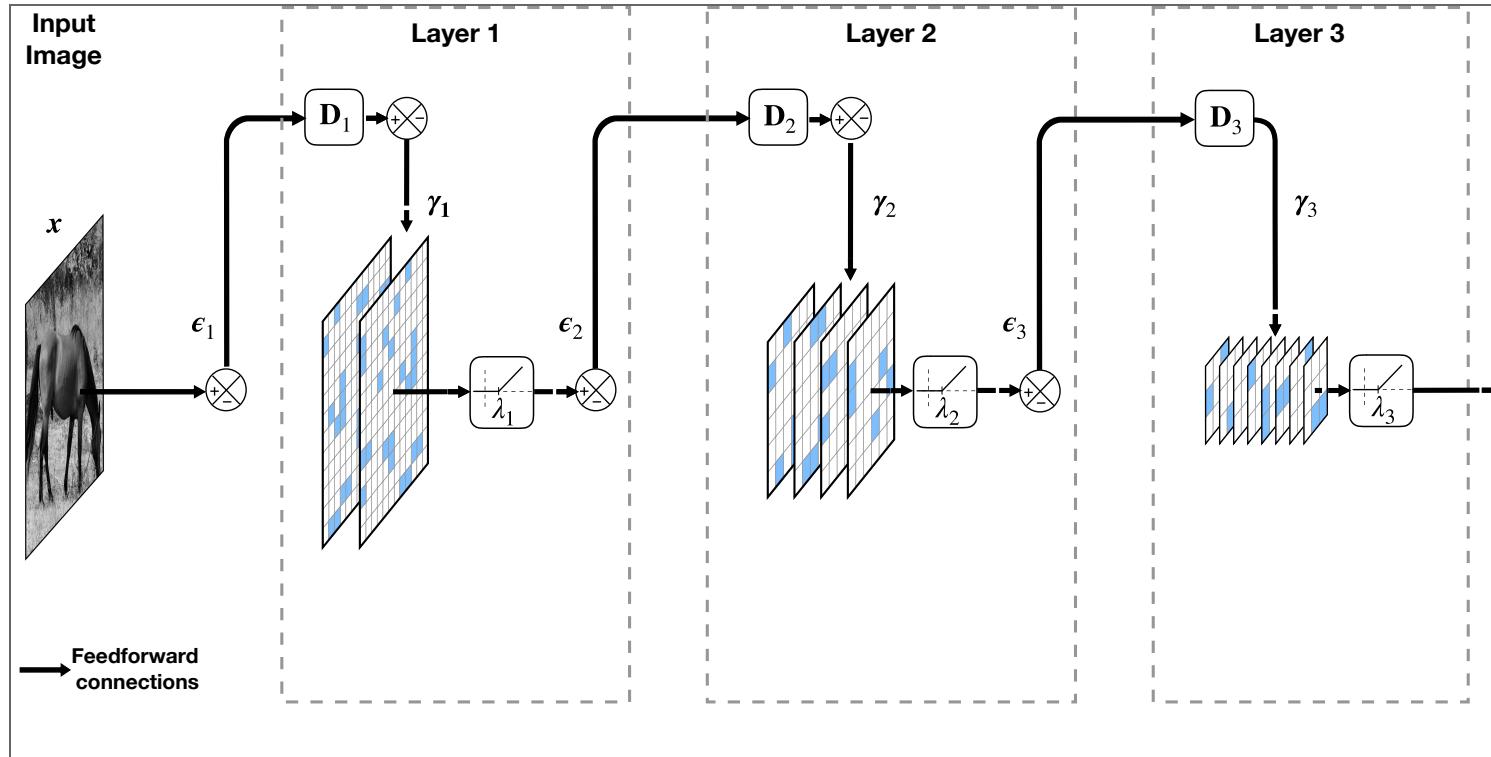
## Mise en pratique: détecter & apprendre

- Tutoriel Apprentissage profond
- Notebook A\_Détecter.ipynb
- Notebook B\_Apprendre.ipynb

# Perspectives

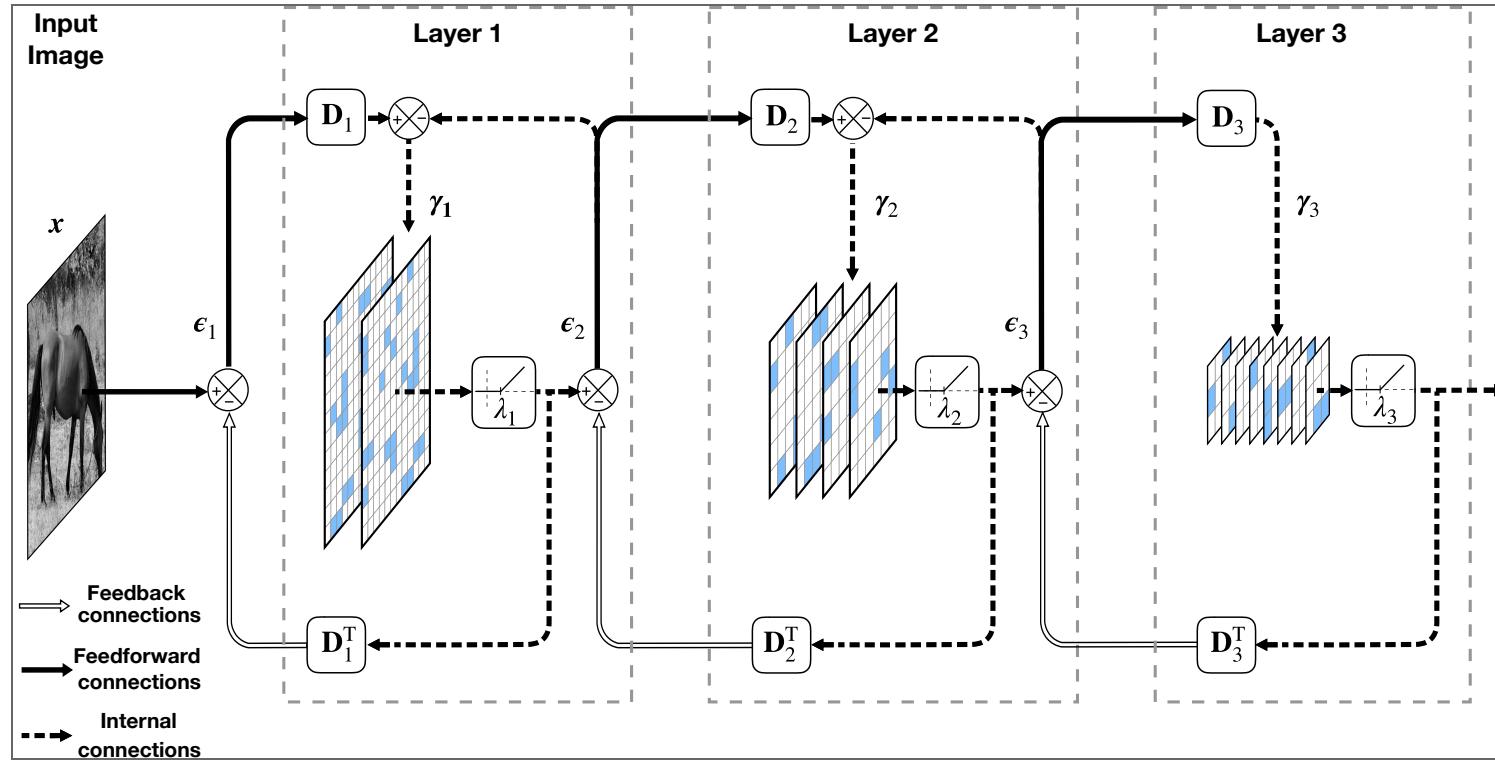


# Réseaux convolutionnels : hiérarchie



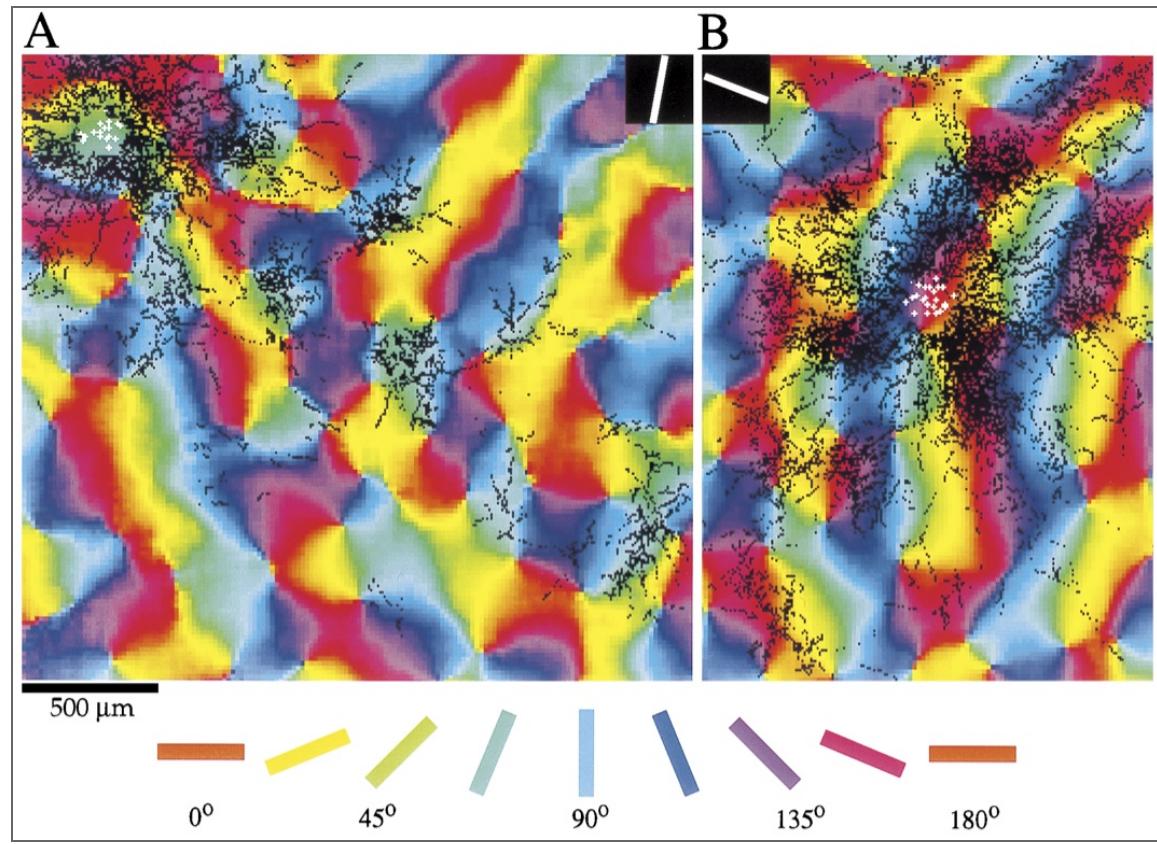
[Boutin et al, 2021]

# Réseaux prédictifs



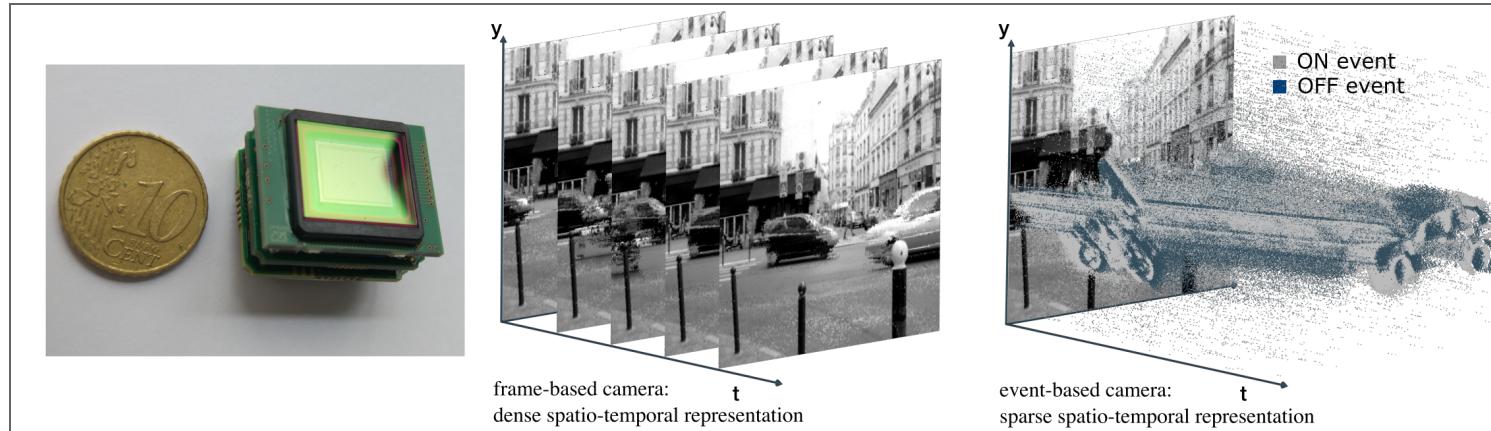
[Boutin et al, 2021]

# Topographie dans V1



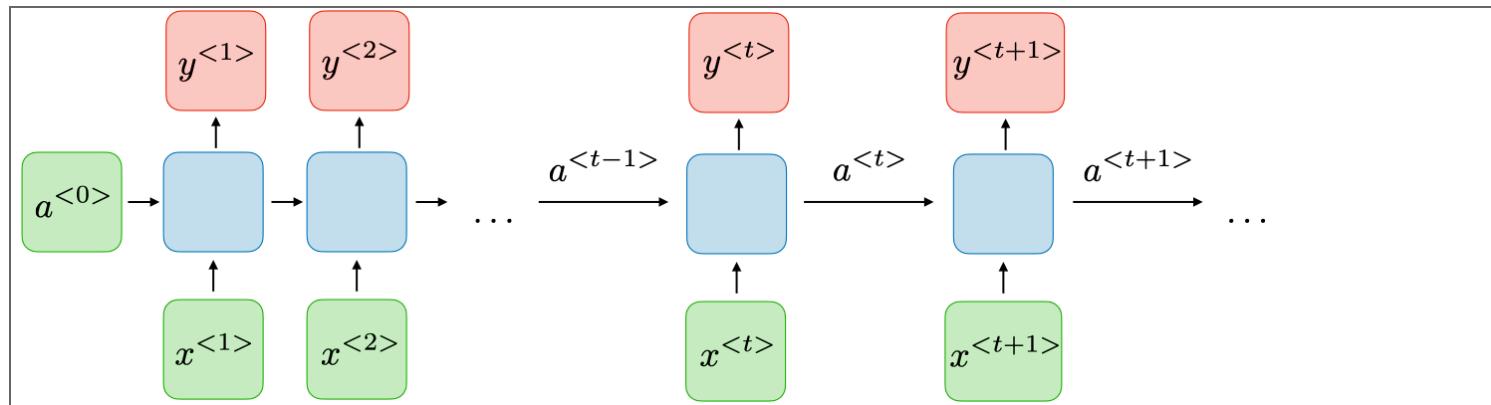
[Bosking et al, 1997]

# Spiking Neural Networks



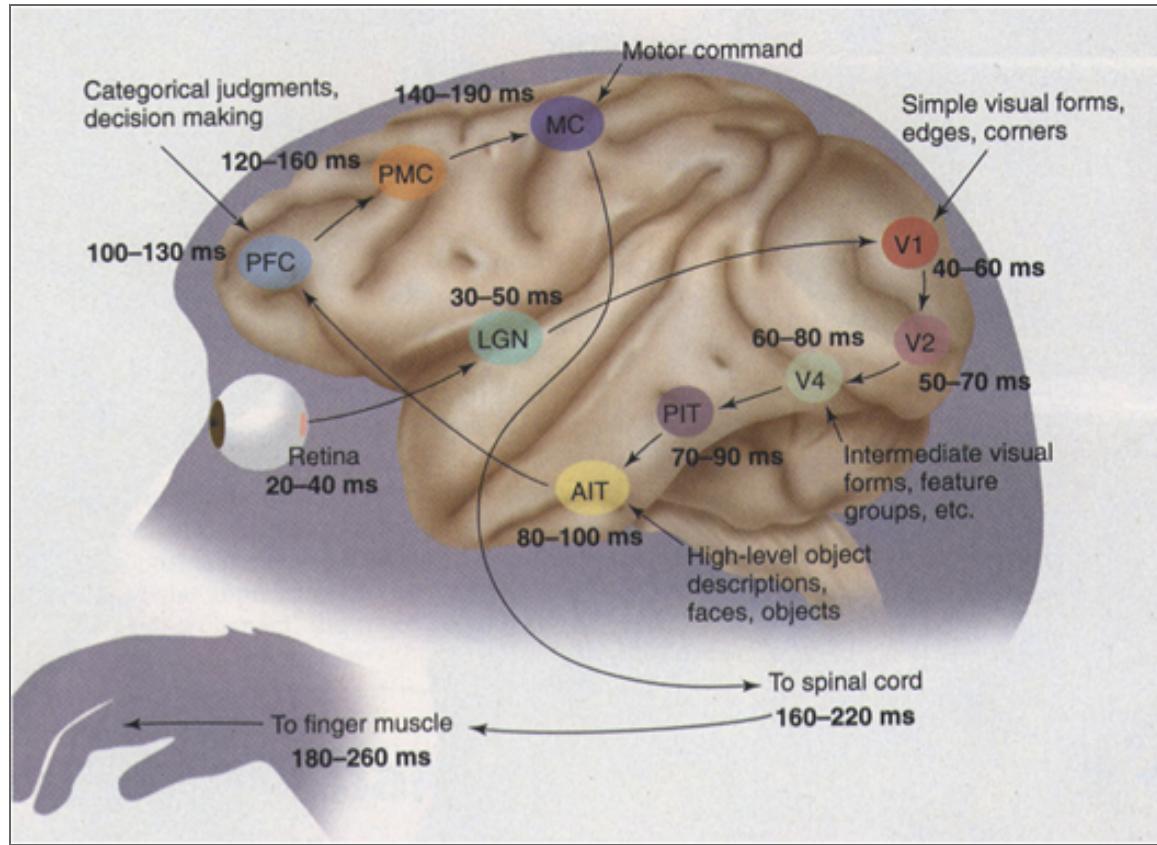
From frame-based to event-based cameras.

# Recurrent processing



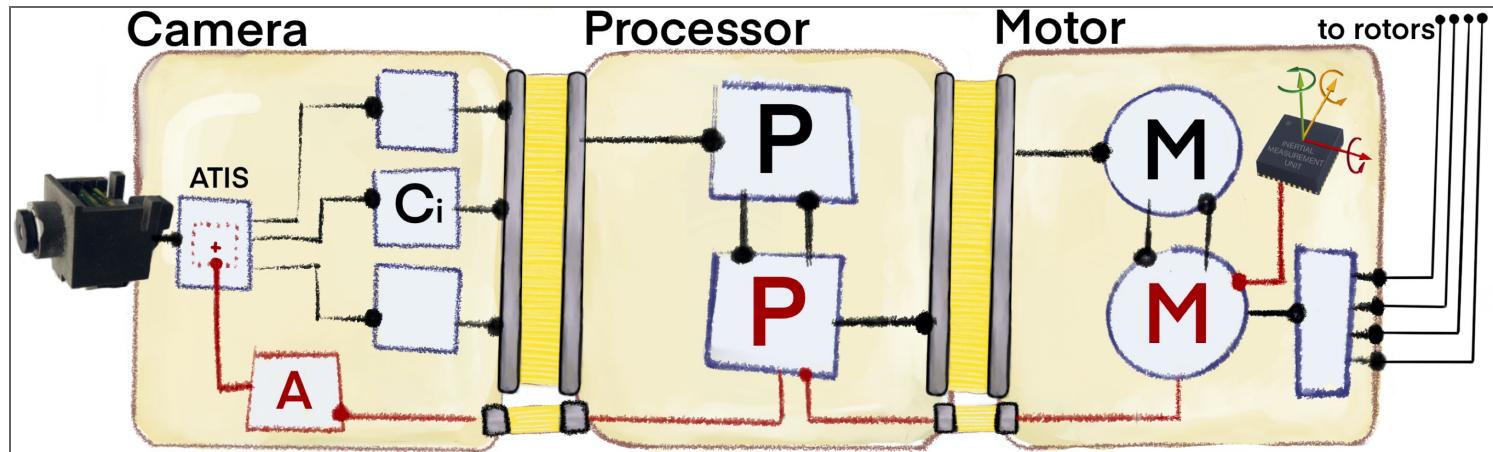
**[Amidi & Amidi]**

# Dynamique de la vision



[Thorpe (2001)]

# Applications robotiques



Our system is divided into 3 units to process visual inputs communicating by event-driven, feed-forward and feed-back communications.

# Questions?

Ask info @ [laurent.perrinet@univ-amu.fr](mailto:laurent.perrinet@univ-amu.fr)

More info @ [web-site](#)

