Review and Preview

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U2IS - ENSTA - IPParis

ecampus moodle: MI210 - Modèles neuro-computationnels de la vision (P4 - 2020-21)

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Plan

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23/03	**M + TD written and code**	**Intro to neuro, neurons, BNN and ANN**	**Implementational + Computational**	**Dynamical systems, Neural Networks**
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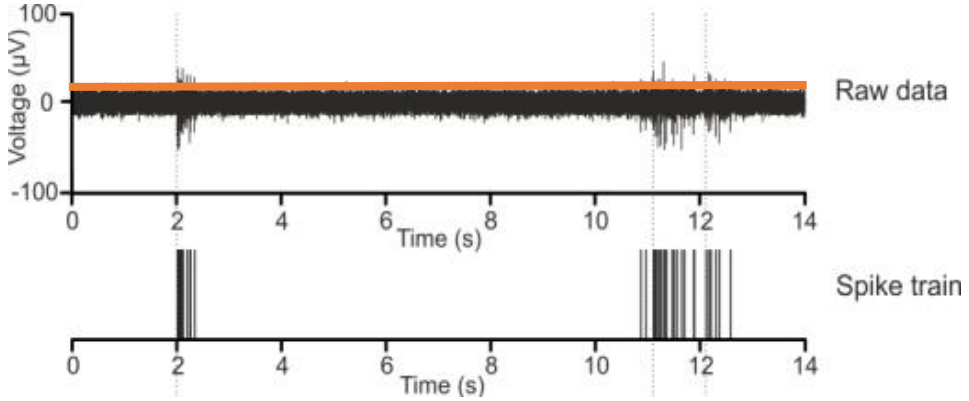
11/05	oral	General vision and brain	All	All above

Chapter 1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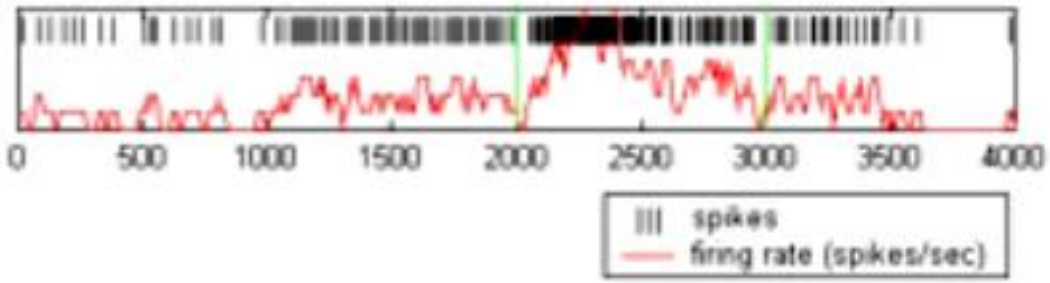
4
6
8
10
12
14
Time (s)
Raw data
Spike train
Time (s)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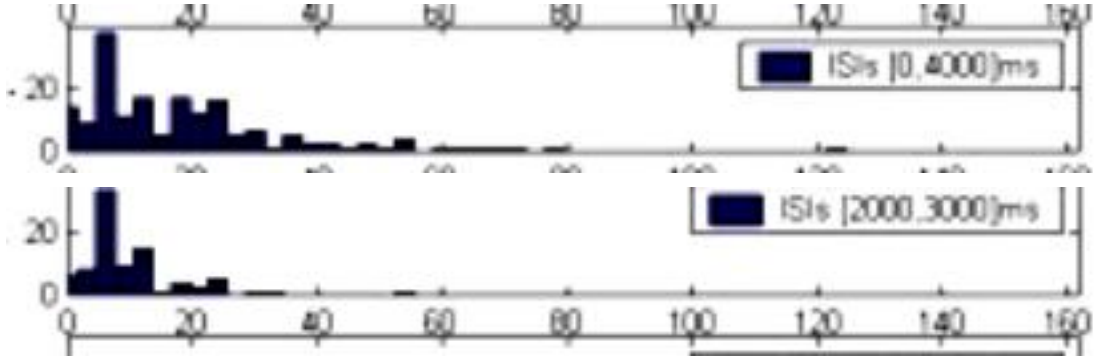
500
1000
1500
2000
2500
3000
3500
4000
spikes
firing rate (spikes/sec)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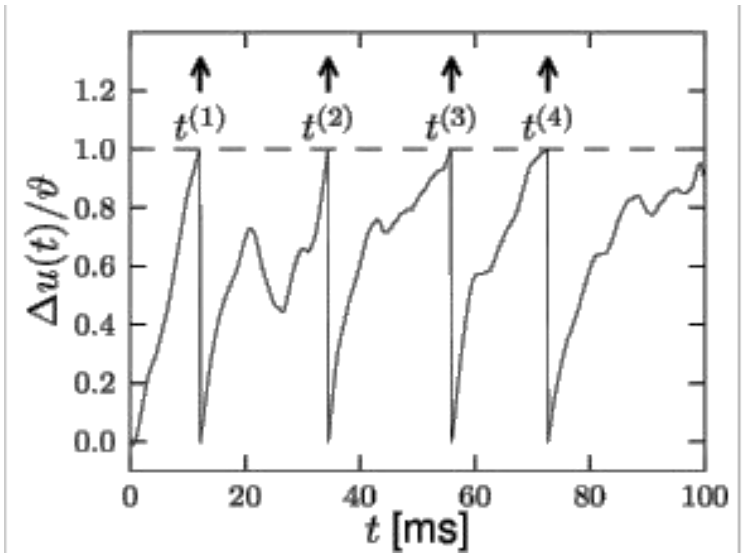
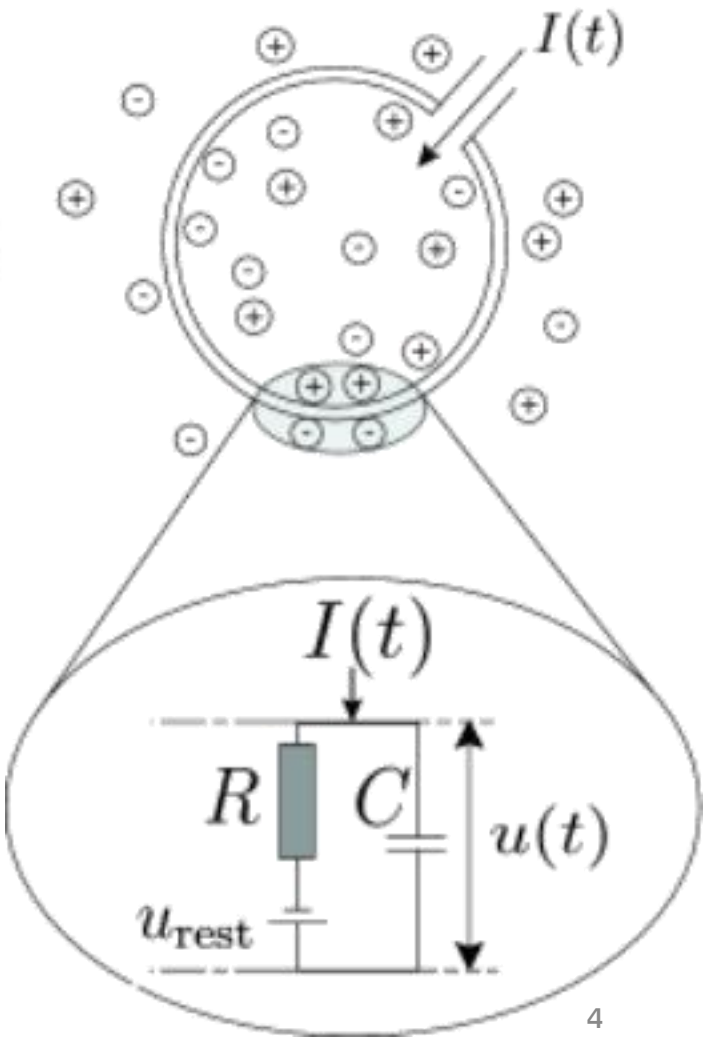
60
80
100
120
140
160

Chapter 1

$$V(t) = \begin{cases} V_{rest} & \text{if } V(t) = v_{th} \\ V_{rest} - \tau \frac{dV}{dt} + RI(t) & \text{o.w.} \end{cases}$$





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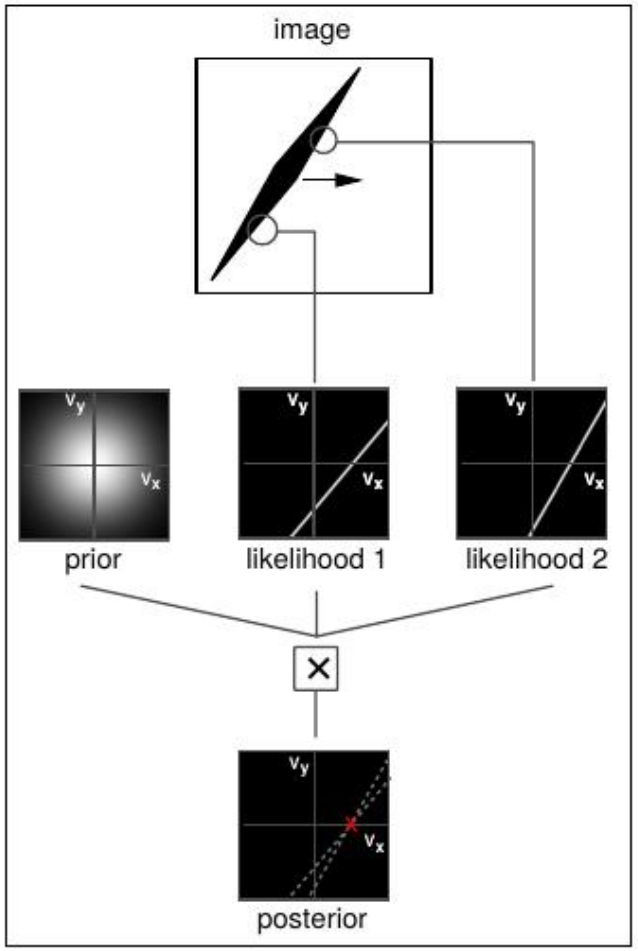
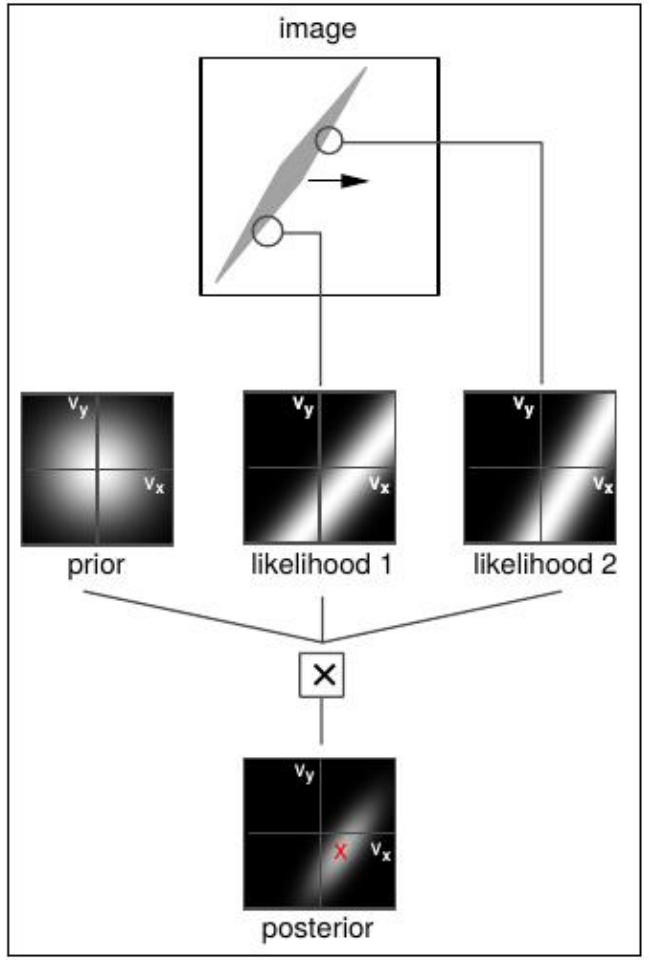
Chapter 2

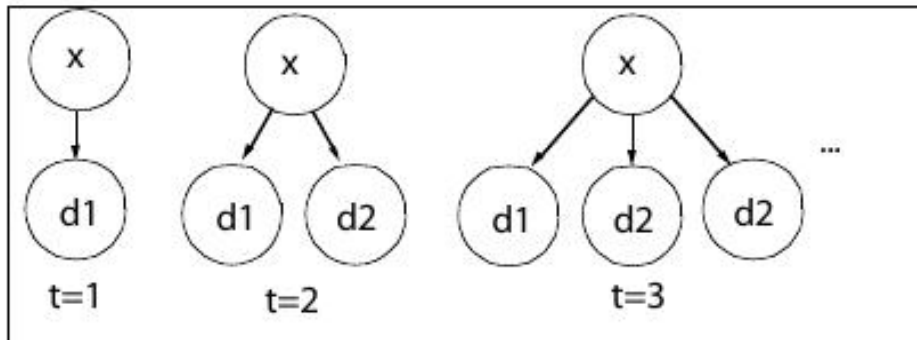




Weiss et al, 2002

Chapter 2

1. The generative model
2. **The inference process**
3. The distribution of the MAP estimate



$$p(x \mid d_1 \cdots d_N) \propto p(x) \prod_{i=1}^{N} p(d_i \mid x)$$

$$= p(x) p(d_N \mid x) \prod_{i=1}^{N-1} p(d_i \mid x) \propto p(x \mid d_1 \cdots d_{N-1}) p(d_N \mid x)$$

The posterior at time N-1 is the prior at time N

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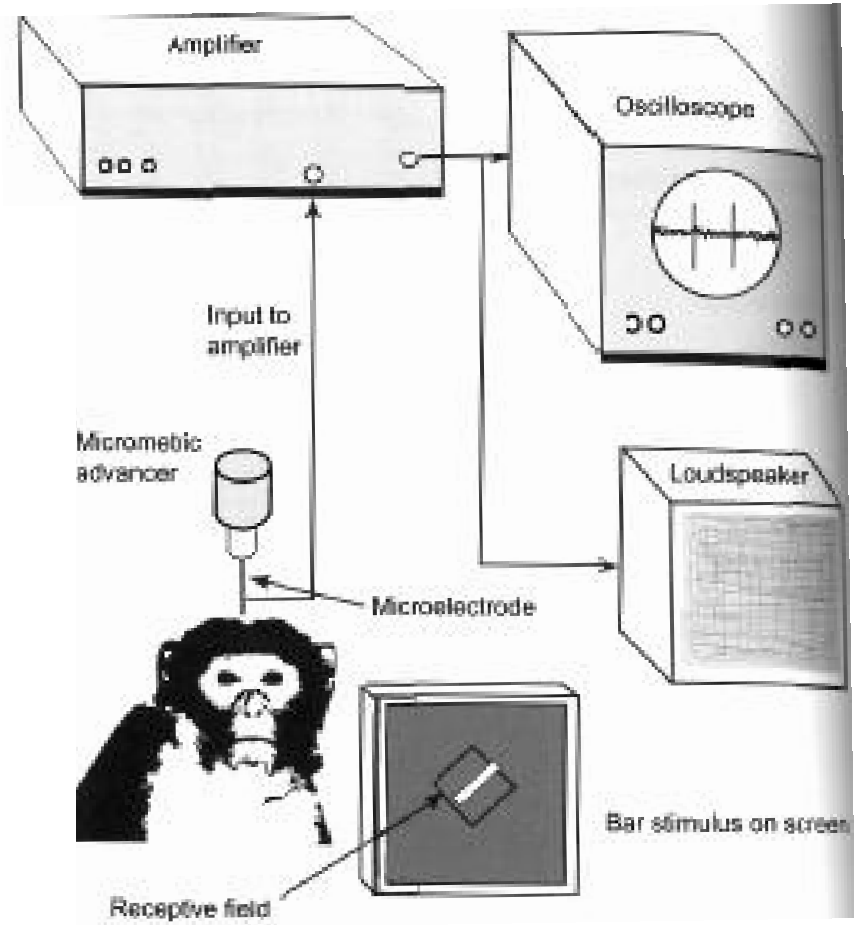
Neural Recordings

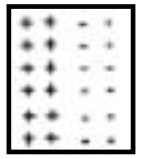


3.5 Single cell recording
The primate looks alert in the picture, and indeed fully conscious animals are sometimes used (the brain has no pain receptors). However, the animal is usually anaesthetized to achieve complete immobilization. This helps control accurately where the eyes are looking

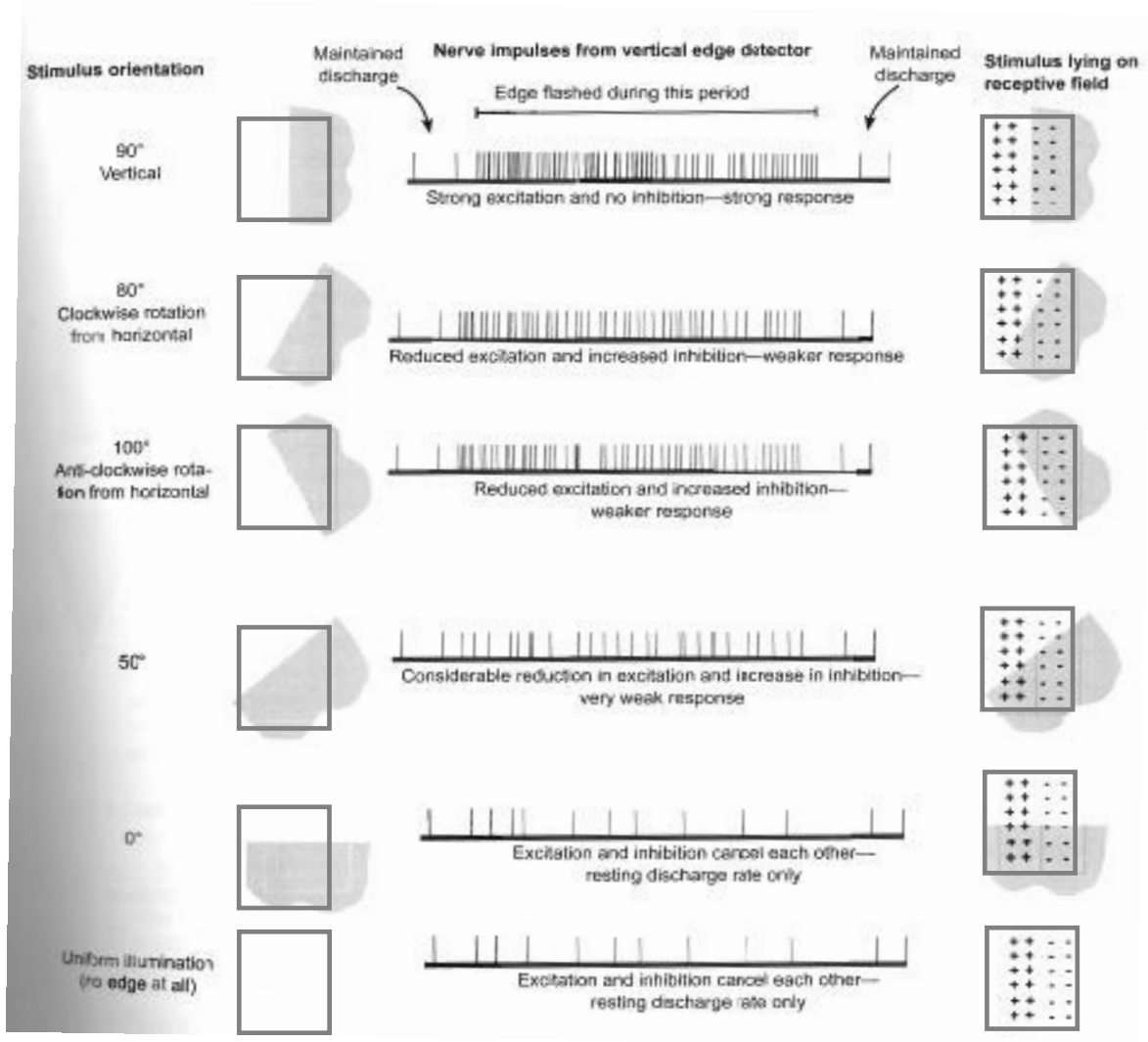
Seeing: The compuational Approach to Biological Vision

Receptive Fields as Templates

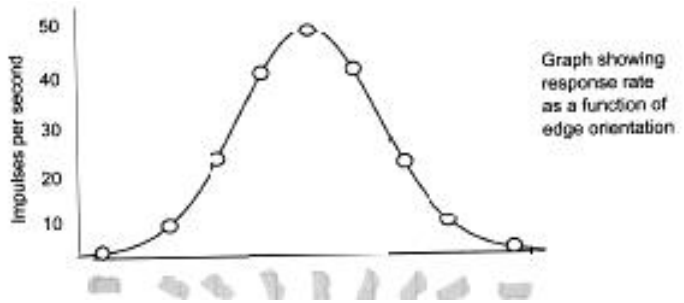
Receptive Field



Stimulus white is + black is -



Tunning Curve



Seeing: The compuational Approach to Biological Vision

Retina: structure

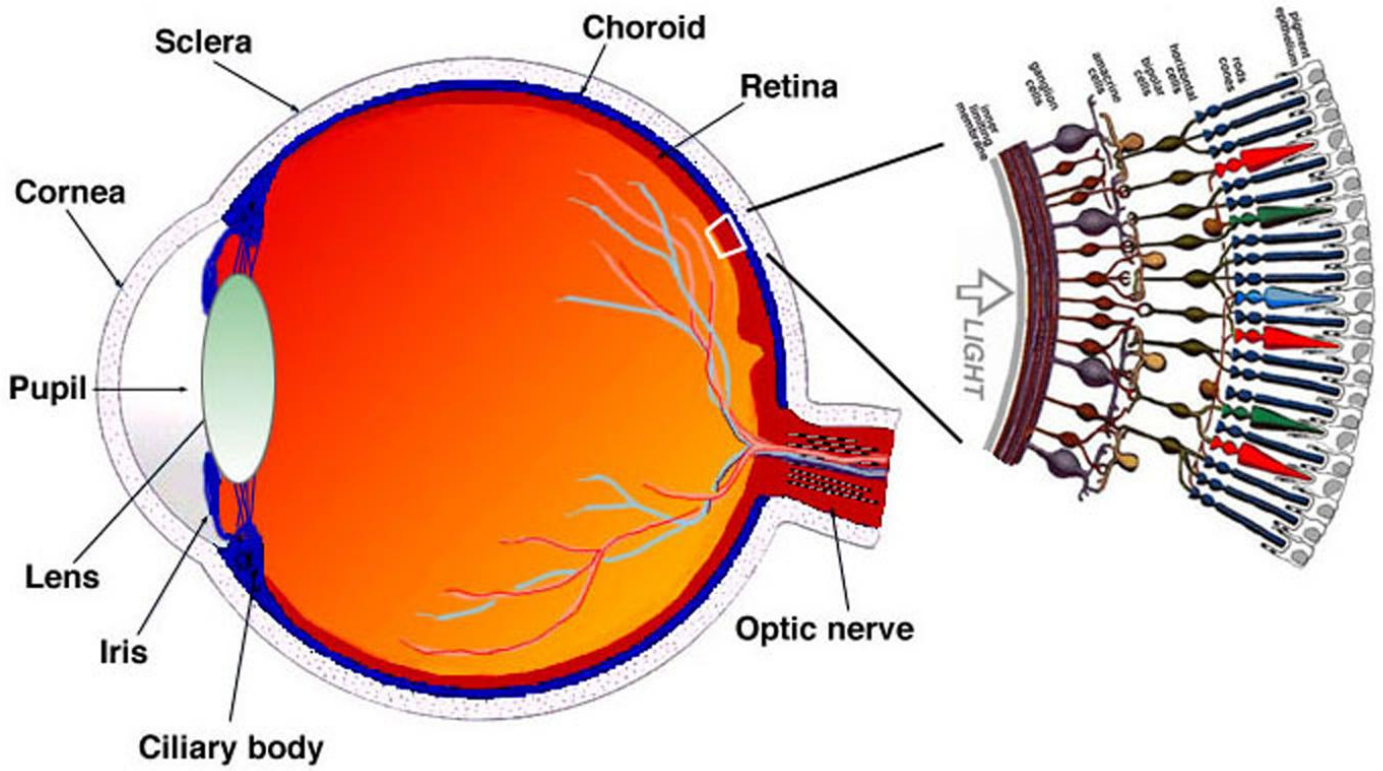
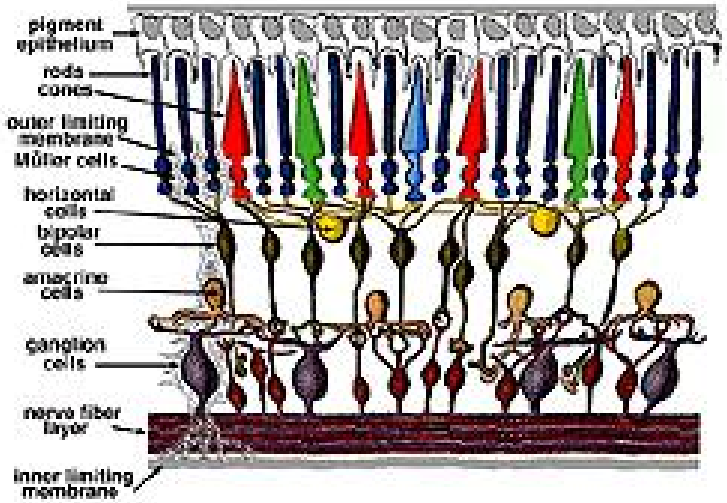
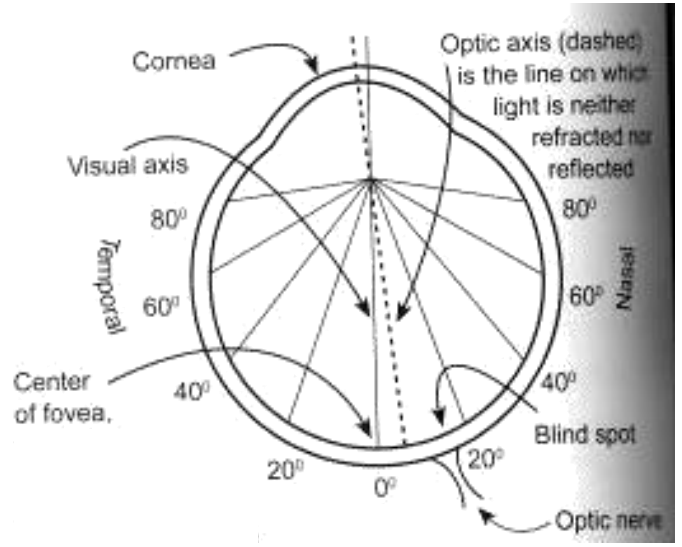


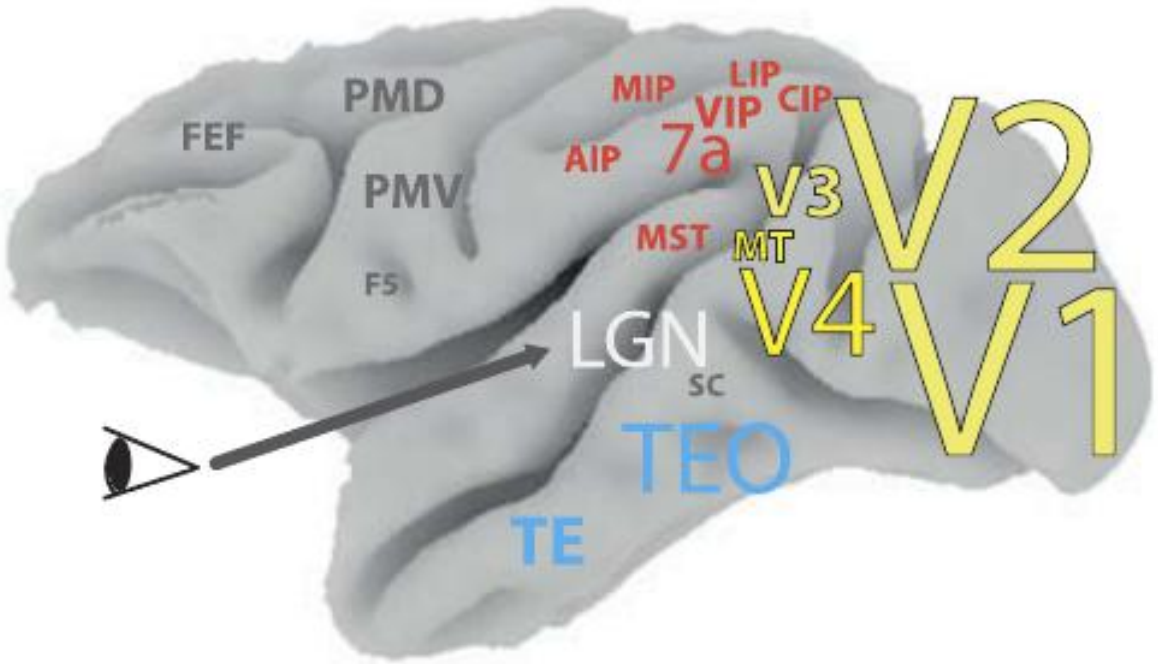
Fig. 1.1. A drawing of a section through the human eye with a schematic enlargement of the retina.





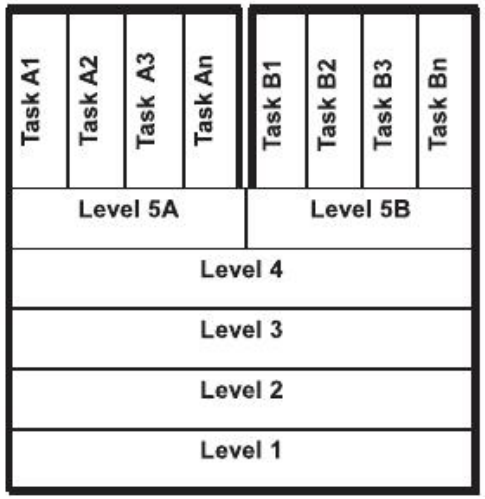
https://webvision.med.utah.edu

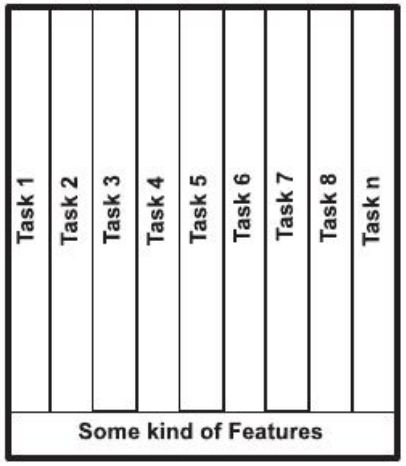
Structure: What are the areas responsible for visual processing

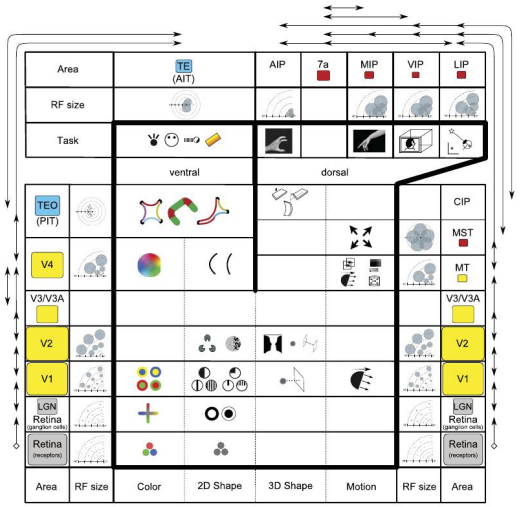


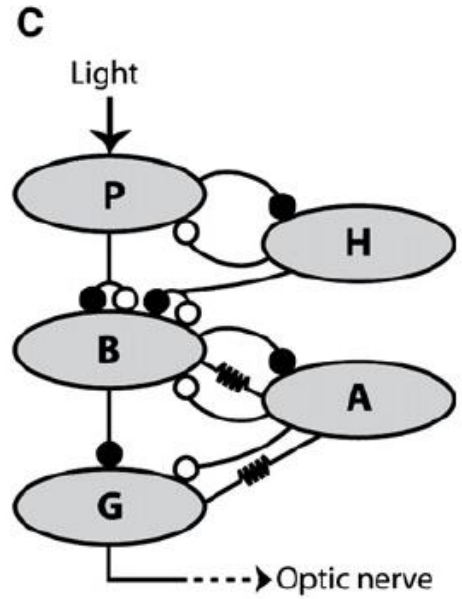
Krüger et al., Deep Hierarchies in the Primate Visual Cortex What Can We Learn for Computer Vision

Hierarchical vs flat hierarchies









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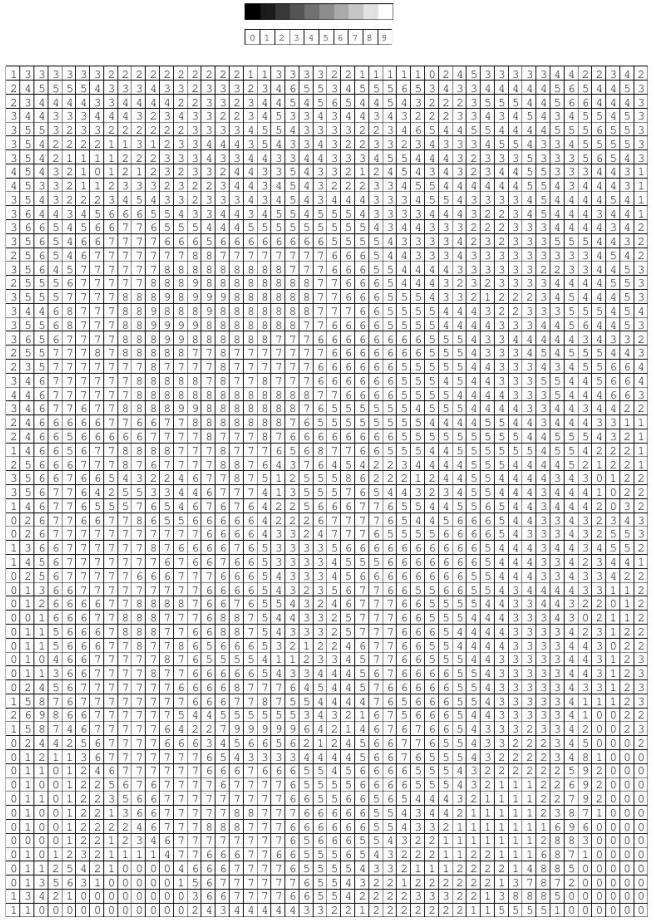
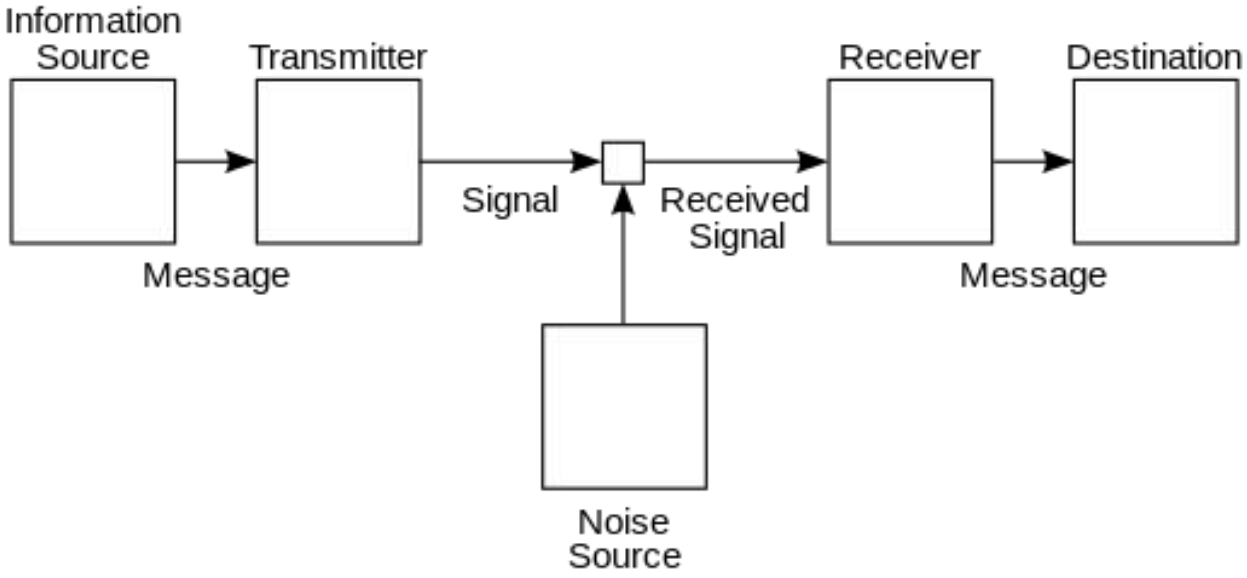
What is in here?



Hyvarinen et al, Natural Image Statistics, 2009

General Communication System



Example: Visual System

Information Source: Environment

Transmitter: Eye

Channel: Early visual system

Noise: Unknown

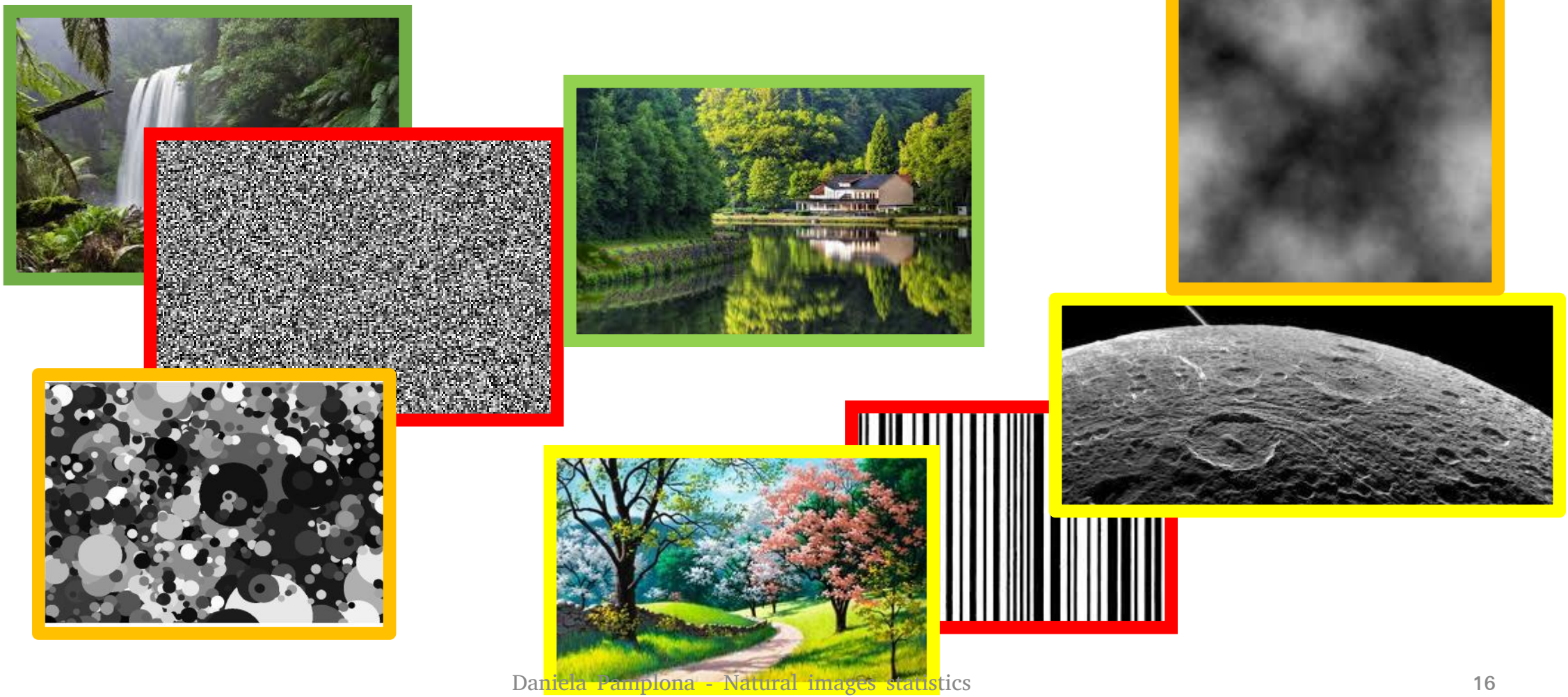
Receiver: Higher areas (MT,TE,MIP,..)

Destination: Other brain areas (PMC,..)

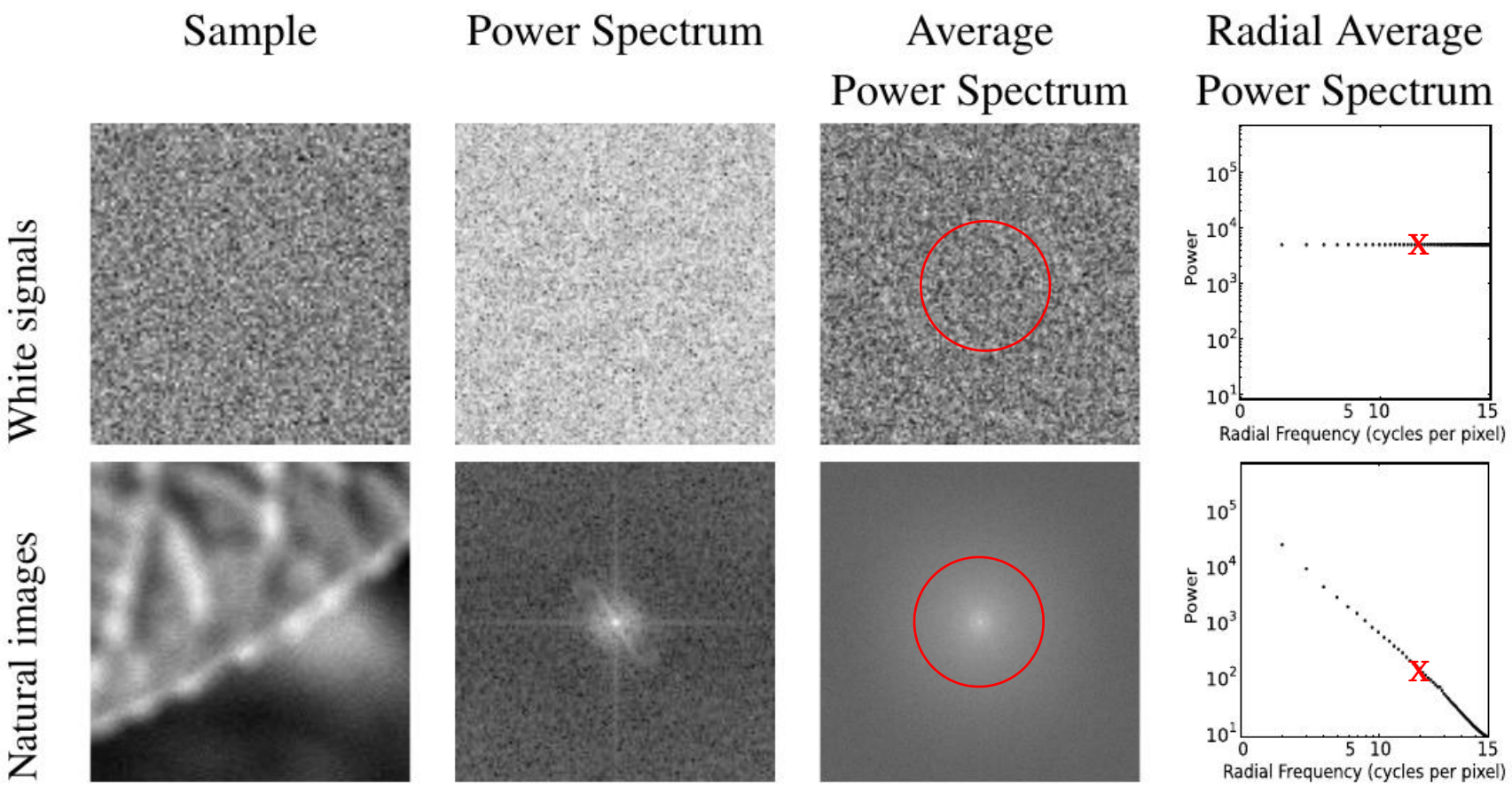
(ultimatly the environment)

What is the message?
What are natural images?

Non Natural Natural

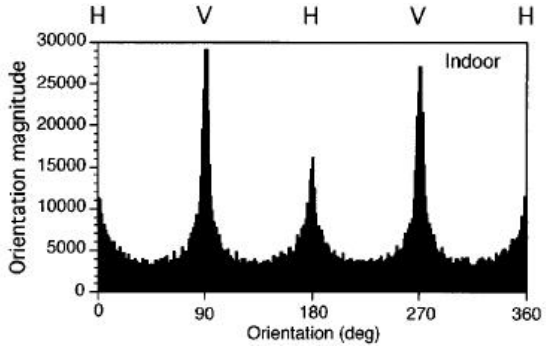


Power Spectrum of Natural Images

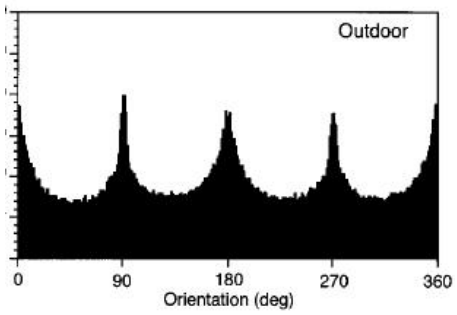


Analysis of edges orientations

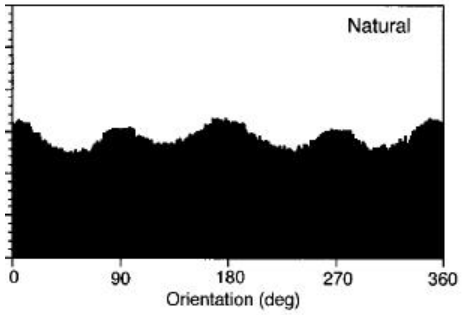
Indoor



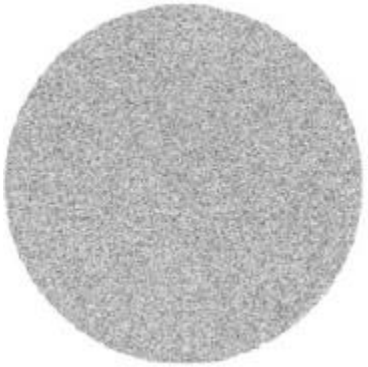
Outdoor

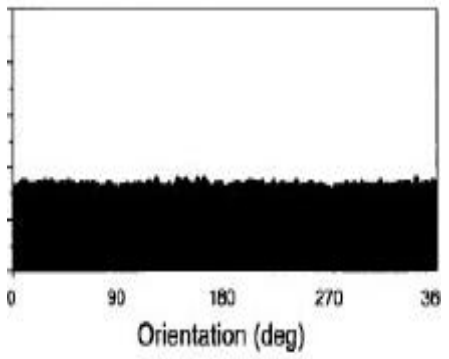


Natural



White Noise





The distribution of oriented contoursin the real world, Coppola et al

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Today

- Retinal Ganglion Cells Modeling
- Modeling the Retinal Ganglion Cells RFs considering the eye's imaging
- V1 Simple Cells Modeling