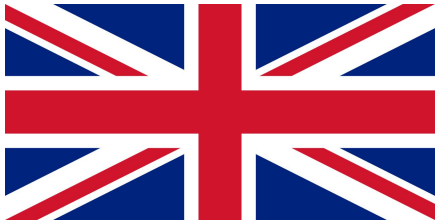

Neuro computational models of vision

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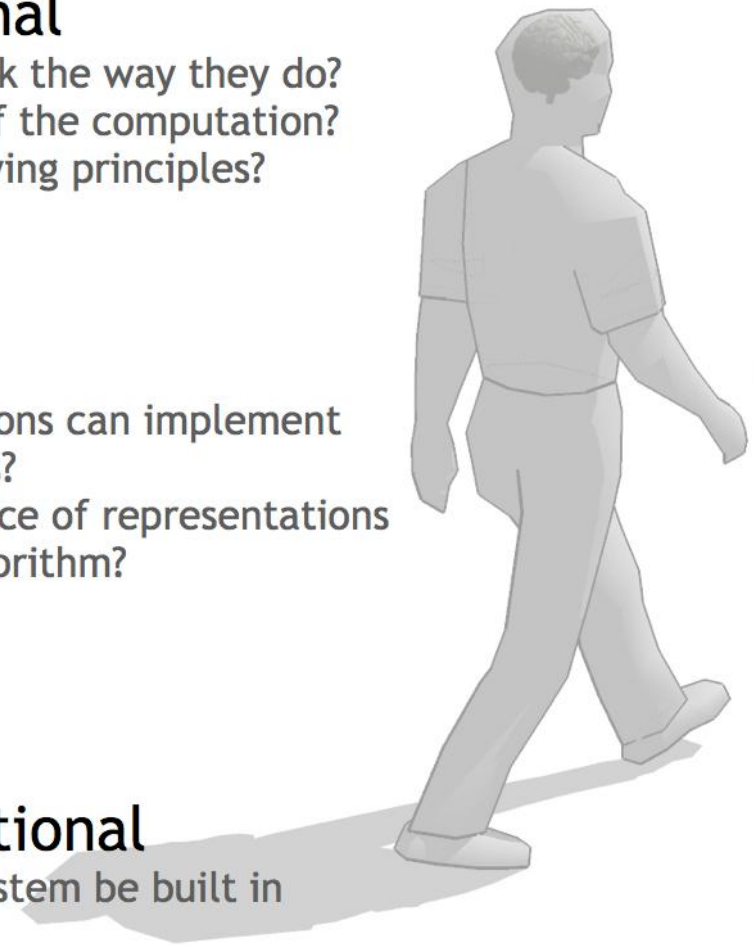
Pam... What?

Three levels of description *(David Marr, 1982)*

Computational

Why do things work the way they do?
What is the goal of the computation?
What are the unifying principles?

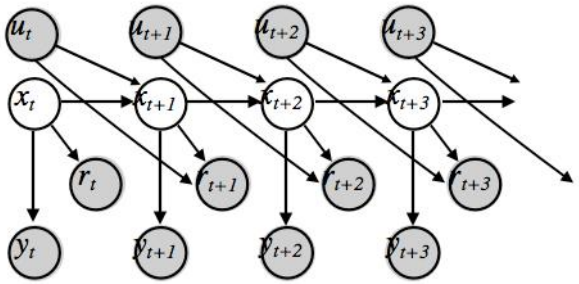


maximize:

$$R_t = r_{t+1} + r_{t+2} + \cdots + r_T$$

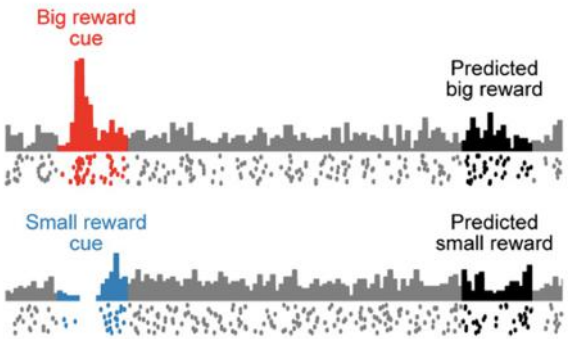
Algorithmic

What representations can implement such computations?
How does the choice of representations determine the algorithm?



Implementational

How can such a system be built in hardware?
How can neurons carry out the computations?



https://fias.uni-frankfurt.de/~rothkopf/docs/david_marr_3_levels.jpg

What is this class about?

We will:

- speak about computational models of vision: from neurons to eye movements
- focus on functional models of visual neurons: efficient coding
- apply biological models on artificial systems
- learn about machine learning

We will not:

- solve the visual processing in the brain
- look at equations carefully, rather we will develop intuitions on their meaning.
- learn thoroughly machine learning

Theoretical objectives

By the end of this class you should be able to:

1. Comprehend that the brain is a complex network with concurrent and multi-function modules
2. Understand how neurons communicate and basic properties of neural data
3. Model visual processing as a Bayesian approach
4. Know statistical properties of visual data
5. Know ecological approach to vision
6. Enumerate basic mechanisms of eye movements

Technical objectives

By the end of this class you should be able to:

- Program in python/jupyter
- Deal with neural simulators
- Work with hdf5 files
- Work with large image data sets

Other skills

By the end of this class you should be able to:

- Propose new methods and evaluate them
- Formalize basic probabilistic/graphical models
- Criticize your results
- Read and analyze a scientific article
- Present a scientific article

Organization

Magistral

- slides
- videos
- animations
- bibliography in the slide and/or in the end of the chapter
- no written notes

Exercises

- Python code/ Report/ Modeling exercises
- Analysis is more important than the code
- Software: jupyter
- Packages: numpy, scipy, h5py, scikits-learn, scikits-image, brian, neurodynex
- Deadline written in the exercise sheet.
- Graded between 0 and 20. Penalization of 2 per day of delay

Magistral + Exercises

- Mixture of both (hands on approach)
- Exercises starting in class finishing at home

Plan

Date	Type	Topic	Level of description	Methods
23/03	M + TD written and code	Intro to neuro, neurons, BNN and ANN	Implementational + Computational	Dynamical systems, Neural Networks
30/03	M + TD written	Probabilistic interpretation of visual processing	Computational	Probabilistic/ Bayesian Approaches
06/04	3 M(remote)	Vision and efficient coding	Computational + Algorithmic	Statistics
13/04	3 M (remote)	Receptive Fields, Retina and V1	Computational + Algorithmic	Unsupervised M.L.
27/04	3 TD (remote)	Applications to artificial vision	Computational + Algorithmic	Statistics +Unsupervised M.L.
04/05	M+TD written	Eye movements	Computational + Algorithmic	Reinforcement Learning
11/05	oral (remote?)	General vision and brain	All	All above

Plan

Date	Type	Topic		Methods
23/03	M + TD written and code	Intro t neuro ANN	+	Dynamical systems, Neural Networks
30/03	M + TD written	Probabilistic interpretation of visual	Computational	Probabilistic/ Bayesian Approaches
06/04	M(remote)	Vision coding		Statistics
13/04	M (remote)	Receptive Fields. Retina	Computational +	Unsupervised M.L.
27/04	TD (remote)	Applic artific		Statistics +Unsupervised M.L.
04/05	M+TD written	Eye movements	Computational +	Reinforcement Learning
11/06	oral (remote?)	Gener brain		All above

Some part of the exercise will be solved indivisually in the class, the remaining at home in groups

Totally remote in zoom

Totally remote in zoom

Your call

Paper presentation

Virtual or in presence?

Choose!

Evaluation

Begin	Deadline	Type	Weight
23/03/2021	30/03/2021	written text and code	2.5
30/03/2021	06/04/2021	written text	2.5
06/04/2021	04/05/2021	written text and code	6
04/05/2021	04/05/2021	written text	3
04/05/2021	11/05/2021	presentation	3
23/03/2021	11/05/2020	oral / participation	2

Classes; forums and others

Questions??

- All the equations/methods are in the slides. Before making a question, please verify that it is not there.
- If there is a problem with the supporting material (file not opening, corrupt data, typos, question ill posed, strange English, sound effects): send me immediately an email.
- Use the moodle tools, use email, make questions