Introduction to Neural Computation – 9.40

- Prof. Michale Fee, Instructor
- Daniel Zysman, Technical instructor

R-01 TAs

- Xiaochen Sun
- Andrew Bahle

R-02 TAs

- Andrés Campero-Núñez
- David Zhou

Graders

- Katrina Mikofalvy
- Maya Jay
- Vivian Hu

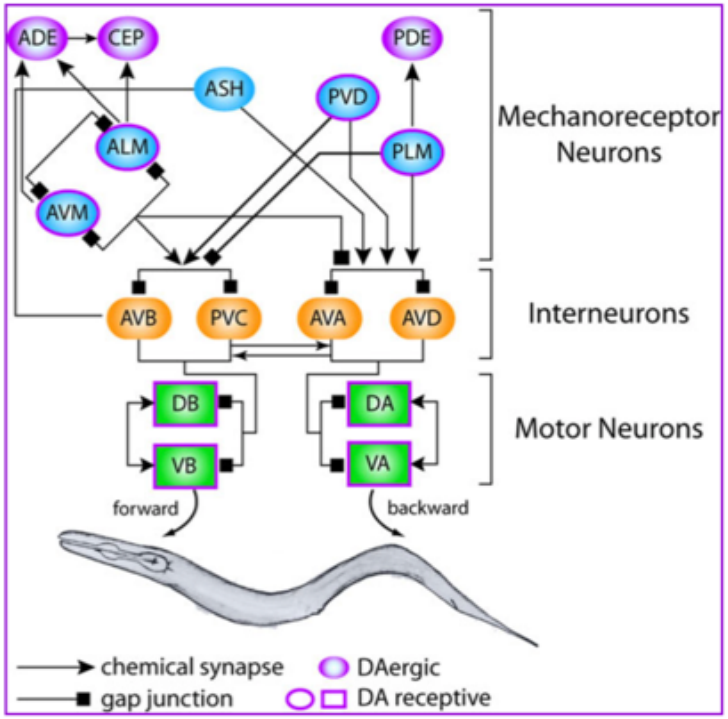
Texts: Selected readings

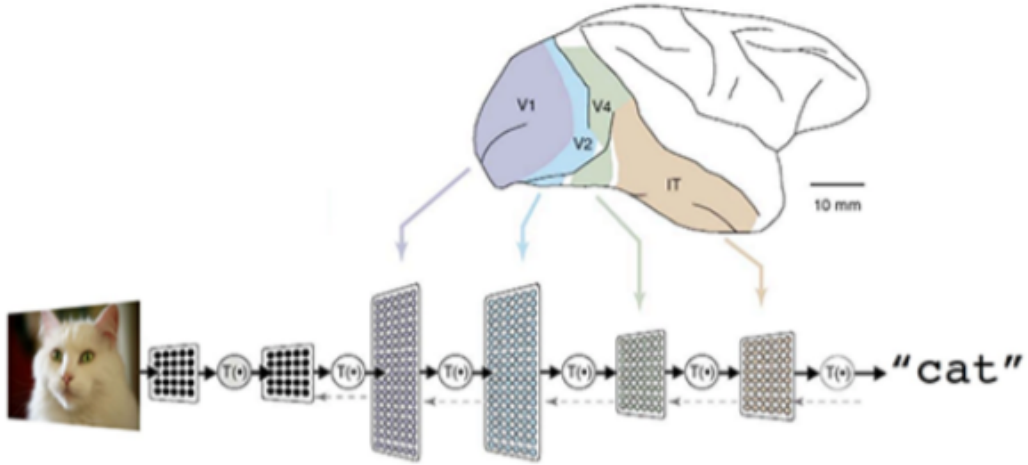
- Berg, Random Walks in Biology
- Dayan & Abbott, Theoretical Neuroscience.
- Hille, Ionic Channels of Excitable Membranes

and others

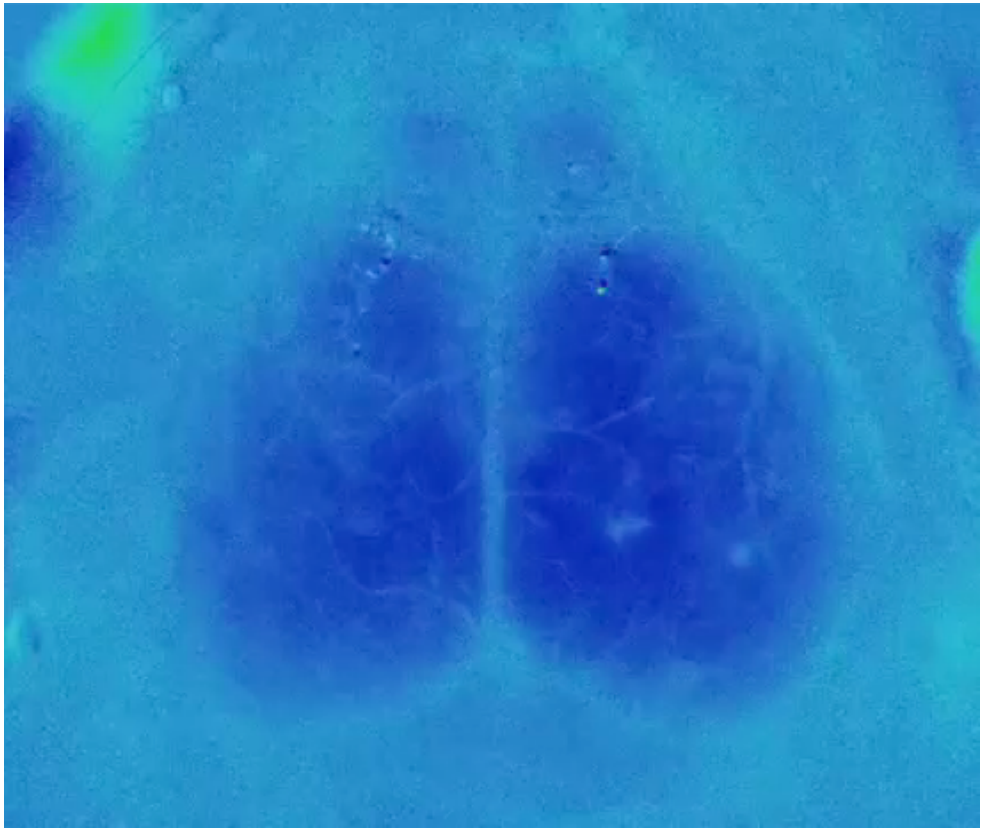
What is neural computation?

- Brain and cognitive sciences are no longer primarily descriptive
  - Engineering-level descriptions of brain systems.



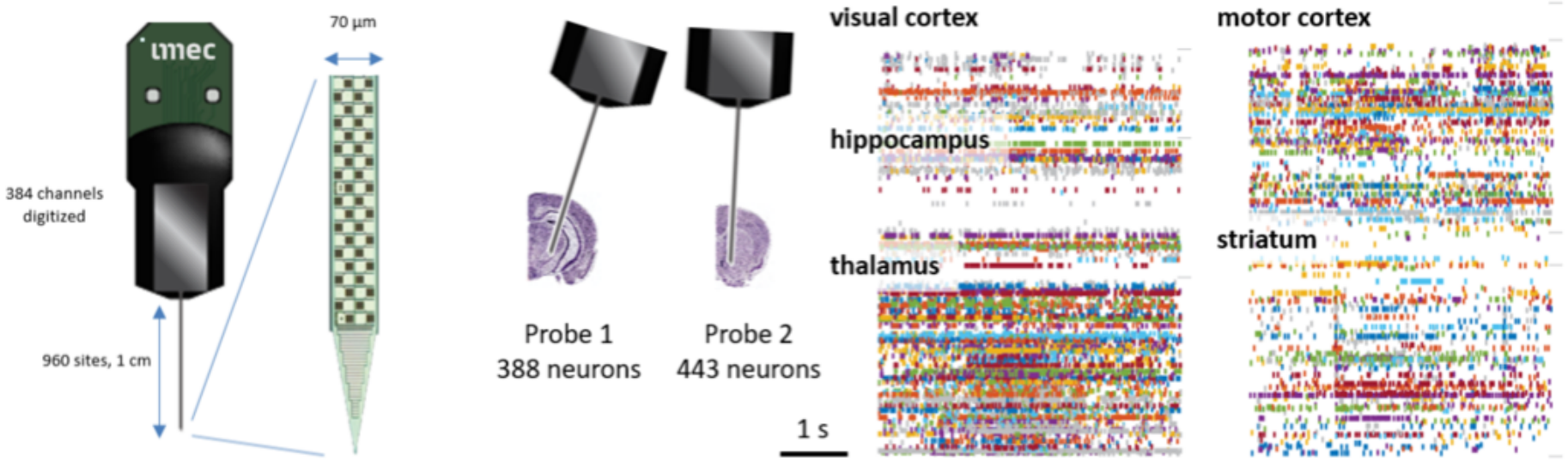


New technologies for neuronal activity measurements



Crair Lab, Yale Univ

Analysis of large datasets

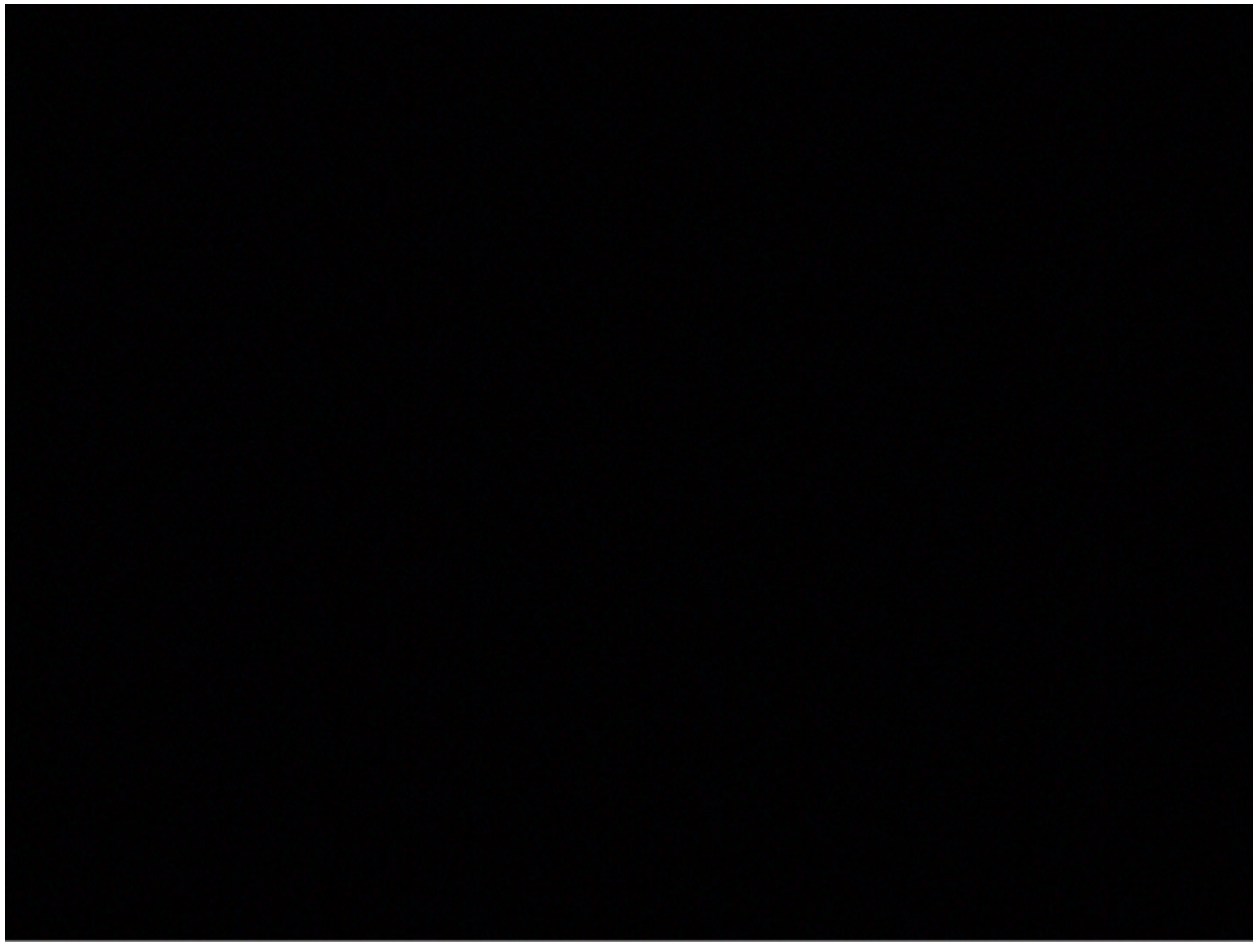


Neuropixels Probes Carandini/Harris Lab, UCL

What is neural computation?

- Brain and cognitive sciences are no longer primarily descriptive
  - Engineering-level descriptions of brain systems.
- Use mathematical techniques to analyze neural data in a way that allows us to relate it to mathematical models.
- In this course we will have the added component that we will apply these techniques to understand the circuits and computational principles that underlie animal behavior.

Neural circuits that control bird song



What is neural computation?

- Computational and quantitative approaches are also important in cognitive science.
- Importance of computation and quantitation in medical sciences

Course Goals

- Understand the basic biophysics of neurons and networks and other principles underlying brain and cognitive functions
- Use mathematical techniques to
  - analyze simple models of neurons and networks
  - do data analysis of behavioral and neuronal data (compact representation of data)
- Become proficient at using numerical methods to implement these techniques (MATLAB)

Topics

Neuronal biophysics and model neurons	Differential equations
Neuronal responses and tuning curves	Spike sorting, PSTHs and firing rates
Neural coding and receptive fields	Correlation and convolution
Feed forward networks and perceptrons	Linear algebra
Data analysis, dimensionality reduction	Principle Component Analysis and SVD
Short-term memory, decision making	Recurrent networks, eigenvalues
Sensory integration	Bayes rule

Skills you will have

- Translate a simple model of neurons and neural circuits into a mathematical model
- Be able to simulate simple models using Matlab
- Be able to analyze neuronal data (or model output) using Matlab
- Be able to visualize high dimensional data.
- Be able to productively contribute to research in a neuroscience lab!

Problem sets

- MATLAB will be used extensively for the problem sets.
  - Free for students. Please install on your laptop.
- We will use live scripts for Pset submissions. Check Stellar for examples.
- Guidelines for preparing Pset submissions are available on Stellar.

Resources

- Recitations
  - Two recitations sessions (Wednesdays at 11am and 4pm)
- Office Hours
  - Professor Fee (see Stellar)
  - Daniel (Tuesdays and Thursdays 1-2pm)
  - TAs (see Stellar)
- Lunch with the Prof
  - Opportunity to give feedback/address concerns
- Piazza
  - Ask questions online and get a fast response (<24 hours)

- Class Lecture!! Students who come to class do much better!