BIPN 146: Computational Neurobiology


April 4 Introduction Chapter 2
April 6 Neural Coding and Decoding Chapter 3
April 11 Olfactory coding Chapter 3
April 13 Retina Chapter 4
April 15 Visual cortex Chapter 4
April 17 Development of visual cortex Chapter 5
April 18 Color vision Chapter 4
April 20 Stereo and motion vision Chapter 4
April 25 Attention Chapter 4
April 27* Space and Gaze (Dave Peterson) Chapter 4
May 2* Midterm Exam
May 4 Working memory Chapter 5
May 9 Motor cortex Chapter 6
May 11 Central pattern generators Chapter 6
May 16 Reinforcement learning Chapter 5
May 18 Deep Learning Chapter 5
May 23* Neuromodulation (Samat Moldakarimov) Chapter 5
May 25 Long-term memory Chapter 5
May 30 Sleep rhythms Chapter 5
June 1 Memory consolidation Chapter 5
June 6 Resting states and default mode Appendix
June 8 Course Holiday

TA: Zhaoren He: theoart.he@gmail.com
Textbook (available at the campus bookstore):


Background Texts:


Course Goals:

This course will provide an introduction to a variety of computer modeling techniques being used to study brains at the systems level.

Course Requirements:

Students are expected to have a basic background in both neurobiology and mathematics; Calculus is an essential mathematical background and experience with differential equations in a physics or chemistry class is desirable.

Course Project: cnl.salk.edu/~terry/BIPN

This course project will count toward 20% of the final grade for the course.

The purpose of the project is to explore a question in neurobiology that can be approached from combined experimental and modeling approaches. You should read several papers in the area to get the background needed to prepare a critique of the computational models that have been developed in that area.

Choose one of the topic areas in the course readings. Read all the papers. Look up references to previous papers, particularly the experimental papers. Pick one of the articles identified with an asterisk (*) as the target article for your paper.
The paper should be no longer than 5 pages double spaced.

Imagine that you have been sent the paper by the journal and are asked to review the paper for publication. The format of the paper is a scientific review:

Required Sections:

1. Citation: Authors of the paper, Title of the paper, Journal, Volume, pages and year.

2. Summary – A brief, one paragraph overview stating the question being asked and the main results.

3. General Comments – Here are some examples of issues that could be addressed:
   a. Did the model provide an explanation for something that previously was unclear?
   b. What were the strengths and weaknesses of the model?
   c. How successful was the paper in answering the question being asked?
   d. What are the testable predictions?
   e. How well organized is the presentation?
   f. What was the most successful and least successful parts of the paper?

4. Minor Comments – Details that could help with the presentation
   a. Can the figures be improved?
   b. Is the writing clear? If not, give examples of bad sentences.
   c. Were there technical terms that were not defined?
   d. Typos?

5. Grade: 
   A = Publish after minor problems are corrected
   B = Requires re-review after revisions in response to the reviews
   C = Major revisions before the paper can be reconsidered
   D = Reject
   F = Submit to another journal

Papers are due on Tuesday, June 3, 2014

Exams and Grading:

There will be a midterm exam, a final exam, problems that will be covered in the sections, and a critique:

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* Target articles for Class Project.
Non target papers are for background reading.

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**Neural networks**


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**Neural coding and decoding**


Olfactory Coding


Retina


**Visual cortex**


**Development of Visual Cortex**


Miller KD, Erwin E. Effects of monocular deprivation and reverse suture on orientation maps can be explained by activity-instructed development of geniculocortical connections. *Vis Neurosci.* 18(5):821-34. 2001

**Stereo vision**


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**Color vision**

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**Visual Motion**

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**Space**

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* Pouget, A.; Sejnowski, T. J.; A Neural Model of the Cortical Representation of Egocentric Distance, *Cerebral Cortex*, 4, 314-329, (1994)


**Gaze**


**Attention**


* Jadi, M. P.; Sejnowski, T. J.; Cortical Oscillations Arise from Contextual Interactions that Regulate Sparse Coding, Proceedings of the National Academy of Sciences, USA, 111: 6780-6785 (2014)
Motor cortex


Central pattern generators


Reinforcement learning


**Neuromodulation**


**Working memory**


Long-term memory

McClelland, J. L., McNaughton, B. L., O'Reilly, R. C. Why there are complementary learning systems in the hippocampus and neocortex: Insights from the successes and failures of connectionist models of learning and memory. Psychological Review. 102(3): 419-457 (1995).


Sleep


Resting State


* Target articles for Class Project
Non * papers are for background reading