

## **Computational Neuroscience**

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**TAs: Salomon Muller, Marjorie Xie, Matteo Alleman, Dan Biderman, Amin Nejatbakhshesfahani**

**Meetings:** Tuesdays & Thursdays, Lecture 2:00-3:30

**Text** - Theoretical Neuroscience by P. Dayan and L.F. Abbott (MIT Press)

**Webpage** - <https://ctn.zuckermaninstitute.columbia.edu/courses>

### **January**

- 21 (Larry) Introduction to the Course and to Theoretical Neuroscience
- 23 (Larry) Mathematics Review
- 28 (Larry) Electrical Properties of Neurons, Integrate-and-Fire Model (Assignment 1)
- 30 (Larry) Adaptation, Synapses, Spiking Networks

### **February**

- 4 (Larry) Numerical Methods, Filtering (Assignment 2)
- 5 Assignment 1 Due
- 6 (Larry) The Hodgkin-Huxley Model
- 11 (Larry) Types of Neuron Models and Networks (Assignment 3)
- 12 Assignment 2 Due
- 13 (Ken) Linear Algebra I
- 18 (Ken) Linear Algebra II (Assignment 4)
- 19 Assignment 3 Due
- 20 (Ken) Linear Algebra III
- 25 (Ken) PCA and Dimensionality Reduction (Assignment 5)
- 26 Assignment 4 Due
- 27 COSYNE

### **March**

- 3 COSYNE
- 5 (Ken) Rate Networks/E-I networks I
- 10 (Ken) Rate Networks/E-I networks II (Assignment 6)
- 11 Assignment 5 Due
- 12 (Ken) Unsupervised/Hebbian Learning, Developmental Models
- 17 Spring Break
- 19 Spring Break
- 24 (Ashok) – Introduction to Probability, Encoding, Decoding
- 25 Assignment 6 Due
- 26 (Ashok) – GLMs
- 31 (Ashok) – Decoding, Fisher Information (Assignment 7)

### **April**

- 2 (Ashok) – Decoding, Fisher Information II
- 7 (Ashok) – Information Theory (Assignment 8)
- 8 Assignment 7 Due
- 9 (Ashok) – Optimization
- 14 (Ashok) – Optimization II (Assignment 9)

- 15 Assignment 8 Due
- 16 Research Topic
- 21 (Stefano) Perceptron (Assignment 10)
- 22 Assignment 9 Due
- 23 (Stefano) Multilayer Perceptrons and Mixed Selectivity
- 28 (Stefano) – Deep Learning I (backpropagation) (Assignment 11)
- 29 Assignment 10 Due
- 30 (Stefano) – Deep Learning II (convolutional networks)

**May**

- 5 (Stefano) Learning in Recurrent Networks (Assignment 12)
- 6 Assignment 11 Due
- 7 (Stefano) Continual Learning and Catastrophic Forgetting
- 12 (Stefano) Reinforcement Learning
- 13 Assignment 12 Due
- 14 Research Topic