

Introduction to Theoretical Neuroscience

Larry Abbott, Stefano Fusi, Ashok Litwin Kumar, Ken Miller

Meetings: Tuesdays Lecture 12.30 – 2.00 Recitation 2.00 – 3.30
Thursdays Math Supplement 12.30 – 2.00 Lecture 2.00 – 3.30

TAs: Ella Batty (erb2180) Danil Tyulmankov (dt2586)
Ramin Khajeh (rk2899) Marjorie Xie (mx2183)
Salomon Muller (szm2106)

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

Webpage: <https://ctn.zi.columbia.edu/courses>

January

22 Math Intro: Differential Equations (Ashok)
24 Electrical Properties of Neurons, Integrate-and-Fire (Larry) - Assign 1
Calculus Review (Dan)
29 Adaptation, Izhikevich Model, Phase-Planes, Stability Analysis (Larry)
Recitation (Ramin)
30 Assign 1 Due
31 The Hodgkin-Huxley Model (Larry)
Taylor Series, Linearization (Dan)

February

5 Synapses, Short-Term Plasticity, Release Probability (Stefano) - Assign 2
Recitation (Ramin)
7 Probability / Poisson spiking, Central Limit Theorem/Gaussian (Larry)
Combinatorics (Dan)
12 Probability / Encoding I (Ken) - Assign 3
Recitation (Ramin)
13 Assign 2 Due
14 Linear Algebra I (Ken)
Linear Algebra 0 (Dan)
19 Linear Algebra II (Ken) Assign 4
Recitation (Marjorie)
20 Assign 3 Due
21 Dimensional Reduction I (Ken)
Lagrange Multipliers (Dan)
26 Dimensional Reduction II (Ashok) - Assign 5
Recitation (Marjorie)
27 Assign 4 Due
28 COSYNE

March

5 COSYNE
Recitation (Marjorie)
7 Receptive Fields, GLMs, and Maximum Likelihood (Ashok)
Multivariate Calculus (Dan)
12 Spike and Rate Networks I (Larry)
Recitation (Marjorie)
13 Assign 5 Due
14 Spike and Rate Networks II (Stefano) - Assign 6
19 Spring Break
21 Spring Break
26 E/I Networks I (Ken)
Recitation (Salomon)
28 E/I Networks II (Ken) – Assign 7
Convolution (Dan)

April

- 2 Decision-Making Networks (Stefano)
Recitation (Salomon)
- 3 Assign 6 Due
- 4 Recurrent Networks - Hopfield and Random (Larry) - Assign 8
Fourier Transforms (Dan)
- 9 Optimization I (Ashok)
Recitation (Salomon)
- 10 Assign 7 Due
- 11 Optimization II (Ashok) - Assign 9
- 16 Perceptron and Decoding (Stefano)
Recitation (Salomon)
- 17 Assign 8 Due
- 18 Learning in Recurrent Networks (Larry)
- 23 Multilayer Perceptrons (Ashok) - Assign 10
Recitation (Ella)
- 24 Assign 9 Due
- 25 Deep Learning I (Stefano)
Bifurcations (Dan)
- 30 Deep Learning II (Stefano)
Recitation (Ella)

May

- 1 Assign 10 Due
- 2 Reinforcement Learning (Stefano) - Assign 11
Information Theory (Dan)
- 7 Recitation (Ella)
- 8 Assign 11 Due