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Boulder Theoretical Biophysics 2019
SE Palmer, Neuroscience Mini-Course

General theme: How do physicists approach coding in the brain?

Books (available as PDF's online):
MacKay, Information theory, inference, and learning algorithms
Dayan and Abbott, Theoretical Neuroscience

Lecture 1
Efficient coding
- Intro to neural coding & dynamics
- Intro to information theory

Readings
- Background: Dayan & Abbott Chapters 2 and 4
- Background: MacKay Chapters 4.4 - 4.6
- Paper: Shannon 1948
- Paper: Barlow 1961

Lecture 2
- Information in spike trains

Efficient coding + input constraints:
- Statistics of natural scenes
- Intro to maximum entropy distributions
- Optimal adaptation to changes in the environment

Readings
- Paper: Brenner & Bialek & deRuyter 2000
- Paper: Laughlin 1981
- Paper: deRuyter & Laughlin 1996
- Paper: Olshausen and Field 1997

Lecture 3
Efficient coding + noise robustness:
- Intro to the channel coding theorem
- Redundancy reduction redux
- Robust population coding in the brain

Readings
- Background: MacKay Chapters 9 - 11
- Paper: Barlow 2001
- Paper: Sreenivasan & Fiete 2011

Lecture 4
Efficient coding + output constraints:
- Adding computational goals
- Relevant information and the information bottleneck technique
- Evolutionary constraints on computation

Readings
- Paper: Tishby, Pereira, Bialek 2000
- Paper: Checkik et al. 2004
- Paper: Palmer et al. 2015
- Paper: Chalk et al. 2018

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