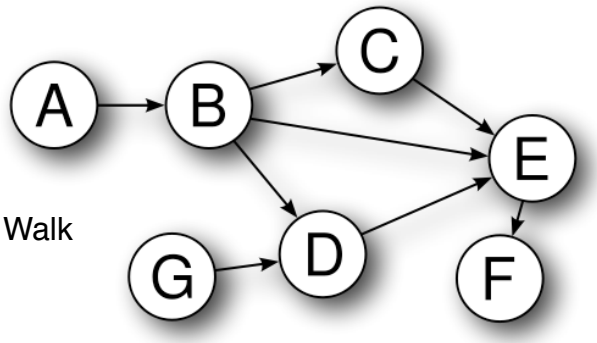
PSYC 739 - PROBABILISTIC MODELS OF PERCEPTION AND COGNITION

Fall 2018
Time: MW 2-3.30p
Location: GLAB 102



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SYNOPSIS:
Our world is a noisy world and thus, our premises and conceptions of physical reality remain subject to doubt. How do we perceive and reason in face of such uncertainty? How do we draw conclusions and take decisions?
Probability theory has become an increasingly popular and successful framework to model and account for human perceptual and cognitive behavior. This course will provide a careful introduction to probability theory and the various ways it has been applied in psychology and neuroscience. Goal is to make students thoroughly understand the most important state-of-the-art probabilistic models in perception and cognition, what they reveal about the brain's underlying computations and strategies in dealing with uncertainty, and how such computations can potentially be performed by populations of neurons.

PREREQUISITES:
A good general math background, although all methods and theories will be developed in the course. Some programming experience in MATLAB or an equivalent high-level programming language (R,PYTHON, JAVA) is required. Contact instructor if unsure.

FORMAT:
The course will be a mixture between lectures, paper discussions (lead by students), homework assignments, and an individual course project.

COURSE PROJECT:
Each student will complete a course project, which she/he will present in a class presentation and a report at the end of the course. The project is meant to re-implement the core model/method of a paper of choice. Creative solutions are completely fine if data are required (e.g. simulating data). Alternatively, running and modeling your own experiment could make for an even more exciting project. Possibilities are large; just make sure that you discuss your ideas with the instructor before making a final decision. Projects will be introduced by the students on October 29. Final presentations will be during our last meetings of the semester. We will emulate a typical conference sessions consisting of a series of presentations with time for questions.

BOOKS/READINGS:
The lectures in the course will be partially based on chapters of the following books:

* Information Theory, Inference, and Learning Algorithms, David MacKay, 2003, Cambridge University Press
* Causality, Judea Pearl, 2nd edition 2009, Cambridge University Press
* Probability Theory - the Logic of Science, E.T. Janes, 2003, Cambridge University Press
* Pattern Recognition and Machine Learning, Christopher Bishop, 2006, Springer

These are great books and will serve as valuable and timeless resources for anybody seriously interested. Relevant chapters will be posted online. In addition, we will read and discuss a series of state-of-the-art papers in the field of cognition and perception.

COURSE-WEBSITE (CANVAS):
Readings, homework assignments, and complete and up-to-date course information will be posted on Canvas.

TENTATIVE LIST OF TOPICS:
* Probability theory
    - Basics
    - Graphical and Hierarchical Bayesian models
* Inference
    - Methods and algorithms
    - Causality
* Probabilistic models of Perception
    - Estimation tasks
    - Decision tasks
    - Ideal observer models
* Model fitting
    - ML fits, Optimization
* Model comparison
    - Occam's razor
    - BIC, AIC
* Probabilistic models of Cognition
    - Categorization
    - Hierarchical structure learning
    - Working memory
    - Intuitive physics
* Neural implementations

FINAL GRADE:
Participation, Homework assignments, Project work and presentation.