# Quantitative Methods for Cognitive Sciences

Spring 2019

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| **Instructor:** | Emre Neftci | **Time:** | Tue, Thu 9:30AM – 10:50AM |
| **Email:** | eneftci@uci.edu | **Place:** | ALP 3600 |

**Course Overview:** Cognitive scientists try to understand how the mind works, especially those of humans. To this end, they create descriptions of cognitive processes to make predictions for behavior and ultimately explain it. Computational modeling is becoming important in this endeavor because it leads to precise quantifiable predictions. Such predictions cannot be obtained with verbal descriptions alone. However, modeling requires some degree of rigor in the form of mathematics and computer programming. Such skills are not always common among cognitive science students.

**The objective of this class is to improve students familiarity of the required methods for modeling and data analysis in cognitive Sciences by consolidating on mathematical skills, namely probability theory, parameter estimation and linear algebra.**

Through the assignments and discussion, this course will illustrate tools for parameter estimation, modeling, classification, clustering, dimensionality reduction techniques on real-world data such as behavioral data, face images and text messages. The skills acquired in this course will prepare students for advanced courses and labs such as Bayesian Cognitive Modeling, Cognitive Robotics and Brain-inspired Learning Machines offered by the Department of Cognitive Sciences.

Classes will be lecture-based and exercise-based with hands-on experimentation using Python. The course is introductory and intended to be accessible to students from a broad range of disciplines, with varying background knowledge in the field. However, quantitative reasoning skills, including basic calculus and basic familiarity with a programming language such as MATLAB or Python are expected.

**References:** Course material is inspired from the following resources (All books are available online)


[1] Simon Farrell and Stephan Lewandowsky. *Computational modeling of cognition and behavior*. Cambridge University Press, 2018.

[2] Ian Goodfellow, Yoshua Bengio, and Aaron Courville. *Deep learning*. MIT press, 2016.

[3] C.M. Bishop. *Pattern recognition and machine learning*. Springer-Verlag New York, Inc. Secaucus, NJ, USA, 2006.

[4] Gilbert Strang, Gilbert Strang, Gilbert Strang, and Gilbert Strang. *Introduction to linear algebra*. Vol. 3. Wellesley-Cambridge Press Wellesley, MA, 1993.


**Course Pages (TBD)** `https://canvas.eee.uci.edu/courses/16991`

**Office Hours:**

- **Neftci:** Wed 1:00PM - 5:00PM by appointment at SBSG 2308

**Tentative Course Schedule:**

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| Introduction: Sequential Sampling Models | Week 1 |
| Parameter Estimation | Week 2 |
| Probability theory: Probabilistic Processes | Week 3 |
| Maximum Likelihood Parameter Estimation | Week 4 |
| Bayesian Inference and Parameter Estimation | Week 5 |
| Midterm | April 30 2019 |
| Linear Algebra: Vectors and Matrices | Week 6 |
| Neural Network Models | Week 7 |
| Linear Algebra: Eigenspaces | Week 8 |
| Principal Component Analysis | Week 9 |
| Combining Data from Multiple Participants | Week 10 |

**Grading:** Reports and assignments must be submitted before the deadline posted with each assignment sheet. Letter grades will be assigned on the basis of assignments (40%), midterm (20%) and final (40%). Assignments returned late will count as half a homework. No make-up examinations.

**Academic Misconduct:** Students found to be guilty of plagiarism or cheating as defined by official university policy will automatically receive an "F" in the course. Other actions consistent with university policy may also be taken where deemed appropriate. Important information on how the university responds to instances of academic dishonesty can be found at http://honesty.uci.edu/students.html.