CLPS 1291 – Computational Cognitive Science

Spring 2013

Instructor:

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TAs:

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Class:

Metcalf #107 TR 02:30–03:50 pm

Course Website:

https://canvas.brown.edu/courses/773190

Office Hours:

Metcalf #343 TR 04:00–05:00 pm

Course description:

Provides an introduction to computational modeling of cognition, summarizing traditional approaches and providing experience with state-of-the-art methods. Covers pattern recognition and connectionists networks as well as Bayesian probabilistic models, and illustrates how they have been applied in several key areas in cognitive science, including visual perception and attention, object and face recognition, learning and memory as well as decision-making and reasoning. Focuses on modeling simple laboratory tasks from cognitive psychology. Connections to contemporary research will be emphasized highlighting how computational models may motivate the development of new hypothesis for experiment design in cognitive psychology.

Course objectives:

Computational modeling is one of the central methods in brain and cognitive science research, and recent developments in computational neuroscience, artificial intelligence, machine learning, and statistics have provided a wealth of new tools for developing computational accounts of human cognition and perception. The objective of this course is to provide advanced students in cognitive and computer science a toolkit (concepts, mathematical techniques, computational methods) for modeling human cognition.

At the end of this course, students should at least be able to identify which type of model would be best to use to fit a given experimental problem, and evaluate the quality of such models. Advanced students will also be able to independently generate such models.

Who should take this course:

The course is designed for ***advanced undergraduate and graduate*** students in cognitive science, neuroscience and computer science interested in developing computational models of cognition. It is intended to provide an introduction to some current research issues in cognitive science, together with examples of the different research paradigms by which they might be investigated. The inherently interdisciplinary nature of the subject is reflected in the course, which brings together issues relating to the disciplines of cognitive psychology, neuroscience, computer science and machine learning.

Prerequisites:

Comfort with basic linear algebra and probability theory and at least one introductory course in computer science or programming or permission of the instructor. Overall basic familiarity with MATLAB and/or previous work in the field and/or willingness to do extra work to learn is expected. The course strongly emphasizes hand-on MATLAB homeworks where students will implement some of the computational models described in class. Last year, motivated students with no prior knowledge of MATLAB did very well in the course as weekly optional MATLAB tutorials will be offered.

Format:

There will be two 80 minutes sessions per week, consisting of a mixture of lecture, hands-on experiments and discussion. There will also be a couple of optional tutorial sections, covering technical material (MATLAB programming and math review) in more detail.

Readings:

There is no textbook for the class. Readings will consist of approximately one or two journal articles or book chapters per class.

Breakdown of assessment:

Contribution	Grade
4 problem sets (involving MATLAB programming)	40%
Final project (involving oral presentation and short write-up)	30%
Take-home exam	20%
Presence / participation in class online lecture notes	10%

Schedule (will most likely change as the course progresses):

	I. FOUNDATIONS
class 1	Course overview
class 2	Computing minds
class 3	Models and levels of analysis
	II. MENTAL SPACES
class 4-7	Averaging and Vector Quantization (VQ)
class 8-10	Principal Component Analysis
class 11	Manifolds, similarity & MDS
	III. SUPERVISED LEARNING & CLASSIFICATION
class 12	Overview
class 13	Perceptron
class 14	Generalization and regularization
class 15	Application to the analysis of neuroscience data (MVPA)
class 16	Hierarchies
	IV. BAYESIAN INFERENCE, GRAPHICAL MODELS AND REASONING
class 17-18	Bayesian inference
class 19-20	Concept learning
class 21	Rational analysis
class 22-23	Causal reasoning