Computational Perception
15-485/785

Spring 2008

1 Teaching Staff

- **Instructor**
  Mike Lewicki
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2 Meeting Times

Tuesdays and Thursdays 10:30 - 11:50 AM in PH A19.

3 Web Page

`http://www.cs.cmu.edu/∼lewicki/cpsa`

Be sure to check there for the latest announcements, homeworks, handouts, etc.

4 Course Description

How brains do it? The perceptual capabilities of even the simplest biological organisms are far beyond what we can achieve with machines. Whether you look at sensitivity, robustness, or sheer perceptual power, perception in biology just works, and works in complex, ever changing environments, and can pick up the most subtle sensory patterns. Is it the neural hardware? Does biology solve funamentally different problems? What can we learn from biological systems and human perception?

This course teaches advanced aspects of perception and scene analysis in both the visual and auditory modalities, concentrating on those aspects that allow us and animals to behave in natural, complex environments. Topics emphasize both the experimental approaches of scientific disciplines and the computational approaches of engineering disciplines.

The focus of the course is on understanding set of fundamental computational problems that must be solved in robust perceptual systems. The course follows the lines of scientific reasoning and key experimental results that lead to our current understanding of the important computational problems in perception and scene analysis. The course then surveys the most important solutions to these problems, focusing on the idealizations and simplifications that are used to achieve practical computational algorithms. Specific topics include sensory coding, perceptual invariance, spatial vision and sound localization, visual and auditory scene segmentation, many aspects of attention, and the basics of recognition in natural visual and auditory scenes.

5 Course Goals

The goal of this course is to develop a comprehensive understanding of the computational problems involved in natural perception. The course will teach how to reason scientifically about problems and issues in perception and scene analysis, how to extract the essential computational properties of those abstract ideas, and finally how to convert these into explicit mathematical models and computational algorithms.

The class is fortunate to have a diverse and talented group of students, and we will make use of this expertise through in class discussions. An important goal of the class is to teach productive discussion, analysis, and critique of issues and topics related to perception and scene analysis.

6 Class Schedule

The schedule is shown on the table and is subject to change. Please check the web page for the latest schedule.

Date	Notes	Topics
Tue Jan 15		Course overview and general issues
Thu Jan 17		Sound localization, linear systems theory
Tue Jan 22	HW 1	
Thu Jan 24		
Tue Jan 29		Bayesian Inference
Thu Jan 31	*HW1 due*; HW2	Auditory sensory coding, information theory
Tue Feb 5		
Thu Feb 7		Visual sensory coding, information theory
Tue Feb 12	*HW2 due*; HW3	
Thu Feb 14		
Tue Feb 19		
Thu Feb 21		Computation and representation of visual motion, regularization
Tue Feb 26	*HW3 due*; HW4	
Thu Mar 28		
Tue Mar 4		Perceptual inference, Bayesian modeling
Thu Mar 6	*HW4 due*	
Mar 10-14	*spring break*	*no class*
Tue Mar 18	*grad project proposals due*	Visual structure, representation of shape and surfaces
Thu Mar 20		
Tue Mar 25	HW5	Perceptual constancy
Thu Mar 27		
Tue Apr 1		Auditory structure
Thu Apr 3		
Tue Apr 8	*HW5 due*	Auditory scene analysis
Thu Apr 10		
Tue Apr 15		Eye movements
Thu Apr 17	*Spring Carnival*	*no class*
Tue Apr 22	HW6	Visual search
Thu Apr 24		Visual scene analysis
Tue Apr 29		Perceptual organization
Thu May 1	*HW6 due*	Object recognition and class retrospective
Fri May 2	grad project reports due	

7 Class topics, readings, and references

There are at present no suitable textbooks for this course. Background material and papers will be handed out in class for subsequent lectures. You will be responsible for understanding the material and participating in class discussion.

8 Course Requirements

The course requirements consist of

- reading the assigned background material
- participation in class discussion
- completion of homework assignments
- giving a class presentation on a perceptual research issue
- completing a write-up describing the research issue
- completion of an independent research project (grad students)

9 Homework

Homeworks are the primary means by which the mathematical material presented in class. These will emphasize thinking more thoroughly about the theoretical problems presented in class, making decisions about how to model complex systems or processes, and design algorithms to solve a particular computational problem. Some of the advanced methods discussed in class are not practical to cover in a homework because of their sheer complexity. If you would like to study a particular topic in greater detail, it would be well worth considering designing a class project around that topic.

10 Exams

There will be no exams in this class.

11 Final Grade

Final grades will be a composite score of course requirements in the following proportions:

	undergrad	grad
homeworks	75%	60%
presentation & writeup	25%	20%
project	(10%)	20%

Graduate students must also complete a final project to pass. The final letter grade for the course will be determined by evaluating each student's performance relative to that of the other students in the class. Undergraduates who wish to do a class project will receive at most 10% extra credit. Extra credit, class participation, and any special circumstances will be used in determining borderline cases.

12 Collaboration

Collaborative discussion is encouraged, but any work submitted as a homework assignment must be entirely your own and may not be derived from the work of others, whether a published source, assignments from previous years, another student, or any other person. Doing otherwise is cheating. It is your responsibilty to take standard measures to protect your programs, homework assignments, and examinations from illicit inspection or copying. Violations will be handled in accordance with the University Policy on Cheating and Plagiarism.