Computational Perception and Scene Analysis
15-485/785, 85-485/785

1 Teaching Staff

- **Instructor**

Mike Lewicki
Department of Computer Science and
Center for the Neural Basis of Cognition
Offices: Mellon Institute 115K (CNBC)
Office hours: by appointment
email: `lewicki@cs.cmu.edu`

2 Meeting Times

Tuesdays and Thursdays 10:30 - 11:50 pm in Scaife Hall 422.

3 Web Page

The course is listed in blackboard:

`https://blackboard.andrew.cmu.edu`

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

4 Course Description

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.

Each topic in the course begins by studying the ethology of natural behaviors, analyzing and decomposing these to identify the essential computational components that are required for the total behavior in a natural environment. This aspect of 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 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 14		Course overview and general issues
Thu Jan 16		Sound localization, linear systems theory, Bayesian inference
Tue Jan 21		
Thu Jan 23		
Tue Jan 28		Auditory sensory coding, information theory
Thu Jan 30		
Tue Feb 4		Visual sensory coding, information theory
Thu Feb 6		
Tue Feb 11		
Thu Feb 13		
Tue Feb 18		Computation and representation of visual motion, regularization
Thu Feb 20		
Tue Feb 25		Perceptual inference, Bayesian modeling
Thu Feb 27		
Tue Mar 4		
Thu Mar 6	*mid-term break*	*no class*
Tue Mar 11		Visual structure, representation of shape and surfaces
Thu Mar 13		
Tue Mar 18		Perceptual constancy
Thu Mar 20		
Mar 24-28	*spring break*	*no class*
Tue Apr 1		Auditory structure
Thu Apr 3		
Tue Apr 8		Auditory scene analysis
Thu Apr 10		
Tue Apr 15		Visual scene analysis and perceptual organization
Thu Apr 17		
Tue Apr 22		
Thu Apr 24		
Tue Apr 29		Object representation and recognition
Thu May 1	take-home final	
Fri May 2	grad projects due	
TBA	final due	

7 Textbooks and Reading Materials

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 and creation of homework assignments
- taking the midterm and final exams
- completion of an independent research project (grad students)

9 Tutorials

Because the class consists of people from a diverse range of backgrouns, tutorials will be provided throughout the course to introduce important background material, and provide exercises to aid understanding of lectures and homework assignments. These will not be graded and are only for the benefit of those who want to get up to speed quickly in a topic or concepts. I will except as extra credit problems of your own design (with solutions) that you think is instructive for illustrating a particular concept. These problems can then be made available as an instructive aid for other members of the class.

10 Homework

In previous years, we have assigned four lengthy problem sets. This year, at the suggestion of former students, we will provide more but shorter homework assignments. Also new this year, and also suggested by former students, is that part of the homework assignment will be to create and work though a problem that other students can use. The most important function this serves is that being able to create small problems for yourself to aid understanding of complex material is an essential part of learning.

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.

11 Exams

There will be a midterm and a final exam. Both will be take-home. The exams will test

- knowledge and understanding of perceptual and computational issues
- ability to simplify and idealize complex processes
- ability to critically research and evaluate scientific findings and computational techniques

12 Final Grade

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

	undergrad	grad
participation	10%	10%
homeworks	40%	30%
midterm	20%	15%
final	30%	20%
project	(10%)	25%

All students must take the final to pass. 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, attendance, and any special circumstances will be used in determining borderline cases.

13 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.