
**Senior Seminar in the Cognitive and Information Sciences
Q400, Section ??? - Spring 2000
Room 115 Psychology
Meeting Time: TBA**

**Instructor
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Course Description

This course is intended for students who have completed or nearly completed their cognitive science coursework. Students will apply previously acquired analytic, computational, mathematical, and experimental skills to independent research projects. Class time will be devoted to descriptions of innovative and useful research methods, discussions of recent developments in cognitive science, and student presentations of their research projects. Discussion and research topics may include: consciousness, representation, artificial intelligence, artificial life, modularity, linguistics, education and instruction, neural networks, functionalism and embodiment, dynamical systems, learning and innateness, philosophy, psychology, anthropology, evolutionary theory, human-computer interaction, cognitive neuroscience, robotics, and adaptive systems.

The three principal obligations of seminar participants are to lead two class discussions, to actively participate in all classes, and to conduct a full-scale research project and to present the results from this research project near the end of the semester. The class discussions that a student leads will often deal with a subject matter related to their final research project.

Leading a Class Discussion

As you begin to read background literature on your research topic, you will become an expert in this field. The point of class discussions is to share your expertise with the other students in the class. When you lead a discussion, you should plan to present a tutorial of some research. The research you present may be a single article or book, or it may summarize a body of work. It will typically involve research that will evolve into your final project, but it might also simply be research in which you are knowledgeable and interested. During the tutorial portion of the class, discussion leaders may want to show overhead slides or computer displays to describe their ideas, methods, results, and conclusions. To reserve a computer projector, let me know ahead of time so I can check it out from the office. In general, you should try to make your talk a genuine learning experience for your peers. Do not attempt to cover all of the material in detail. Rather, select a handful of points that seem to be of

fundamental importance. Consider time to be a precious resource; do not waste it on digressions

Your tutorial should last about half an hour. The remaining class time should be reserved for discussion, but don't necessarily expect the class to wait until the discussion period to start discussing! To facilitate class discussion, you should come prepared with about three open-ended questions that you can pose to the class. These questions should be formulated to provoke reactions and to stimulate interactive discourse.

As you plan for leading your discussion, bear in mind that the other students will not have read the material that you will be discussing. In designing this course, I weighed the benefits of having everybody read every class reading, and having only one person be the expert who shares their knowledge with the rest of the class. Both course structures work well, but for this course, my highest priority was that everybody would have an impressive class project completed by the end of the semester. My impression was that having weekly class materials that every student was required to read would compete too heavily for time that should be invested in thoroughly understanding the background literature for the topic that they choose, and preparing their own original contribution.

I am intentionally leaving it open-ended as to what you present. Part of what it means to be a scholar is to be able to distinguish important research from the other 95%. One imperfect clue to the importance of a piece of research is whether it is cited or used by other people. Not all journals are created equal. The following journals usually present high-quality research: Cognitive Science, New trends in Cognitive Science, Cognitive Psychology, Machine Learning, Artificial Intelligence, Complex Systems, Psychological Review, Cognition, Behavioral and Brain Sciences, Cognitive Neuroscience, Human Factors, Neural Networks, Neural Computation, Computational Neuroscience, Mind, Science, Nature, Scientific American. For a list of some of the most influential papers in cognitive science, see: <http://cogsci.umn.edu/millennium/home.html>

Final Project

The form that your final project takes is up to you, but you should get permission for the format, particularly if it is unorthodox. Standard formats are:

- Experiment and write-up. This would involve designing, running, and analyzing an experiment and reporting the results. For example, you could run an experiment on human unconscious perception using your friends as subjects. Your report would probably contain the following sections: introduction to the issue, background literature, experimental methods used, experimental results, and discussion.
- Computer program. Your final project could involve any of a variety of computer programs. Such programs might include: computer simulations of human behavior, simulations of natural processes, neural networks, expert

systems, artificial life, novel human-computer interfaces, or data-mining systems. The program will often need to be supplemented by a document describing the theory behind the program and how it executes.

- Interactive Web site. Demonstrations of theories are often times presented very effectively by taking advantage of interactive web resources such as scripting, Java, and HTML.
- Archival research. Some questions about cognition are best asked not by conducting experiments, but by examining archives. For example, if interested in language and how words change their meaning, you might systematically analyze entries in a dictionary. If interested in the organization of scientific fields, you might explore structures in the "Science Citation Index."
- Construction. You may want to build a working model or demonstration of some phenomenon. You might, for example, construct a path-following robot, an artificial retina, or a device for measuring skin resistance. As with computer programs, in most cases, you will also need to prepare some written documentation describing the construction.
- Traditional research paper. In some cases, the best vehicle for describing your research may simply be to write a report that describes it.

Other project formats, such as tutorial cartoons, art objects, musicals, theatrical or radio plays, dialogs, or fictional novels are also possible. They will be acceptable to the extent that they are informed in a non-trivial and extensive way by cognitive science research.

Regardless of the format you use, the basis for evaluating your final project will be the same: creativity, amount and quality of work, clarity, and logic. Evaluations will be particularly influenced by amount of effort as evidenced by your final project. For an impressive final project, it is important to work consistently throughout the semester rather than cramming in all of your work in the final few weeks.

Group projects are welcome and encouraged. The same grade will be given to all members of a group project unless different members prepare different descriptions of the project or give different presentations. As with any collaboration, if you are contemplating doing a group project, you should carefully analyze whether your collaborators are likely to put in their fair share of work. Group projects are exciting because of the out-of-class discussions and interaction that they generate, and because the end product is often more impressive than would be possible for a single person to achieve. Educational reforms, automatic object recognition, user interface design, the treatment of neurologically impaired patients, machine translation, computer speech production and recognition, real-world robotics, and information search techniques have all depended upon contributions from cognitive scientists. Importantly, these applications have not been generated by one individual, or even discipline, acting alone. These real-world applications have been developed by teams of psychologists, computer scientists, neuroscientists, linguists, educators, and medical researchers who have been able to communicate with each

other at a high level of discourse. Still, do not expect to maximize efficiency by working in a group. Experience reveals that if there are N workers on a project and each could achieve P working independently, then they do not achieve $P*N$ when working together. Expect $(P*N)/3$ and then perhaps you will be pleasantly surprised.

Final projects should have some aspect of originality in them, but they can be based fairly directly on other work. You should be particularly wary of the tendency to bite off more than you can chew. You only have one semester for these projects. You should figure on spending about 6 hours per week on the project. Thus, you only have about 84 hours in total for the project, including time spent preparing for discussions, reading background literature, conducting your research, and preparing a written description of your project (if needed).

Here are some examples of projects that are about the right "size" assuming that you already have the necessary experimentation, statistical, mathematical, or computational skills:

Implement a simple back-propagation neural network for recognizing letters.

Create an artificial intelligence program that can predict how sequences like "1 3 5 7 ...," "1 2 3 1 2 3 1 2 ...," and "1 2 3 4 2 3 4 5 3 4 5 6 ..." will continue.

Create a computer program that generates grammatical and quasi-meaningful poems.

Create a computer simulation of how religious or political beliefs spread in a community. Compare this model to actual sociological patterns of belief dissemination.

Analyze and classify the types of metaphors used in poems by William Blake.

Design an experiment to test the Whorfian hypothesis that language influences thought.

Build a robot that learns to kick a ball.

Write a philosophical dialog between a functionalist and an embodied-cognition theorist.

Create a web site that graphically and interactively shows the relation between theories related to free will.

Conduct an experiment to see whether there is a left or right hemisphere advantage for face perception.

Create a new system of logic that allows for more than the two standard truth values of "True" and "False."

Based on principles of human perception, create a set of guidelines for how people should plot data in graphs to make the data most understandable.

Grading

Grades will be broken down as follows:

First discussion leading: 10%

Second discussion leading: 10%

General Class participation: 5%

Final Project and presentation: 75%