COGNITIVE SCIENCE 222

Minds, Brains, & Intelligent Behavior: An Introduction to Cognitive Science

Bronfman 106, Tuesdays and Thursdays, 9:55 to 11:10 AM
Williams College, Spring 2007

INSTRUCTOR CONTACT INFORMATION

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ABOUT THE COURSE

This course will emphasize interdisciplinary approaches to the study of intelligent systems, both natural and artificial. Cognitive science synthesizes research from cognitive psychology, computer science, linguistics, neuroscience, and contemporary philosophy. Special attention will be given to the philosophical foundations of cognitive science, symbolic and connectionist architectures, the neural basis of cognition, perception, learning and memory, language, action, problem solving, and artificial intelligence.

REQUIREMENTS

Lab Exercises: 50% of the final grade

Students will be assigned take-home lab exercises, approximately weekly, for a total of 10 assignments. Assignments will include complete instructions, and will usually be self-contained. In cases where lab exercises require a computer, the software for the course has been tested only on the Mac operating system. Mac labs can be found throughout campus, but you may reliably work in TCL 216 or in Bronfman 340.

Typically, lab work and write-ups will be due at the beginning of class one week after they are assigned. They will be graded on a 10 point scale, and will be penalized 1 point the first day late, 2 points the second day, and four points the third day.

Midterm and Final Exams: Each worth 25% of the final grade

Both exams will be 24 hour self-scheduled take-home exams. They will include quantitative portions and short essays. Both will be open book and open notes, but students may not discuss the exam material with each other.

The midterm will be available in the computer science administrative office (TCL 303) between 8:30 AM and 4:00 PM starting April 3. It will be due by 4:00 PM on April 10. The final exam will be available in the Registrar's Office, and can be taken at any time during the final exam period.

READINGS

There are two required books for this course, which are available at Water St. Books:

Thagard, Paul. (2005). *Mind: Introduction to cognitive science (2nd ed.)*. Cambridge, MA: MIT Press.

Thagard, Paul. (1998). *Mind readings: Introductory selections on cognitive science*. Cambridge, MA: MIT Press.

All additional readings will be on-line or posted on Blackboard in PDF format. They can be downloaded to any on-line computer, and printed on any of several campus printers.

CLASS ATTENDANCE

As adults, it is up to each student whether to attend classes, do the readings, and participate in class discussions. We will not take roll or keep track of how often people speak in class. We rely on grading to uncover lack of effort and reveal understanding of the course material. However, the success of a course of this type depends in part on the richness of the class discussions. Class discussions are a team effort, and if students fail to prepare and participate they let down their classmates. Students should accept the responsibility for helping to make the class better for everyone, including themselves.

DISABILITIES

Students with disabilities who may need disability-related classroom accommodations for this course are encouraged to set up an appointment to meet with either instructor as soon as possible and to contact the Dean's Office at x4262 to insure that accommodations are provided in a timely manner.

HONOR CODE

All assignments in this course (the weekly labs, the midterm exam, and the final exam) are to be completed by each student independently. Students may seek help from the course teaching assistant on lab assignments. Students may *always* seek help from the instructors on any assignment.

Plagiarism includes copying text or making use of ideas from any source (such as another person, a book, an article, or a web site) without acknowledging that source. Thus, in the assignments students must acknowledge all sources *with citations*, and either endnotes or footnotes containing the full reference information for those citations.

Please see the statement on "Academic Honesty and Honor Code" in the *Student Handbook*.

CLASS SCHEDULE

FEB 1 Introduction; History of Cognitive Science, part I

6 History of Cognitive Science, part II

Mind, Ch. 1 (Representation and Computation) and Ch. 2 (Logic)

Mind Readings, Ch. 1 (Simon,1992)

8 Representation

Davis, R., Shrobe, H., & Szolovits, P. (1993) What is a knowledge representation? *AI Magazine, 14*(1), 17-33.

13 Computation

Barker-Plummer, D. (2004). Turing machines. *Stanford Encyclopedia of Philosophy*. http://plato.stanford.edu/entries/turing-machine/.

15 Symbolic architectures: Symbols and rules

Mind, Ch. 3 (Rules)

Newell, A. & Simon, H. (1976). Computer science as empirical inquiry: Symbols and search. *Communications of the Association for Computing Machinery, 19(3),* 113-126.

20 Symbolic architectures: Production systems

Mind Readings, Ch. 3 (Anderson,1993)

Anderson, J. et al. (2004). An integrated theory of the mind. *Psychological Review, 111,* 1036-1060.

22 Concepts

Mind, Ch. 4 (Concepts)

Mind Readings, Ch. 5 (Medin,1989)

27 Concept acquisition, part I

Kruschke, J. K. (2003). Concept Learning and Categorization: Models. *Encyclopedia of Cognitive Science*, *Vol. 1* (pp. 653-659). New York: Nature Publishing Group.

Anderson, J. R. & Betz, J. (2001). A hybrid model of categorization. *Psychonomic Bulletin & Review*, *8*(4) 629-647.

MAR 1 Concept acquisition, part II

Dietterich, T. G. (2003). Machine learning. *Encyclopedia of Cognitive Science*, *Vol. 2* (pp. 971-981). New York: Nature Publishing Group.

Quinlan, R. J. (1986). Induction of decision trees. *Machine Learning*, *1*, 81-106.

6 Problem solving

Lovett, M. C. (2003). Problem solving. *Encyclopedia of Cognitive Science*, *Vol. 3* (pp. 728-733). New York: Nature Publishing Group.

Korf, R. E. (2003). Search. *Encyclopedia of Cognitive Science*, *Vol. 3* (pp. 1009-1017). New York: Nature Publishing Group.

Epstein, S. L. (2003). Game-playing programs. *Encyclopedia of Cognitive Science*, *Vol. 2* (pp. 181-186). New York: Nature Publishing Group.

8 Low-level vision, part I

Mind, Ch. 9 (Brains)

Riesenhuber, M. & Poggio, T. (2002). Neural mechanisms in object recognition. *Current Opinion in Neurobiology, 12,* 162-168.

13 Low-level vision, part II

Cawsey, A. (1998). *The Essence of Artificial Intelligence* (Chapter 6). London: Prentice Hall.

15 Mid-to-high-level vision

Biederman, I. (1995). Visual object recognition. In S. M. Kosslyn & D. N. Osherson (Eds.), *Visual cognition: An invitation to cognitive science, Vol. 2* (2nd ed., pp. 121-165): The MIT Press.

Spring Break

APR 3 Debate: Visual imagery

Mind, Ch. 6 (Images)

Pylyshyn, Z. (2003). Return of the mental image: Are there really pictures in the brain? *Trends in Cognitive Sciences*, *7*, 113-118.

Kosslyn, S. M., Ganis, G., & Thompson, W. L. (2003). Mental imagery: Against the nihilistic hypothesis. *Trends in Cognitive Sciences*, *7*, 109-111.

Pylyshyn, Z. W. (2003). Explaining mental imagery: Now you see it, now you don't: Reply. *Trends in Cognitive Sciences*, *7*, 111-112.

Ganis, G., Thompson, W. L., Mast, F., & Kosslyn, S. M. (2004). The brain's mind's images: The cognitive neuroscience of mental imagery. In M. S. Gazzaniga (Ed.), *The cognitive neurosciences* (3rd ed., pp. 931-941). Cambridge, MA: MIT Press.

APR 5 Connectionist architectures

Mind, Ch. 7 (Connections)

Mind Readings, Ch. 8 (Rumelhart,1989)

10 Connectionist architectures: Learning

Munro, P. (2003). Backpropagation. *Encyclopedia of Cognitive Science*, *Vol. 1* (pp. 309-318). New York: Nature Publishing Group.

12 Debate: Symbols versus connections in language

Mind Readings, Ch. 4 (Pinker,1991)

Pinker, S. & Ullman, M. (2002). The past and future of the past tense. *Trends in Cognitive Sciences, 6(11),* 456-463.

McClelland, J. & Patterson, K. (2002). 'Words *or* Rules' cannot exploit the regularity in exceptions. *Trends in Cognitive Sciences, 6(11),* 464-465.

McClelland, J. & Patterson, K. (2002). Rules or connections in past-tense inflections: What does the evidence rule out? *Trends in Cognitive Sciences, 6(11),* 465-472.

Pinker, S. & Ullman, M. (2002). Combination and structure, not gradedness, is the issue. *Trends in Cognitive Sciences, 6(11),* 472-474.

17 Computational grammar

Crain, S. & Pietroski, P. (2003). Innateness and universal grammar. *Encyclopedia of Cognitive Science*, *Vol. 2* (pp. 556-559). New York: Nature Publishing Group.

Chomsky, N. (2006). "The formal nature of language." *Language and mind* (3rd ed., pp. 102-127). Cambridge: Cambridge University Press.

19 Meaning and Latent Semantic Analysis

Bach, K. (2003). Meaning. *Encyclopedia of Cognitive Science*, *Vol. 2* (pp. 1047-1055). New York: Nature Publishing Group.

Landauer, T. (2003). Latent semantic analysis. *Encyclopedia of Cognitive Science*, *Vol. 2* (pp. 775-779). New York: Nature Publishing Group.

24 Intentionality

Mind, Ch. 12 (Bodies, the World, and Dynamic Systems)

Searle, J. R. (1980). Minds, brains, and programs. *Behavioral and Brain Sciences, 3*, 417-457.

26 Dynamic architectures

Mind Readings, Ch. 13 (Eliasmith,1996)

May 1 Emergent properties

Peterson, S. & Simon, T. (2001). Computational evidence for the subitizing phenomenon as an emergent property of the human cognitive architecture. *Cognitive Science, 24*(1), 93-122.

3 Emergent cognition and behavior

Mind, Ch. 13 (Societies)

Hofstadter, D. R. (1979). "Prelude … Ant Fugue." *Gödel, Escher, Bach: an Eternal Golden Braid* (Ch. 11). New York: Basic Books.

8 Consciousness

Mind, Ch. 11 (Consciousness)

Mind Readings, Ch. 10 (Flanagan,1992)

Dennett, D. (2001). Are we explaining consciousness yet? *Cognition, 79*, 221-237.

10 The Future

Mind, Ch. 8 (Review) and Ch. 14 (The Future)