Computational Cognitive Modeling
PSYC 768 (section 004)
Syllabus

Time: Thursdays, 4:30-7:10pm
Classroom: Innovation, room 316
Instructor: William G. Kennedy, PhD
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Office hours: Thursdays, 3-4pm, Research 1, room 373.

Course Description:
This course will introduce students to the concept and practice of modeling cognitive behavior. We will review the basic concepts of cognitive architectures, cognitive models, their use in Cognitive Science, and associated issues. Students will learn the fundamentals of how to build cognitive models using ACT-R and will exercise the perception, memory, reasoning, and learning theories in the standard ACT-R. The class will include some programming to run basic ACT-R models, but it will be minimized. Class will include lectures, demonstrations, reading assignments, hands-on modeling exercises, and a project in computational cognitive modeling of a cognitive behavior.

Prerequisites:
General knowledge of human cognitive psychology is necessary. While no knowledge of a specific computer programming language is required, familiarity with programming concepts will be beneficial and familiarity with the academic use of personal computers for writing short pieces and e-mail is assumed. Students are not expected to have prior knowledge of a cognitive modeling system or cognitive modeling.

Objectives:
1. Students can discuss cognitive architectures, cognitive modeling systems, particularly ACT-R, and the goals of Cognitive Science and Artificial Intelligence.
2. Students are able to build cognitive models of cognitive behavior in ACT-R.
3. Students understand issues associated with the cognitive plausibility of cognitive models.

Required Readings:
Required Text: John R. Anderson, (Anderson, 2007) *How Can the Human Mind Occur in the Physical Universe*. Oxford University Press.

Recommended text: Alan Newell (Newell, 1990) *Unified Theories of Cognition.* Harvard University Press.

Additional papers will be identified.

Attendance Policy: Attendance is not graded, but homework is due in class, the tutorial exercises will be discussed, and lectures integrating readings and experience will be provided. Therefore, attendance is expected.

Disabilities: If you are a student with a disability and need academic accommodations, please let the instructor know and, as required, contact the Disability Resource Center at 703 993 2474 to arrange academic accommodations.

GMU Honor Code:
GMU's honor code is available at http://mason.gmu.edu/~montecin/plagiarism.htm. Students are encouraged to discuss readings and topics discussed in class with others. Students can collaborate in pairs to accomplish the cognitive modeling tutorial exercises, but each student is expected to individually provide evidence of completion of each unit with comments. The written reviews of selected readings and the cognitive modeling project are to be the work of the individual student alone.

Evaluation:
Reviews of readings: 30%
Students are expected to write a short review (150-250 words) of selected readings identifying the contribution, strengths, and weaknesses of the reading. Six readings will be identified by the instructor (* in class schedule) and each will be worth 5 pts.

Cognitive Modeling exercises: 42%
We will work through seven exercises of the ACT-R tutorial. Students are encouraged to consult each other on the tutorial exercises, but each student is expected to submit their own ACT-R model, evidence of successful completion, and comments on the unit (50-150 words) at the beginning of the next class. Tutorials 2-7 will be worth 7 points each.

Cognitive Modeling project: 28%
The cognitive modeling project is intended to have students apply their knowledge of cognitive modeling in ACT-R, or another approved system, by developing a cognitive model for a behavior of their choosing. Students will propose a cognitive modeling project and the instructor will provide feedback on scope and projected level of difficulty. Projects will be completed individually and presented to the class a 15-minute time slot near the end of the classes. Projects will be graded on modeling difficulty (7 pts), successful operation (7 pts), matching of data (7 pts), and cognitive plausibility, (7 pts).

Grading scale: (points = percentage)

90-100 = A
87-89 = A-
84-86 = B+
80-83 = B
77-79 = B-
70-76 = C
<69 = F

Class Plan

Class 1: (1/22) In class: Introduction: models, architectures, cognitive plausibility, AI, Cognitive Science, Computational Social Science
Outside class: Read: (optional) Newell 1990 pp 1-36
(required) Anderson 2007 chap. 1*
Do: install ACT-R software from www.act-r.psy.cmu.edu

Class 2: (1/29) In class: Newell's UTC concept, ACT-R, Lisp, knowledge representation
Outside class: Read: (required) Anderson 2007 chap. 2*
(optional) Newell 1990 chap. 3
Do: ACT-R Tutorial Unit 1 (Production Systems)

Class 3: (2/5) In class: Cognition at the symbolic level, perception & action
Outside class: Read: (required) Anderson 2007 chap. 4
Do: ACT-R Tutorial Unit 2 (Perception and Motor Actions in ACT-R)

Class 4: (2/12) In class: Discussion of Tutorial Unit 2, attention & executive control
Outside class: Read: (Altmann & Trafton, 2002)*
Do: ACT-R Tutorial Unit 3 (Attention)

Class 5: (2/19) In class: Discussion of Unit 3 & Sub-symbolic memory representation
Outside class: Read: Anderson 2007 chap. 3
Do: ACT-R Unit 4 (Activation of Chunks and Base-Level Learning)

Class 6: (2/26) In class: Discussion of Tutorial Unit 4, Spreading of Activation
Outside class: Read: tbd
Do: ACT-R Unit 5 (Activation and Context)

Class 7: (3/5) In class: Discussion of Tutorial Unit 5 & Production Selection
Outside class: Read: Anderson 2007 chap. 5
Do: ACT-R Tutorial Unit 6 (Selecting Productions on the Basis of Their Utilities and Learning these Utilities)

SPRING BREAK (3/12)

Class 8: (3/19) In class: Discussion of Tutorial Unit 6 & Production Learning
Outside class: Read: Anderson 2007 chap. 6
Do: ACT-R Tutorial Unit 7 (Production Rule Learning)

Class 9: (3/26) In class: Discussion of Tutorial Unit 7, Introduction to Soar
Outside class: Read: (Lehman, Laird, & Rosenbloom, 2006)*
Do: submit 1 page project proposal

Class 10: (4/2) In class: Soar and ACT-R comparison
Outside class: Read: tbd
Do: cognitive modeling project

Class 11: (4/9) In class: Other cognitive modeling systems and multi-agent systems
Outside class: Read: (papers on Clarion, Icarus, & Epic tbd)*
(Cassimatis, Bugajska, Dugas, Murugesan, & Bello, 2007)
Do: cognitive modeling project

Class 12:(4/16) In class: Applications of cognitive modeling
Outside class: Read: tbd
Do: cognitive modeling project

Class 13:(4/23) In class: Issues in cognitive plausibility and cognitive modeling
Outside class: Read: tbd*
Do: cognitive modeling project

Class 14:(4/30) In class: Cognitive modeling project presentations
Outside class: Read: tbd
Do: cognitive modeling project

Exam: (5/7) In class: Cognitive modeling project presentations
Outside class: nil

References:

Altmann, E. M., & Trafton, J. G. (2002). Memory for Goals: An activation-based model. *Cognitive Science, 26*(1), 39-83.

Anderson, J. R. (2007). *How Can the Human Mind Occur in the Physical Universe?* Oxford: Oxford University Press.

Cassimatis, N. L., Bugajska, M., Dugas, S., Murugesan, A., & Bello, P. (2007). An Architecture for Adaptive Algoritymic Hybrids. In *National Conference of the Association for the Advancement of Artificial Intelligence (AAAI 2007)* (pp. 1520-1526).

Lehman, J. F., Laird, J., & Rosenbloom, P. S. (2006). A Gentle Introduction to Soar, An Architecture for Human Cognition: 2006 Update. Soar Group Website.

Newell, A. (1990). *Unified theories of cognition*. Cambridge, MA: Harvard University Press.