Cognitive Modeling, Intelligence, & Intelligent Systems
Phil 237 (Fall 2014): TR 11:00 – 12:20
Professor William Seeley, 315 hedge Hall
Office Hours: TR: 12:30-1:30 & by appointment
wseeley@bates.edu

Course Description:
Artificial Intelligence is an interdisciplinary research field dedicated to the study of intelligence and intelligent systems. The field draws on materials from computer science, psychology, neuroscience, and philosophy. Its history is closely associated with the development of cognitive science. The course provides a historical introduction and overview of theories and methods within the field with a strong focus on the development of computational modeling and simulation as research methods. Coursework will include hands-on modeling and simulation exercises to enable students to explore the practical applications and limits of different models for intelligent behavior. No prior programming experience is required.

Course Goals:
The goals of this course are threefold. We will try to come to an understanding of what artificial intelligence is, and more importantly what it is not, as a research program in psychology and computer science. In this context we will evaluate the validity of several philosophical problems associated with artificial intelligence. This debate will be used to evaluate the traditional symbol system model for AI and introduce contemporary dynamic systems and behavior-based alternatives. Along the way we will evaluate, challenge, and develop our own common sense assumptions about the nature of intelligence.

** This seminar will be of interest to students with some background in cognitive science (e.g. students who have taken courses like Philosophy of Mind, Cognitive Psychology, Sensation and Perception, Brain Matters, Animal Learning, Physiological Psychology, or Formal Logic). However, the course does not presuppose any prior specialized knowledge of philosophy, psychology, or computer science.

Texts:
- Electronic resources: online resources & pdf files on Lyceum (L).

Requirements:
- Class participation (including attendance) is worth +/- (5%) of your grade.
- Cognitive modeling and artificial neural network exercises(15%).
- A 3 page analysis paper due early in the semester (15%).
- A 6 page paper on an assigned topic due at the midterm (25%).
- A 12 page final paper on a topic of your choosing (40%). Topics must be cleared by week 10.
SCHEDULE OF READINGS:

Lecture 1, 09/04. Introduction
The goal of this session is to preview the semester by convening a discussion of our folk intuitions about intelligence.

Lecture 2, 09/09. A Model for Cognitive Science
The goal of this session is to introduce students to the basic framework of research in cognitive science developed by David Marr and discuss its implications for research in artificial intelligence.


Lecture 3, 09/11. The Symbol System Hypothesis I: A Computational Theory of Mind
The goal of this session is to introduce students to some fundamental concepts in AI research and the basic framework of the symbol system hypothesis.


Lecture 4, 09/16. Automatic Formal Systems
The goal of this session is to introduce the concept of an automatic symbol system and open discussion about Turing Machines, computer architecture, and intelligence.


Lecture 5, 09/18. The Symbol System Hypothesis II: The Architecture of Intelligence
The goal of this session is to continue the discussion of Turing Machines, computer architecture, and computer intelligence.


Lecture 6, 09/23. The Symbol System Hypothesis III: Strong AI
The goal of this session is to discuss a range of early implementations of the symbol system hypothesis.


Lecture 7, 09/25. Knowledge Representation I: The Approach
The goal of this session is to introduce knowledge representation as a potentially sticky issue for the symbol system hypothesis.


SSH Exercises: Algorithms, Symbol Systems, & Heuristic Search (TBA)

The following supplementary resources are useful to thumb through

- The Tower of Hanoi Problem *(Onl)*
- General Problem Solver *(Onl)*
- Larry Learner Program
- Heuristic Search
  [http://artint.info/html/ArtInt.html](http://artint.info/html/ArtInt.html)
- General Issues:

Lecture 8, 09/30. The Chinese Room Problem
The goal of this session is to introduce and evaluate Searle's *Chinese room problem* as an objection to the strong symbol system hypothesis.


The Mind Project: The Chinese Room *(Onl)*

Lecture 9, 10/02. Knowledge Representation II: The Frame Problem
The goal of this session is to introduce and evaluate the *frame problem* as an objection to the strong symbol system hypothesis.


Lecture 10, 10/07. Connectionism I
The goal of this session is to introduce connectionist modeling as an alternative to the symbol system hypothesis.


The Mind Project: Connectionism 1-3. (Onl)
http://www.mind.ilstu.edu/curriculum/connectionism_intro/connectionism_1.php

Lecture 11, 10/09. Connectionism II
The goal of this session is to open discussion about the potential of connectionist modeling as an alternative to the symbol system hypothesis.


Lecture 12, 10/14. Connectionism III
The goal of this session is to continue discussion about the potential of connectionist architectures.


FALL BREAK: 10/15 – 10/19

Lecture 13, 10/21. Connectionism IV
The goal of this session is to evaluate the systematicity argument against connectionist models in artificial intelligence.


Lecture 14, 10/23. Connectionism V
The goal of this session is to discuss how knowledge effects and long term memory might be modeled in connectionist systems.


Lecture 15, 10/28. Connectionism, & Artificial Neural Networks: Text & Exercises I

The goal of these sessions is to acquire hands-on experience with connectionist and artificial neural network modeling in order to gain a better practical understanding of the promise and pitfalls of this approach to understanding cognition and modeling intelligent behavior. We will work through some of the exercises from each of the resources below.

Fred Cummins, BasicProp: (http://basicprop.wordpress.com/)


Jay McClelland: The PDP lab (http://web.stanford.edu/group/pdplab/resources.html#pdptool)

Matlab Exercises (TBA) (L)

Lecture 16, 10/30. Connectionism, & Artificial Neural Networks: Text & Exercises II

The goal of these sessions is to acquire hands-on experience with connectionist and artificial neural network modeling in order to gain a better practical understanding of the promise and pitfalls of this approach to understanding cognition and modeling intelligent behavior.

Lecture 17, 11/04. Connectionism, & Artificial Neural Networks: Text & Exercises III

The goal of these sessions is to acquire hands-on experience with connectionist and artificial neural network modeling in order to gain a better practical understanding of the promise and pitfalls of this approach to understanding cognition and modeling intelligent behavior.


Lecture 18, 11/06. Connectionism, & Artificial Neural Networks: Text & Exercises IV

The goal of these sessions is to acquire hands-on experience with connectionist and artificial neural network modeling in order to gain a better practical understanding of the promise and pitfalls of this approach to understanding cognition and modeling intelligent behavior.

Lecture 19, 11/11. Connectionism, & Artificial Neural Networks: Text & Exercises V

The goal of these sessions is to acquire hands-on experience with connectionist and artificial neural network modeling in order to gain a better practical understanding of the promise and pitfalls of this approach to understanding cognition and modeling intelligent behavior.

Lecture 20, 11/13. Connectionism, & Artificial Neural Networks: Text & Exercises VI

The goal of these sessions is to acquire hands-on experience with connectionist and artificial neural network modeling in order to gain a better practical understanding of the promise and pitfalls of this approach to understanding cognition and modeling intelligent behavior.
Lecture 21, 11/18. Behavior-Based Robotics
The goal of this session is to introduce behavior-based robotics as an alternative to GOFAI and Connectionist approaches to artificial intelligence.


Lecture 22, 11/20. Dynamic Systems Approaches
The goal of this session is to introduce a dynamic systems approach to modeling intelligent behavior as an alternative to approaches to artificial intelligence.


THANKSGIVING BREAK!!!!!!!

Lecture 23, 12/0. Behaviors, Dynamic Systems, & Representations
The goal of these this session and the following is to evaluate the scope of behavior-based and dynamic systems approaches to modeling intelligent behavior by evaluating a) their arguments against the need for representations and b) the claims that these systems themselves should not be interpreted as exploiting representational states.


Lecture 24, 12/04. In Defense of Representation
The goal of these this session and the following is to evaluate the scope of behavior-based and dynamic systems approaches to modeling intelligent behavior by evaluating a) their arguments against the need for representations and b) the claims that these systems themselves should not be interpreted as exploiting representational states.

Andy Clark (2014). Dynamics (continued).

ASSIGNMENTS: All assignments must be handed in both in hard copy and electronically via the dropbox for that assignment on LYCEUM

Analysis Paper (1000 words): The goal of this paper is to critically evaluate the argument presented in syllabus reading. Focus should be placed on critically evaluating the reasoning and evidence presented in support of the argument in the reading.

Due Date: October 5, 2014

Synthesis Paper (1800 words): The purpose of this paper is to demonstrate that you can identify & evaluate a standard argument in the literature and synthesize the diverse range of material covered in the first half of the semester into a coherent position.

Due date: October 26, 2014

Final Paper (1800 words): The purpose of this paper is to demonstrate that you can identify & evaluate a standard argument in the literature, synthesize the diverse range of material covered on the syllabus into a coherent position, and incorporate comments on revisions to a draft. Please write on a topic of your choosing.

Topic Due Date: Week 12
Paper Due Date: The scheduled exam date (there is no final exam), December 11, 2014.

Computational Modeling Exercises:
I will assign several exercises in October exploring the nature of algorithms, symbol systems, and heuristic search for students to work through on their own (see schedule of readings for dates and links to software & exercises).

We will meet for three weeks in November to run through a range of connectionist / artificial neural network modeling exercises (see schedule of readings for dates and links to software & exercises).

Some Miscellaneous Notes and Guidelines:
Moral behavior is the grounds for, and the framework of, a healthy society. In this regard it is each of our responsibility as an individual within the community of our classroom to act responsibly. This includes following the rules and guidelines set out by Bates College for academic behavior. Plagiarism is a serious matter. It goes without saying that each of you is expected to do his or her own work and to cite EVERY text that is used to prepare a paper for this class.

Please familiarize yourself with the guidelines for academic integrity posted on the Bates Website: http://www.bates.edu/entering/policy/judicial-affairs/code-of-student-conduct/academic-misconduct/

This is a seminar. This means that the content of the course, and our progress through the syllabus, should ideally be student driven. I have designed the course to allow us some flexibility so that we can spend more time on issues of interest to the class. I reserve the right to make changes to the syllabus as we go along in order to accommodate our interests as they emerge in class discussions. I will also occasionally upload supplementary materials to Lyceum for students interested in pursuing particular issues beyond class discussion.
### SCHEDULE OF READINGS

The reading schedule that follows is a loose guideline for our progress through the syllabus. It is open to change at the Professor’s discretion contingent on the pace of the class and evolving interests of the group.

<table>
<thead>
<tr>
<th>Date</th>
<th>Readings</th>
<th>Assignments (due Fridays: 5pm)</th>
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<tbody>
<tr>
<td>1:</td>
<td>09/03</td>
<td>No Readings</td>
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<tr>
<td>2:</td>
<td>09/09</td>
<td><em>Marr, Vision</em> (excerpt): 8-37. <em>(L)</em></td>
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<td>3:</td>
<td>09/11</td>
<td>*Haugeland, What is Mind Design?: 8-21. <em>(MD)</em></td>
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| 4:    | 09/16                                                                     | *Turing, Computing Machinery…: 29-56. *(MD)*  
                           | *Haugeland, Automatic Formal Systems: 47-86. *(L)* |
| 5:    | 09/18                                                                     | *Copeland, The Symbol System Hypothesis: 58-82. *(L)*  
                           | *Haugeland, Computer Architecture: 125-166. *(L)* |
| 6:    | 09/23                                                                     | *Newell & Simon, Computer Science as…: 81-110. *(MD)*  
                           | *Haugeland, Real Machines: 176-195. *(L)*  
                           | *Copeland, Some Dazzling Exhibits: 11-26. *(L)* |
| 7:    | 09/25                                                                     | *Minsky, A Framework…: 111-142. *(MD)*  
                           | *Haugeland, Real Machines: 195-203. *(L)*  
                           | *Copeland, Some Dazzling Exhibits: 26-32. *(L)*  
                           | SSH exercises distributed |
| 8:    | 09/30                                                                     | *Searle, Minds, Brains, Programs: 183-204. *(MD)*  
                           | *Copeland, The Chinese Room from…: 109-122. *(L)*  
                           | *The Mind Project: The Chinese Room, *(Onl)* |
| 9:    | 10/02                                                                     | *Dreyfus, Al at an Impasse: 143-182. *(MD)*  
                           | *Haugeland, Real Machines: 203-212. *(L)*  
                           | *Copeland, knowledge representation: 91-95. *(L)*  
                           | *Boden, the frame problem: 772-774. *(L)*  
                           | Analysis Paper: Sunday evening |
| 10:   | 10/07                                                                     | *Rumelhart, The Architecture of…: 205-232. *(MD)*  
                           | *Smolensky, Connectionist Modeling: 233-250. *(MD)*  
                           | *The Mind Project, Connectionism, *(Onl)* |
| 11:   | 10/09                                                                     | *Clark, What Networks Know: 41-68. *(AE)*  
                           | *Clark, What Networks Don’t Know: 69-86. *(AE)* |
| 12:   | 10/14                                                                     | *Clark, Concept, Category, Prototype: 87-114. *(AE)* |
|       | Fall Recess: 10/15 – 10/19                                                |                                 |
| 13:   | 10/21                                                                     | *Fodor & Pylyshyn, Connectionism and…: 309-350. *(MD)* |
| 14:   | 10/23                                                                     | *Clark, The Presence of a…: 115-130. *(AE)*  
                           | *Clark, The Role of…: 1510179. *(AE)* |
| 15:   | 10/28                                                                     | Connectionism & Artificial Neural Network Modeling (TBA) |
| 16:   | 10/30                                                                     | Connectionism & Artificial Neural Network Modeling (TBA)  
<pre><code>                       | Synthesis Paper: Sunday Evening |
</code></pre>
<p>| 17:   | 11/04                                                                     | Connectionism &amp; Artificial Neural Network Modeling (TBA) |
| 18:   | 11/06                                                                     | Connectionism &amp; Artificial Neural Network Modeling (TBA) |
| 19:   | 11/11                                                                     | Connectionism &amp; Artificial Neural Network Modeling (TBA) |</p>
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<tr>
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<tr>
<td>20: 11/13</td>
<td>Connectionism &amp; Artificial Neural Network Modeling (TBA)</td>
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| 21: 11/18 | Brooks, Intelligence without Representation: 395-420. (*MD*)  
Beer, Chiel, & Sterling, A Biological perspective on…: 169-186. (*L*) |
| 22: 11/20 | Van Gelder, Dynamical Approaches to…: 91-99. (*MD*)  
Beer, Dynamical Approaches to…: 91-99. (*L*)  
**Paper Topics Due** |

**THANKSGIVING BREAK!!!!!!!**

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| 23: 12/02 | Clark, Dynamics: 140-165. (*L*)  
Markman & Dietrich, In Defense of Representation: 138-171. (*L*) |
| 24: 12/04 | Clark, Dynamics: 140-165. (*L*)  
Markman & Dietrich, In Defense of Representation: 138-171. (*L*) |

**Final 12/12**  
**NO FINAL EXAM**  
**Final paper**