

CS371 - TOPICS IN COMPUTER SCIENCE: ARTIFICIAL INTELLIGENCE

Professor:	Russell C. Bjork bjork@gordon.edu	Spring Semester, 2006
Office:	MacDonald 217 x4377	MWF 3:20-4:20 pm
Hours:	MWF 2:10-3:10 pm; Th 1:30-4:30 pm and by appointment	http://www.cs.gordon.edu/courses/cs371

PREREQUISITES: Consent of the instructor

CATALOG DESCRIPTION: Surveys basic methods of artificial intelligence research. Exposure to AI Programming, using PROLOG. Considers philosophical and theological issues raised by work in AI. Prerequisite: Permission of the instructor.

COURSE OBJECTIVES: In general, this course is meant to introduce you to the field of Artificial Intelligence. Obviously, in 14 weeks we can only survey some high points, but this course should lay the foundation for a critical appreciation of AI research and technology and for further study. Specifically, upon completion of this course you should be familiar with the following:

1. The history and goals of AI research, including some milestone systems.
2. Some of the practical techniques which have emerged from AI research.
3. One of the major AI programming languages: PROLOG.
4. Symbolic and Connectionist models for AI.
5. Future directions and prospects for AI.
6. Some philosophical, ethical, and theological issues raised by attempts to develop a “machine that thinks”.

TEXT: Luger, George. *Artificial Intelligence: Structures and Strategies for Complex Problem Solving* (5th ed) (Addison Wesley, 2005)

RECOMMENDED: Boden, Margaret (ed). *The Philosophy of Artificial Intelligence* (Oxford: Oxford University Press, 1990)

ON RESERVE: Boden, Margaret (ed). *The Philosophy of Artificial Intelligence* (Oxford: Oxford University Press, 1990)

Clocksinn, W.F. and C.S. Mellish. *Programming in Prolog* (4th ed.) (New York: Springer Verlag, 1994)

Dreyfus, Hubert L. and Stuart E. *Mind Over Machine*. (New York: The Free Press, 1986).

MacKay, Donald. “Artificial Intelligence? - A Christian Appraisal” in *Proceedings of a Fifth Conference on Mathematics From a Christian Perspective, May 29-June 1, 1985* - published by the Association of Christians in the Mathematical Sciences.

Nilsson, Nils. *Artificial Intelligence: A New Synthesis* (San Mateo, CA: Morgan Kaufmann, 1998)

Rumelhart, David and James McClelland. *Parallel Distributed Processing: Explorations in the Microstructure of Cognition*. Vol 1. (Cambridge, MA: The MIT Press, 1986).

Weizenbaum, Joseph. *Computer Power and Human Reason*. (San Francisco: W.H. Freeman, 1976).

COURSE TECHNIQUES AND PROCEDURES

This is a survey course, meant to introduce you in a general way to the field of AI. Our goal will be to gain general familiarity with key principles and some historically-significant applications of them. We will also devote a block of class time several times during the term to discussing key papers related to philosophical and theological issues raised by work in AI.

COURSE REQUIREMENTS AND EVALUATION:

1. You will be expected to read much of the text, plus related material in other works, as shown in the course schedule below. Note that reading assignments are to be completed **before** the class in which they are assigned, since the lecture/discussion will assume the reading as background.
2. Six problem sets will be distributed during the semester, and will be due as shown in the course schedule, with value in the final grade computation as shown below. Note that these will be fairly substantial assignments; you would do well to work on the problems as the material is covered in class, rather than waiting until just before the set is due to tackle the whole assignment. Solutions to each problem set will be posted on the bulletin board near the professor's office door after the set is turned in.

<u>Set</u>	<u>Emphases</u>	<u>Value</u>
1	Predicate Calculus	4%
2	Search	4%
3	Knowledge Representation	4%
4	Expert Systems; Alternative Logics; Planning	4%
5	Natural Language; Vision	4%
6	Learning	<u>4%</u>
	Total	24%

The following guidelines should be observed when doing these homework sets

- Homework sets will be due at the start of class on the date indicated. Late homework sets will **NOT** be accepted.
 - Homework sets must be done on one side only of 8-1/2 x 11 paper, and pages must be stapled in problem-number order. Problems must be numbered, and final answers (where appropriate) should be highlighted. (Homework sets not conforming to these standards will be returned ungraded.)
 - You may work together with another student on homework, provided each of you works on each problem.
 - Where an exercise calls for writing a program, it is sufficient to write it out by hand; you need not enter it into the computer.
3. Three programming projects will due as shown in the course schedule, with emphases and weights in the final grade as shown.

<u>Project</u>	<u>Emphasis</u>	<u>Value</u>
1	A Rule-Based Program Using PROLOG	6%
2	Search Techniques	6%
3	Natural Language Processing	<u>7%</u>
	Total	19%

At your option, you may do any or all of these projects (your choice) as part of a team of two students. For additional details, see “Guidelines for Computer Science Projects”. You are expected to read these carefully and comply with them fully.

4. You will read several articles dealing with philosophical / theological issues arising from work in AI. For each article, you must turn in a short (about 1-2 pp double-spaced) response paper in which you both: (a) briefly summarize the author's thesis and (b) personally respond to the author's thesis. (In formulating your response, you should draw on articles assigned previously.) These response papers will be due as shown in the course schedule, and part of the class time on the due date will be used for discussion of the article and responses. Each paper and your discussion participation, together, will be worth 3% of the final course grade (21% total for the seven articles). Note: Since some of these articles are on library reserve, it will not be possible for everyone in the class to read them the night before they are due - so please plan ahead! The articles are:

Turing, Alan M. “Computing Machinery and Intelligence” - article 2 in Boden.

Searle, John R. “Minds, Brains, and Programs” - article 3 in Boden.

Newell, Allen and Simon, Herbert. “Computer Science as Empirical Inquiry: Symbols and Search” - article 5 in Boden.

Brooks, Rodney A. et. al. “Alternative Essences of Intelligence” in *Proceedings of the Fifteenth National Conference on Artificial Intelligence (AAAI-98)* (Madison, Wisconsin, 1998.) <http://people.csail.mit.edu/brooks/papers/group-AAAI-98.pdf>

Dreyfus, Hubert L. and Dreyfus, Stuart E. “Five Steps from Novice to Expert” - chapter 1 of Dreyfus book on reserve.

Dennett, Daniel C. “Cognitive Wheels: The Frame Problem of AI” - article 7 in Boden.

MacKay, Donald. “Artificial Intelligence? - A Christian Appraisal” - on reserve

5. There will be three hour exams given as shown in the course schedule. These will be open book, open notes (course text, notes, and written work only.) Each will account for 12% of the final course grade. (Total 36% for all three). The exams will cover material covered in lecture and assigned reading and/or used on homework, plus the articles listed above, but will **not** ask about programming.

7. Summary:

Problem Sets	24%
Programming Projects	19%
Response Papers/Discussion	21%
Hour Exams	<u>36%</u>
Total	100%

The following are minimum guaranteed grades for the percentages indicated:

	93% - 100%: A	90% - 92.9%: A-
87% - 89.9%: B+	83% - 86.9%: B	80% - 82.9%: B-
77% - 79.9%: C+	73% - 76.9%: C	70% - 72.9%: C-
67% - 69.9%: D+	63% - 66.9%: D	60% - 62.9%: D-

POLICY STATEMENT ON EXTENSIONS AND INCOMPLETES:

1. Extensions of the due dates for homework or projects will be given in the event of extenuating circumstances (such as illness, personal emergency) IF you submit a brief written request to the professor as soon as possible after the circumstances arise. This request will be initialed (if approved) and will be returned to you. You must attach it to the piece of work for which the extension was granted.
2. A grade of Incomplete will be given without penalty IF you are unable to complete the course work by the last day of the term due to major illness or other similar emergency. Again, a written request should be submitted. Such a request will only be granted if you are substantially up-to-date with your course work and were making good progress in the course up to the time that the difficulty arose. Of course, you must complete all work for the course by the midpoint of the next semester in accordance with College policy.
3. A grade of Incomplete with a penalty of one letter grade to be applied in the final grade computation MAY be given if you are unable to complete all the course work for reasons other than those noted above. You must make a written request, and your progress in the course, class attendance etc. will be taken into consideration in determining whether to grant it. Again, you must complete all work for the course by the midpoint of the next semester.

ATTENDANCE POLICY:

Regular class attendance is expected of all students, and class attendance will be recorded. Absences from class will be classified as “documented” or “undocumented”. A documented absence is one where written documentation is submitted supporting an absence from class due to circumstances beyond the student’s control. An undocumented absence is any other absence, including one which could qualify as documented if proper documentation were submitted.

Students who have more than three absences (of any kind) during the semester should expect to see their final grade reduced by 1% for the lesser of the number of undocumented absences and the total number of absences over 3, and students who have more than 12 undocumented absences will fail the course automatically. Note that it is not necessary to document absences unless there are more than three total absences; for most students, this will avoid the need to submit documentation. A student who anticipates the need to miss more than three classes due to athletic competitions or other student activities should review the college’s attendance policy on page 31 of the catalog, and should then discuss alternatives to class attendance with the professor at the start of the semester.

A student who is habitually late will have late arrival for class counted as a half absence for that class, and a student who sleeps through most or all of a given class session will be counted as absent for that class.

You may ask the professor to waive this policy for you if you earned an A in the last CS course you took, or if you have an A average in this course as of mid-semester. If you wish to take advantage of this exemption, you must so inform the professor. However, the attendance policy will be reimposed if your subsequent work deteriorates.

ACCOMMODATION FOR STUDENTS WITH DISABILITIES:

Gordon College is committed to assisting students with documented disabilities (see Academic Catalog Appendix C, for documentation guidelines). A student with a disability who may need academic accommodations should follow this procedure:

1. Meet with a staff person from the Academic Support Center (Jenks 412 X4746) to:
 - a. make sure documentation of your disability is on file in the ASC,
 - b. discuss the accommodations for which you are eligible,
 - c. discuss the procedures for obtaining the accommodations, and
 - d. obtain a **Faculty Notification Form**.

2. Deliver a Faculty Notification Form to each course professor *within the first full week of the semester*; at that time make an appointment to discuss your needs with each professor.

Failure to register in time with your professor and the ASC may compromise our ability to provide the accommodations. Questions or disputes about accommodations should be immediately referred to the Academic Support Center. See Grievance Procedures available from the ASC.

NOTE: In the assignments below, readings without an author name are in the text by Luger; readings with an author name are from reserves. In the case of readings in Luger, if the assignment is a specific section then it includes all of its subsections - e.g. §2.3-2.5 includes 2.3.1, 2.3.2, 2.3.3. Naturally, the relevant articles on library reserve must be read before writing the article summaries!

TENTATIVE COURSE SCHEDULE

<u>Date</u>	<u>Topic(s)</u>	<u>Reading</u>	<u>Written Work Due</u>
UNIT I: INTRODUCTION			
W 1/11	Course Introduction; What is AI?; The Goals and History of AI Work	Part I Intro; ch. 1 (skim §1.1.1-1.1.3)	
F 1/13	(ctd)	Weizenbaum pp. 1-8.	
UNIT II: THE FUNDAMENTAL CONCERNS OF AI: KNOWLEDGE REPRESENTATION AND SEARCH			
W 1/18	Discussion of Turing Article; Introduction to Knowledge Representation; Introduction to The Predicate Calculus	Part II Intro pp. 35-40; §2.0-2.2 (§2.1 should be review - skim)	TURING ARTICLE PAPER
F 1/20	(ctd)		
M 1/23	(ctd)	§2.3-2.5; 13.2.1-13.2.3, 13.2.5	START HOMEWORK 1
W 1/25	(ctd)		
F 1/27	Discussion of Searle Article; An Introduction to PROLOG	Part VI Intro; §15.0-15.1, 15.6.1, 15.6.3, 15.10	SEARLE ARTICLE PAPER
M 1/30	(ctd)		
W 2/1	(ctd)		HOMEWORK 1; START PROJECT 1
F 2/3	Introduction to Search; State Spaces	Part II Intro pp. 40-44; §3.0-3.4 (§3.1.1-3.1.2 should be review - skim)	
M 2/6	(ctd)		
W 2/8	Heuristic Search	§4.0-4.3	
F 2/10	(ctd)		
M 2/13	Search in Two-Player Games	§4.4-4.6	
W 2/15	Production Systems	§6.2; 15.3	
F 2/17	Blackboard Architecture; Discussion of Newell/Simon article	§6.3-6.4	NEWELL/SIMON ARTICLE PAPER
M 2/20	Semantic Networks, Scripts, Frames, Conceptual Graphs	Part III Intro; §7.0-7.2; 15.7.3-15.7.4	
W 2/22	(ctd)		HOMEWORK 2

F 2/24	Alternatives to Explicit Representation; Discussion of Brooks article	§7.3-7.4; Rumelhart and McClelland ch. 1	BROOKS ARTICLE PAPER
M 2/27	(ctd)		
W 3/1	HOUR EXAM #1 (Through Search - §6.2; HW 1, 2; Turing, Searle, Newell/Simon) <i>(Quad Break)</i>		
	UNIT III: AI APPLICATIONS		
M 3/13	Rule-Based Expert Systems	§8.0-8.3; 15.7.1- 15.7.2	
W 3/15	(ctd); Discussion of Dreyfus chapter		DREYFUS CHAPTER PAPER
F 3/17	Incomplete, Uncertain, or Imprecise Information: Truth Maintenance, Probability, Fuzzy Logic	§5.0; (5.1-5.2 as needed); 5.3-5.5; ch. 9	HOMEWORK 3
M 3/20	(ctd)		
W 3/22	(ctd); Modal Logic	Nilsson §23.3	
F 3/24	Planning Systems	§8.4-8.5; 15.5	
M 3/27	(ctd); discussion of Dennett article		DENNETT ARTICLE PAPER
W 3/29	Natural Language Processing	Part V Intro; ch. 14	
F 3/31	(ctd)		HOMEWORK 4
M 4/3	(ctd)	Clocksin and Mellish ch. 9	
W 4/5	Machine Vision	Nilsson §6.1, 6.3- 6.7	
F 4/7	(ctd)		
M 4/10	HOUR EXAM #2 (through Planning; HW 3, 4; Brooks, Dreyfus, Dennett)		
	UNIT IV: LEARNING		
W 4/12	Symbol-Based Learning	Part IV Intro; ch. 10; 15.8	
W 4/19	(ctd)		HOMEWORK 5
F 4/21	Connectionist Learning	ch. 11	
M 4/24	(ctd)		
W 4/26	Social and Emergent Learning	ch. 12	
F 4/28	(ctd)		
	UNIT V: CONCLUSION AND FUTURE DIRECTIONS		
M 5/1	Where is AI Going?	Part VII Intro; §17.0-17.1, 17.3	
W 5/3	(ctd); Discussion of MacKay Article		MACKAY ARTICLE PAPER
F 12/12 by 4 PM			HOMEWORK 6
	FRIDAY, MAY 5 - 10:30-12:30 AM - HOUR EXAM #3		