

## CPS331 - ARTIFICIAL INTELLIGENCE

Professor:	Russell C. Bjork russell.bjork@gordon.edu	Fall Semester, 2016
Office:	KOSC 242 x4377	MWF 2:10-3:10 pm KOSC 126
Hours:	MWF 3:20-4:20 pm; Tu 1:30-4:30 pm and by appointment	
Course Site:	Blackboard Site + <a href="http://www.cs.gordon.edu/courses/cps331">http://www.cs.gordon.edu/courses/cps331</a>	

**CATALOG DESCRIPTION:** Approaches to producing "intelligent" systems. Knowledge representation (both symbolic and neural network), search, and machine learning. Exposure to AI programming using PROLOG. Theological and philosophical issues raised by work in AI. Prerequisites: PHI118 and NSM202.

**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 work, for grappling with some of the philosophical and theological issues raised by AI, and for further study. Specifically, upon completion of this course you should be familiar with the following:

1. The key approaches to automating intelligence that AI has developed, and some practical applications of them.
2. One of the major AI programming languages: PROLOG.
3. Symbolic and biologically-inspired models for AI.
4. Some philosophical, ethical, and theological issues raised by attempts to develop a "machine that thinks".

**TEXT:** Cawsey, Alison. *The Essence of Artificial Intelligence*. (Harlow, England: Pearson Prentice-Hall Europe, 1998)

**ON RESERVE:** Dreyfus, Hubert L. and Dreyfus, Stuart E. *Mind Over Machine: The Power of Human Intuition and Expertise in the Era of the Computer* (New York: The Free Press, 1986)

### 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:

The college has adopted the following statement regarding work expectations for courses; "For each semester hour of credit, students should expect to spend a minimum of 2-3 hours per week outside of class in engaged academic time. This time includes reading, writing, studying, completing assignments, lab work, or group projects, among other activities."

1. You will be expected to read most of the text, plus several articles online, 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. You will read a number of articles dealing with philosophical / theological issues arising from work in AI. (Most will be accessible through the Blackboard course site). For each article, you must turn in a short (about 2-3 pp double-spaced) response paper in which you both: (a) 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.) Three pitfalls to avoid: reacting without understanding (show me that you have understood the author); rehearsing without reflecting (show me that you have thought about the issues raised) and missing the forest for the trees (keying in on a secondary detail rather than addressing the major point).

A brief introduction and some questions to help you think about the article's theme will be distributed in class: We will devote a block of class time to discussing each article on the due date. Your response paper and participation in discussion on the first articles will account for 2% of the final course grade; the remaining participation/papers will be 3% each. The articles are:

Turing, Alan M. "Computing Machinery and Intelligence". Originally published in *Mind* LIX no 2236 (October, 1950) 433-460. (Online copy linked from Blackboard)

Newell, Allen and Simon, Herbert. "Computer Science as Empirical Inquiry: Symbols and Search". Originally appeared in *Communications of the ACM* 19 (March, 1976) 113-126. (Online copy linked from Blackboard)

Dreyfus, Hubert L. and Dreyfus, Stuart E. "Five Steps from Novice to Expert" - chapter 1 of *Mind Over Machine: The Power of Human Intuition and Expertise in the Era of the Computer* (New York: The Free Press, 1986). (On reserve in library)

Searle, John R. "Minds, Brains, and Programs" Originally appeared in *The Behavioral and Brain Sciences* 3 (1980) 417-424 . (Online copy linked from Blackboard)

Fogel, David B. "Intelligent Machines: Imitating Life." - chapter 1 of *Blondie24: Playing at the Edge of AI*. (San Francisco: Morgan Kaufmann, 2002) (ebook from library - assigned chapter linked from Blackboard).

Brooks, Rodney. "Elephants Don't Play Chess". Originally published in *Robotics and Autonomous Systems* (6), 1990, pp. 3-15. (Online copy linked from Blackboard)

VanderLeest, Steve and Derek S. Schuurman. "A Christian Perspective on Artificial Intelligence" Originally published in the *Proceedings of the 2015 Christian Engineering Conference*. (Online copy linked from Blackboard)

Bjork, Russell C. "Artificial Intelligence and the Soul". Originally published in *Perspectives on Science and the Christian Faith* 60.2 (June, 2008) 95-102. (Online copy linked from Blackboard)

3. Nine problem sets will be posted on Blackboard during the semester, will be due as shown in the course schedule, and together will account for 30% of the final grade in the course. (The size and hence weight of individual problem sets may vary) Solutions to each problem set will be posted on Blackboard after the graded set is returned to you. (Topics below are tentative)

<u>Set</u>	<u>Emphases</u>
1	Knowledge Representation
2	Predicate Logic
3	PROLOG; Rule-Based and Expert Systems
4	Search
5	Planning; Natural Language Processing
6	Fuzzy Logic; Vision
7	Symbolic Learning; Genetic Algorithms
8	Neural Networks
9	Biologically-Inspired AI; Agents

The following guidelines should be observed when doing these problem sets

- Problem sets will be due at the start of class on the date indicated. Late problem sets will **NOT** be accepted.
  - Problem 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. (Sets not conforming to these standards may be returned ungraded.)
  - You may work together with another student on a problem set provided each of you works on each problem, and each turns in his/her own work.
4. Two projects will be posted on Blackboard during the semester, each consisting of two parts, will be due as shown in the course schedule, and together will account for 14% of the final course grade (7% each). At your option, you may do either or both of these projects (your choice) as part of a team of two students.
5. As part of a team of 4-5 students, you will teach one of the following topics to the class on the date shown in the course schedule (1/2 class period for each topic). (Your first, second, and third choices of topic must be turned in as noted in the schedule below.) I will give each team some starting points for their preparation. Your class presentation, together with your outline, will account for 5% of your final course grade.
- If the topic is broader than, focus on the AI aspects of the topic
  - Be sure to discuss the relationship between the topic and appropriate ones of the various articles/chapters you have done for the course
  - **A detailed outline for your presentation must be turned in and discussed with the professor at least one week before your scheduled presentation date.**

The topics are:

Statistical Machine Translation  
Data Mining  
Affective Computing

Situated AI / Behavior-Based Robotics  
Deep Learning  
Transhumanism/"The Singularity"

6. There will be a midterm exam and a final exam given as shown in the course schedule. These will be open book, open notes (course text, notes, and written work only.) The midterm will account for 14% of the final course grade and the final exam for 17%.

7. Summary:

Response Papers/Discussion	20%
Problem Sets	30%
Projects	14%
Teaching a Topic	5%
Exams	<u>31%</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.

## TENTATIVE COURSE SCHEDULE

<u>Date</u>	<u>Topic(s)</u>	<u>Reading</u>	<u>Written Work Due</u>
<b>UNIT I: INTRODUCTION</b>			
W 8/24	Course Introduction; What Is AI?		
F 8/26	Discussion of Turing Article; ELIZA	ch 1; Turing article	<b>Turing Response Paper; Start ELIZA Project</b>
<b>UNIT II: KNOWLEDGE REPRESENTATION</b>			
M 8/29	Symbolic Representation of Knowledge	§2.1-2.2	(Start Problem Set 1)
W 8/31	(continued)		
F 9/2	(continued); Discussion of Newell and Simon article	Newell and Simon article	<b>Newell and Simon Response Paper</b>
M 9/5	<i>(Labor Day - no class)</i>		
W 9/7	Predicate Logic	§2.3	
F 9/9	(continued)		<b>ELIZA Project Part I Due</b>
M 9/12	(continued)		<b>Problem Set 1 Due</b>
W 9/14	PROLOG		<b>Team Presentation Topic Choices Due</b>
F 9/16	(continued)		
M 9/19	Rule-Based Systems	§2.4-2.5	<b>Problem Set 2 Due</b>
W 9/21	Expert Systems	§3.1-3.3	
F 9/23	(continued)	Dreyfus chapter	
M 9/26	Dealing with Uncertainty; Discussion of Dreyfus chapter	§3.4-3.5; but you may skip 3.5.3	<b>Dreyfus Response Paper</b>
<b>UNIT III: SEARCH</b>			
W 9/28	Introduction to Search; Uninformed Search	§4.1-4.2.2; 4.3-4.3.1	<b>ELIZA Project Part II Due; Start Expert Systems Project</b>
F 9/30	Heuristic Search	§4.2.3	<b>Problem Set 3 Due</b>
M 10/3	Adversary (Game) Search	§4.3.3-4.3.4	
W 10/5	Constraint Propagation		
F 10/7	Planning	§4.3.2	<b>Problem Set 4 Due</b>
M 10/10	(continued)		
W 10/12	<b>MidTerm Exam (through Constraint Propagation; Problem Sets 1-4 + ELIZA Project)</b>		
F 10/14	<i>(quad break - no class)</i>		

#### UNIT IV: COMMUNICATION

M 10/17	Natural Language Processing	ch. 5	<b>Expert Systems Project Part I Due</b>
W 10/19	(continued); Discussion of Searle article	Searle article	<b>Searle Response Paper</b>
F 10/21	Fuzzy Logic		
M 10/24	Vision	§6.1, 6.3-6.5 (skim §6.2)	<b>Problem Set 5 Due</b>

#### UNIT V: LEARNING

W 10/26	Introduction to Learning; Discussion of Fogel chapter	Fogel Chapter	<b>Fogel Response Paper</b>
F 10/28	Symbolic Learning	§7.1-7.4	
M 10/31	(continued)		<b>Problem Set 6 Due</b>
W 11/2	Genetic Algorithms	§7.5	
F 11/4	(continued)		<b>ES Project Part II Due</b>
M 11/7	Neural Networks	§7.6-7.8	
W 11/9	(continued)		<b>Problem Set 7 Due</b>
F 11/11	(continued)		
M 11/14	Biologically-Inspired AI; Discussion of Brooks Article		<b>Brooks Response Paper</b>
W 11/16	(continued)		
F 11/18	Agents and Robots	ch. 8	<b>Problem Set 8 Due;</b> <b>REMEMBER: Team Outlines are to be discussed with the professor at least one week in advance</b>

#### UNIT VI: TEAM PRESENTATIONS

M 11/21	Statistical Machine Translation; Situated AI/Behavior-Based Robotics		
W 11/23	<i>Thanksgiving Break - no class</i>		
F 11/25	<i>Thanksgiving Break - no class</i>		
M 11/28	Data Mining; Deep Learning		
W 11/30	Affective Computing; Transhumanism/"The Singularity"		<b>Problem Set 9 Due</b>

#### UNIT VII: THE FUTURE

F 12/2	Artificial General Intelligence (Strong AI)		
M 12/5	General Artificial Intelligence and Christian Faith; Discussion of VanderLeest/Schuurman and Bjork articles	VanderLeest/Schuurman and Bjork articles	<b>VanderLeest/Schuurman and Bjork Response Paper (one paper dealing with both)</b>
W 12/7	Review and Catch-up		
R 12/15 9 - 11 am	<b>Final Exam (Focus on material since MidTerm Exam; Problem Sets 5-9)</b>		

All Reading Assignments are in the main text by Cawsey except as otherwise noted