CS-0175: What Computers Can't Do

COURSE INFORMATION

Instructor Info: **Lee Spector**
lasCCS@hampshire.edu
Office Extension: x5352

Office Hours: Regular office hours: Tuesdays 10:00-11:30, Wednesdays 1:00-2:30, and Thursdays 10:00-11:30. Other times can be set up by arrangement (in person or via email). Sign up for regular office hours, advising day meetings, and occasionally other signup times on Moodle here.

Term: 2015S

Meeting Info:
Tuesday 12:30 PM - 01:50 PM Adele Simmons Hall (ASH) 222
Thursday 12:30 PM - 01:50 PM Adele Simmons Hall (ASH) 222

Description: Computers are commonly (and inconsistently) regarded as both omnipotent and as "stupid machines." In this course we will explore the real limits of computation from philosophical, logical, mathematical and public-policy perspectives. We begin with a discussion of the possibility of "artificial intelligence" (AI), covering the claims that have been made by AI scientists and the critiques of such claims that have arisen from the philosophical community. We then focus on the fundamental logic and mathematics of computation, including techniques for proving that certain problems are "intractable" or "unsolvable." In the third part of the course we turn to social and political questions on which an enlightened view of the limits of computation can have an impact. Students will be evaluated through a combination of short papers and problem sets, along with a final project.

Course Objectives:

- To understand the limits of computation from philosophical, logical, mathematical and public-policy perspectives.
- To learn fundamental concepts and skills in logic and discrete mathematics.
- To develop improved skills for conducting research, framing arguments, writing, and engaging in academic discussions.
- To develop and complete a large-scale project.
- To work collaboratively with classmates.

Evaluation Criteria: Each student is expected to attend consistently, to read all assigned readings, to participate actively in class discussions, and to complete all assignments: two short papers, three problem sets, a final project, and a few other small assignments.

Additional Info:

Division I Distribution Credit

Successful completion of this course satisfies the Divison I distribution requirement in Mind, Brain, and Information. This course provides opportunities for satisfaction of Division I cumulative skills requirements in Quantitative Skills, Independent Work, and Writing and Research.

Texts

- *Smarter Than Us: The Rise of Machine Intelligence*, by Stuart Armstrong. 2014. Available directly from amazon.com.
- *Logicomix: An Epic Search for Truth*, by Apostolos Doxiadis and Christos H. Papadimitriou, 2009.

Other readings will be made available from the class website.

Policies in Regards to Illness, Epidemic, or Pandemic

If you have a fever, please stay home, take good care of yourself, and contact me by email or phone. When you are able to work at home you should be able to participate in classes and to submit work electronically. If your illness makes it impossible for you to meet the course deadlines then contact me and we will negotiate an accommodation.

Plagiarism Policy

Official policy text:

> All Hampshire College students and faculty, whether at Hampshire or at other institutions, are bound by the ethics of academic integrity. The entire description and college policy can be found in Non Satis Non Scire at handbook.hampshire.edu under Academic Policies/Ethics of Scholarship. Plagiarism is the representation of someone else's work as one's own. Both deliberate and inadvertent misrepresentations of another's work as your own are considered plagiarism and are serious breaches of academic honesty and integrity. All sources used or consulted in the process of writing papers, examinations, preparing oral presentations, course assignments, artistic productions, and so on, must be cited. Sources include material from books, journals or any other printed source, the work of other students, faculty, or staff, information from the Internet, software programs and other electronic material, designs and ideas.

All cases of suspected plagiarism or academic dishonesty will be referred to the Dean of Advising who will review documentation and meet with student and faculty member. Individual faculty, in consultation with the Dean of Advising, will decide the most appropriate consequence in the context of the class. This can range from revising and resubmitting an assignment to failing the course. Beyond the consequence in the course, CASA considers first offenses as opportunities for education and official warning. Multiple or egregious offenses will have more serious consequences. Suspected instances of other breaches of the ethics of academic integrity, such as the falsification of data, will be treated with the same seriousness as plagiarism and will follow the same process.

Thursday, 22 January (12:30PM - 01:50PM)

Introduction, syllabus, first assignments

Tuesday, 27 January (12:30PM - 01:50PM)

The Turing test

Alan Turing, "Computing Machinery and Intelligence"

Listen: Lee Spector, "Rethinking Computer Intelligence"

Thursday, 29 January (12:30PM - 01:50PM)

The Chinese room

John Searle, "Minds, Brains and Programs"

Tuesday, 3 February (12:30PM - 01:50PM)

Paper discussion

Thursday, 5 February (12:30PM - 01:50PM)

Behavior-based AI

Rodney A. Brooks, "Intelligence Without Representation"

Due: Paper 1

Tuesday, 10 February (12:30PM - 01:50PM)

Evolutionary computing

Lee Spector, Evolution of Artificial Intelligence

Thursday, 12 February (12:30PM - 01:50PM)

ADVISING DAY - no class

Tuesday, 17 February (12:30PM - 01:50PM)

Risks of superintelligence

Stuart Armstrong, *Smarter Than Us: The Rise of Machine Intelligence*

Watch: James Barrat, "Book Discussion on Our Final Invention"

Thursday, 19 February (12:30PM - 01:50PM)

Paper discussion

Tuesday, 24 February (12:30PM - 01:50PM)

Crisis in the foundations of mathematics

Apostolos Doxiadis and Christos Papadimitriou, *Logicomix*

Due: Paper 2

Thursday, 26 February (12:30PM - 01:50PM)

The dawn of unsolvability

Alan Turing, "Solvable and Unsolvable Problems" (and "Introduction" by Jack Copeland)

Apostolos Doxiadis and Christos Papadimitriou, *Logicomix*

Tuesday, 3 March (12:30PM - 01:50PM)

Logic

Wikipedia page: http://en.wikipedia.org/wiki/Logic

Thursday, 5 March (12:30PM - 01:50PM)

Algorithms

Wikipedia page: http://en.wikipedia.org/wiki/Algorithm

Tuesday, 10 March (12:30PM - 01:50PM)

Finite state automata

Wikipedia page: http://en.wikipedia.org/wiki/Deterministic_finite_automaton

Simulator: http://ivanzuzak.info/noam/webapps/fsm_simulator/

Udacity video on programming a FSA in python:
https://www.udacity.com/course/viewer#!/c-cs262/l-48699658/e-48725299/m-48718348

Thursday, 12 March (12:30PM - 01:50PM)

The Chomsky hierarchy

Wikipedia page on the Chomsky hierarchy:
http://en.wikipedia.org/wiki/Chomsky_hierarchy

Wikipedia page on the pumping lemma:
http://en.wikipedia.org/wiki/Pumping_lemma_for_regular_languages

Due: Problem Set 1

Tuesday, 17 March (12:30PM - 01:50PM)

SPRING BREAK - no class

Thursday, 19 March (12:30PM - 01:50PM)

SPRING BREAK - no class

Tuesday, 24 March (12:30PM - 01:50PM)

More powerful automata

Wikipedia page on pushdown automata:
http://en.wikipedia.org/wiki/Pushdown_automaton

Wikipedia page on linear bounded automata:
http://en.wikipedia.org/wiki/Linear_bounded_automaton

Wikipedia page on Turing machines: http://en.wikipedia.org/wiki/Turing_machine

Turing Machine simulator: http://morphett.info/turing/turing.html

---

Thursday, 26 March (12:30PM - 01:50PM)

The halting problem and incompleteness

Wikipedia page on the halting problem: http://en.wikipedia.org/wiki/Halting_problem

Wikipedia page on Godel's incompleteness theorem: http://en.wikipedia.org/wiki/G%C3%B6del's_incompleteness_theorems

---

Tuesday, 31 March (12:30PM - 01:50PM)

Computational complexity

Wikipedia page: http://en.wikipedia.org/wiki/Computational_complexity_theory

Due: Problem Set 2

Thursday, 2 April (12:30PM - 01:50PM)

NP completeness

Wikipedia page: http://en.wikipedia.org/wiki/NP-complete

Tuesday, 7 April (12:30PM - 01:50PM)

Quantum computing

Lee Spector, Chapter 1 of Automatic Quantum Computer Programming

Due: Problem Set 3

Thursday, 9 April (12:30PM - 01:50PM)

Discussion of ideas for final projects

Due: Initial idea

Tuesday, 14 April (12:30PM - 01:50PM)

Discussion of abstracts relevant to final projects

Due: An abstract from the literature

Thursday, 16 April (12:30PM - 01:50PM)

Continued discussion of abstracts relevant to final projects

Tuesday, 21 April (12:30PM - 01:50PM)

Small group discussions/work on final projects

Thursday, 23 April (12:30PM - 01:50PM)

Small group discussions/work on final projects

Tuesday, 28 April (12:30PM - 01:50PM)

Presentations

Thursday, 30 April (12:30PM - 01:50PM)

Last class

Presentations

Due: Final Projects

Tuesday, 5 May (12:30PM - 01:50PM)