Research in Artificial Intelligence

COURSE INFORMATION

Instructor Info:	**Lee Spector** lasCCS@hampshire.edu Office Extension: x5352 Office Hours: Regular office hours: Tuesdays 9:30-11:00, Wednesdays 1:00-2:30, and Thursdays 2:00-3:30. 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 Hampedia here.
Term:	2011S
Meeting Info:	**Thursday** 12:30 PM - 03:20 PM Adele Simmons Hall (ASH) 126
Description:	Students in this course will become members of research teams focusing on projects designated by the instructor. Projects will involve open research questions in artificial intelligence, artificial life, or computational models of cognitive systems. They will be oriented toward the production of publishable results and/or distributable software systems. Students will gain skills that will be useful for Division III project work and graduate-level research. Prerequisite: one programming course (in any language). This class meets once a week for two hours and 40 minutes.
Course Objectives:	◦ To engage in scientific/technological inquiry. ◦ To work collaboratively with classmates, the professor, and the larger research community. ◦ To understand be able to navigate current research literature.
Evaluation Criteria:	◦ Attendance: Because this class meets only once a week it is particularly important to attend every session. ◦ Participation: Each student is expected to be continuously engaged in course-related activities throughout the semester, to be responsive (always within 24 hours) to their classmates and the professor via electronic mail, and to participate actively in class presentations and discussions. ◦ Documentation: Each student is expected to contribute to a project blog on a regular basis. Students will be evaluated with respect to their performance relative to the expectations listed above. Students falling significantly short of these expectations — for example, students with more than one unexcused absense or students who fail to contribute to class discussions or project blogs — should not expect to receive evaluations.

Additional Info:

Texts

There is no text for this course. Project-specific readings will be assigned on an as-need basis.

Blog

Project blogging will be supported at http://i3ci.hampshire.edu.

Facilities

Students may use their own computers, the Macs in ASH 126, and the high performance computing cluster in the Hampshire College Cluster Computing Facility.

Division I Distribution Credit

This course does **not** satisfy any Division I distribution requirement.

Difficulty/Level

This course is intended to serve students with a wide range of backgrounds. Students with little previous experience should resist being intimidated and bear in mind that I take background into account in writing evaluations. Students with extensive previous experience should note that the class is structured to provide ample opportunities for more advanced work.

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

Hampshire College has a rigorous policy on plagiarism, outlined in detail in the student handbook. As stated in College documents "Plagiarism (from the Latin for 'kidnapper') is a term covering everything from inadvertently passing off as one's own the work of another because of ignorance, time constraints, or careless note-taking, to hiring a ghost writer to produce an examination or course paper." In particular, it covers false citation, false data, intentional poor documentation, papers written by others, unacknowledged multiple authors or collaboration, unacknowledged multiple submission, and other forms of academic dishonesty. The penalties are severe, so you should always be proactive in identifying all sources. When in doubt you should ask your professor about what is and isn't appropriate.

In this course we will often be sharing and borrowing code. This is

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CS-0148-1_2011F

CS-0201-1_2011F

CS-0254-1_2011F

CS-0109-1_2012F

CS-0254-1_2012F

CS-104T-1_2013F

CS-0303-1_2013F

SETTINGS

Course administration

Turn editing on

Edit settings

Users

Filters

In this course we will often be sharing and borrowing code. This is an important aspect of the course and an important aspect of modern programming practice. This does not mean, however, that it is acceptable to submit code that is not your own without acknowledging sources. Sources should be clearly and explicitly provided in everything that you produce.

Project Areas

Students will be assigned to project teams based on experience, expressed preferences, and availability of positions.

The preliminary list of potential projects is as follows. Each will be described in detail in class. The listed references are intended only as starting points.

1. Tool development for AI research: Research in artificial intelligence often relies on the prior development of new software technologies to support specific types of computations. Prior work at Hampshire in this area has focused on the development of simulation systems (such as breve) and frameworks for using networked computers in novel ways, for example with "unwitting" or parasitic computing. AI work at Hampshire has also utilized the the Hampshire College Cluster Computing Facility, houses a high-performance Beowulf-style computer cluster called fly (supported by grants from DARPA and NSF). This work has mostly been conducted on an ad-hoc basis, without the development and distribution of easy-to-use tools that help AI researchers (including students) to utilize the cluster to its full potential. The focus of this project is to develop, refine, distribute, and publicize such tools.
2. The GECCO "Visualizing Evolution" competition: The focus of this project is to develop an entry to a competition at the 2011 Genetic and Evolutionary Computation Conference. From http://www.sigevo.org/gecco-2011/competitions.html:

   "This competition aims to enable participants to exhibit their cutting edge visualizations of evolutionary processes. The competition is a general set of guidelines and a framework within which a variety of visualization and interaction technologies can be used to portray current work in evolutionary computing in a compelling and elucidating manner. Hopefully, by visualizing these processes and applying techniques from scientific visualization and visual analytics, new insights and a broader understanding will be achieved."
3. The GECCO "Evolutionary Art" competition: The focus of this project is to develop an entry to a competition at the 2011 Genetic and Evolutionary Computation Conference. From http://www.sigevo.org/gecco-2011/competitions.html: "Entrants must submit: (1) a brief artistic statement illustrating the concept, (2) a short paper describing the technical details, and (3) a set of multimedia files to illustrate the result of the evolutionary process. Artists can either submit five still images, or a video of up to 5 minutes, or a sound file of up to 5 minutes." Previous work at Hampshire in this area has focused on the production of music and art from evolutionary and adaptive systems: http://hampshire.edu/lspector/genbebop.html, http://hampshire.edu/lspector/ccc.html.
4. The GECCO "Simulated Car Racing Championship" competition and/or "Demolition Derby" competition: The

Grades
Backup
Restore
Import
Reset
Question bank
Legacy course files
Switch role to...
My profile settings
SEARCH FORUMS
Go
Advanced search

competition and/or "Demolition Derby" competition. The focus of this project is to develop an entry to a competition at the 2011 Genetic and Evolutionary Computation Conference. From http://www.sigevo.org/gecco-2011/competitions.html: "The goal of the [car racing] championship is to design a controller for a racing car that will compete on a set of unknown tracks first alone (against the clock) and then against other drivers. The controllers perceive the racing environment through a number of sensors that describe the relevant features of the car surroundings (e.g., the track limits, the position of near-by obstacles), of the car state (the engine RPMs, the current gear, wheel speeds, etc.), and the current game state (lap time, number of lap, etc.). The controller can perform the typical driving actions (clutch, changing gear, accelerate, break, steering the wheel)." "The

Demolition Derby 2011 competition challenges you to design a racing car controller that manages to effectively crash into other cars while avoiding being crashed itself. Thus, the goal is simple: Wreck all opponent cars by crashing into them without getting wrecked yourself."

5. Evolution of software agents for economic games: The focus of this project is work on an NSF-funded project entitled "Evolution of Robustly Intelligent Computational Systems" (http://www.hampshire.edu/news/18982.htm). From the grant proposal:

> "The intention here is to work in an application area that requires not only multiple interacting functionalities and interfaces but also some degree of robust intelligence. Real-world environments such as economic markets often have these requirements, but they cannot be controlled sufficiently well to study the performance of the proposed methods in a systematic way. Game theory provides a wide range of well-characterized and well-studied environments for which optimal strategies are, however, not yet known, and the PI has worked on some problems in this area.
>
> For the proposed project new games will be developed that combine elements of several previous games such as donation games, ultimatum games, bargaining games, and coordination games in ways that can be scaled to provide progressively richer environments in terms of demand for robust intelligence. The goal in devising these games will be to retain as much as possible of the clarity of the previously-studied games but to introduce interactions between elements, some of which may be time-varying or stochastic, that require robust intelligence for consistently good performance. These games will be intermediate in difficulty between classic games considered in the game theory literature, many of which have known optimal strategies, and the environments navigated by real- world economic agents. The more complex games developed may resemble real-world markets in several respects, and indeed it may be possible to demonstrate the proposed
>
> methods in existing market simulations like that provided by the commercial Beat the Market game software.
>
> Development of games with the desired properties is itself a significant research project to which the PI will devote time in the first year of the project.

Implementations will be produced in part by undergraduates under the supervision of the PI, and experiments evolving agents for the resulting environments will be conducted by undergraduates, graduate students, and the PI."

6. Autoconstructive Evolution: In autoconstructive evolution the mechanisms of reproduction and diversification are themselves evolved within a genetic programming system. Prior work at Hampshire on autoconstructive evolution includes http://hampshire.edu/lspector/pubs/push-gpem-final.pdf, http://hampshire.edu/lspector/pubs/spector-alife8.pdf, and http://hampshire.edu/lspector/pubs/spector-gptp10-preprint.pdf. This project will focus on the refinement and extension of autoconstructive evolution methods.
7. Genetic programming applications to integer sequence induction problems: The most often cited problem domain for genetic programming is symbolic regression. In a symbolic regression problem one is provided with a sequence of <x,y> data pairs and the goal is to produce a symbolic expression f(x) with a parameter x that, when evaluated with a particular value of x returns the corresponding value for y. Ideally the expression will correctly generalize to data points not used as fitness cases during evolution. Integer sequence problems are identical to symbolic regression problems except that: 1) The x values are positive integers, indices into the sequence. 2) The y values are integers, the values in the sequence. 3) The equation for f(x) may include references to f(z) for z<x. The On-Line Encyclopedia of Integer Sequences (http://oeis.org/) lists thousands of integer sequence problems, many currently unsolved, with comments on difficulty and history of each; this will serve as the source of the integer sequence problems to be used. Solutions to many of these problems may provide fundamental insights in number theory.

8. Genetic programming applications to analysis of SETI data: One of the types of problem most commonly addressed by genetic programming involves the discovery of programs that explain numerical data -- this is often called "symbolic regression." This project will focus on the use of genetic programming to detect signatures of extraterrestrial intelligence in data produced by the SETI project.
9. Genetic programming applications in climate science or green energy production: Prior work at Hampshire on the application of genetic programming to climate science has been preliminary, but this is an important area that appears to have potential. This is in part because a large number of simulation systems exist for modeling chemical and climate systems, and these simulations could conceivably be used in the "fitness testing" step of genetic programming. This project will involve significant initial work to find appropriate targets for genetic programming.
10. Genetic programming applications in quantum computing: Once realized, the potential of large-scale quantum computers promises to radically transform computer science. Despite large-scale international efforts, however, essential questions about the potential of quantum algorithms are still unanswered. Prior work on the application of genetic programming to problems in quantum computing at Hampshire in this area has produced several significant results including award-winning, human-competitive results: http://hampshire.edu/lspector/aqcp/, http://hampshire.edu/lspector/pubs/AIEDAM-Quantum.pdf. This project will extend this prior work by investigating and

pursuing other related applications.

Course website: https://moodle.hampshire.edu/course/view.php?id=1536

News forum
intro.clj
regressionForClass.clj
collider.clj
pushcollider.clj

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Moodle Docs for this page

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