Artificial Intelligence for Non-Majors at Multiple Levels

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Outline

- Will claim that we can draw students to CS through two kinds of courses
  - Introductory courses
  - Accessible electives of relevance to other fields

  Think “French Drain”
- Two courses (syllabi and materials)
  - Intro for non-majors
  - Elective on machine learning
- Will argue that this isn’t just about AI

AI: Image and Reality

- One of several theme-based intros
  - For non-majors: AI, Graphics, Game Design, BioInformatics
  - For majors: Networks
- Offered every 2-3 years since S95
- S99 version introduced robotics emphasis (Meeden)

Goals

- Introduce students to fundamental questions of *computer science*
- Programming and problem solving (for those who might want to go on)

  Give an accurate picture of CS
- Safe environment for all students
- Motivate students to continue with CS

Course Format

- 3 50-min lectures/discussions per week
- 1.5-hour (or 3-hour) lab per week
- 12 week semester

Student Work

- Reading
  - Textbook
  - Position papers on AI, Philosophy, Psychology
  - Fiction
- Reading response on discussion topics
- Four problem sets
- Lab (group) work - construction and programming of simple robots

Lecture Syllabus

- First 6 weeks: Robotics
  - Applications and challenges
  - Robot parts: sensors and effectors
  - Classical planning vs behavorial approach
  - Interactive C programming
- Last 6 weeks: General AI topics
  - Knowledge representation and reasoning
  - Search; games
  - Learning; NLP; Vision

Other Topics

- Robot ethics
- Creativity
- The nature of intelligence

Lab Syllabus

- Soldering and wiring
- Testing
- Building robot chassis
- Touch sensing
- Sonar vs touch navigation
- Line following
- Trashbot (multiweek) [Hank / Elevator]

Link to all course materials in paper

Enrollment Outcomes

	Enrolled	Majors	Other CS	Courses
F06	4	1 of 18	2	3
F04	10	0	8	9+4
F00	15	2 of 14	6	12
S99	14	0	5	10

Why call it a success?

- Small liberal arts college
- Low enrollments but high satisfaction
- Fall 2006: 4 students, but
  - 3 women (1 now a CS major)
  - 2 African American

Machine Learning: not just for the CS major

Beauty by numbers

Art historians have been using statistical methods to classify ancient works since the 1970s, when computers were introduced to the field. By measuring the physical dimensions of clay pots and stoneware items whose origins are well established, for instance, scholars can identify the variables that link the pieces to specific cultures. That information, in turn, helps historians identify the provenance of newly discovered works.

This kind of quantitative approach is useful for studying simple objects like pottery, which can be characterized by a few variables, but it's not typically used to examine sculpture or visual art. How could you quantify, say, the subtle iconographic elements that distinguish an ancient Phoenician ivory carving from one produced in nearby North Syria?

Art historian Amy Gansell '98BC has done just that, and her solution involves one of the most sophisticated tricks of number crunching ever attempted in her field. As part of her Harvard dissertation, she recently scrutinized female figures depicted in hundreds of decorative ivories from first millennial BCE Mesopotamia, recording the shapes of eyes, noses, and chins, whether hair is curly or if the women wear jewelry, and dozens of other details. Gansell then recruited Chris Wiggins, a Columbia associate professor of applied mathematics and applied physics, to examine the 32,000 resulting pieces of data. Wiggins employed a new, high-powered type of statistical analysis called "machine learning," which can reveal hidden patterns and associations amid huge data sets. (Biologists use machine learning to untangle the human genome, and political scientists use it to comb election results for voting trends.)

Gansell used the technology to brush off what had become a dusty topic for art historians, revealing previously unobserved differences in how Phoenician and North Syrian artisans plied their trade.

She discovered that among ivory carvings whose female forms have well-defined eyelids and nostrils that are delicately scooped out (rather than drilled straight through), 95 percent are from North Syria, as determined by previous studies. "No one would have noticed the association between those variables and the

… employed a new, high-powered type of statistical analysis called “machine learning”

Electives as a hook into CS

- Relevance to other disciplines
- Advocates in other departments
- Relatively small number of hurdles
  - CS1
  - CS2 (Data Structures)
  - *Discrete Math*

Tutorial Course Format

- Modeled roughly on tutorial style of teaching at Oxford
- Students meet once per week with instructor in pairs
- Instructor assigns reading and paper topic of the week
- One student presents paper; other presents critique

Students take more responsibility for learning

Machine Learning Tutorial

- Like AI, requires only CS1, CS, Discrete Math
- Primary focus on classification (Naïve Bayes, ANNs/Backprop, Support Vector Machines, Decision Trees, kNN, ensembles) and regression
- Evaluation methodology
- Computational learning theory

Weekly Work

- Textbook readings on the topic of the week
- Problem set
- *Implementation and critique*
- Research paper, *critique, and critique of critique*

See link in paper for sample assignments

Tutorial Sessions

- Presentation of problems at the board
- Weeks with research articles
  - One student presents research paper and offers initial critique
  - Other student presents evaluation of first critique + evaluation of research article
- Weeks with implementation
  - General discussion of algorithm, problems, issues
  - Student code review

Some Tutorial Stats

- College-wide
  - 50 offered 2007-08; >60 in 2006-07
  - Most Physics electives are tutorials
- In Computer Science
  - Offer two each year
  - Class of 06: 2 of 9 majors took none
  - Class of 07: 3 of 16 took none (some took 3, 4, or even 5 in CS)
  - Class of 08: 3 of 13 will have taken none

Appeal of Tutorials

- Both strong and weak students
- Combination of independence and one-on-one attention
- Natural format for teaching a diverse group of students
  - Last week's Decision Tree discussion: one group didn't get beyond problem set

Adapting for Other Settings

- Alternative to seminar
- Guided independent study
  - More classroom contact hours than standard lecture
  - More directed than independent study in general
- Lecture + conference
  - Level- or interest-based conference sections
  - “Interest” can be “disciplinary” or “skill”

Summary

- Syllabi and materials for two very different courses
- Can draw students to CS through AI at all levels

More General Conclusions

- This isn't just about AI
  - Computational Thinking (Wing)
  - Other disciplines becoming more computational
- Need to forge relationships with other departments and programs

What we can do

- Advertise CS in other departments
  - CS1 counts as half elective in Chem
  - Any CS above intro level is half elective in Phys
  - 109 advertised by Studio Art Chair
- Cross-list courses
  - Game design course is also Art
  - Theory of Computation is also Math
  - Bioinformatics is also Bio, Chem, Phys…

Need to be open to such requests from others

Thank you