CPS 570

Artificial Intelligence
(emphasizing planning and sensing)

Introduction
Ron Parr

Who is Ron?
• Professor of Computer Science & Chair
• 15th year at Duke
• A.B. in Philosophy (though I don’t use that much)
• Interests:
  – Robotics
  – MDPs & Reinforcement learning
  – Game theory
  – Sensing

More AI at Duke
• In CS: Vince Conitzer (Computational Economics), Bruce Donald & Alex Hartemink (Computational Biology), Carlo Tomasi (vision),
• In Engineering: Larry Carin (Machine Learning), Guillermo Sapiro (Vision)
• In Statistics: Katherine Heller & Sayan Mukherjee (Machine Learning)
• In Math: Mauro Maggioni (Machine Learning)
• In Biostatistics: Raluca Gordan (Computational Biology)
• (With apologies to those I left out...)

What is AI?
• For centuries, perhaps longer, people have wondered how to reproduce the smarts that people have...
• Even though we really have no idea how to define such things
• The task of defining intelligence has, itself, been a career long endeavor for many scholars
Machine Intelligence

- For as long as people have made machines, they have wondered if these machines could exhibit human-like intelligence
- von Kempelen’s (fraudulent) Turk (1700s), Babbage’s analytical and difference engines (1800s), Turing’s Turing machine (1900s)

Exhibit at the Computer History Museum in Santa Clara

AI after Turing

- Modern AI is almost 60 years old
- “AI” term proposed at the famous “Dartmouth Conference” in 1957, when computers were slow, room-sized monstrosities
- Has been a subject of intense study since then
  - Most CS departments have at least one AI expert
  - Defense department, national science foundation, industry invest heavily in AI every year
  - Google, amazon, etc. all have robust AI groups – often machine learning

Are We Making Progress?  
(AI in your life)

- Game playing - chess, jeopardy
- Voice recognition – siri
- Recommendation systems – netflix, amazon
- Handwriting recognition
- Automated logistics – UPS, US military
- Space exploration
But Where’s the General Intelligence?

• AI didn’t get traction until it focused on more specific problems
• Hard to provide “general intelligence” if you don’t know what it is
• Are we mimicking intelligence or getting closer to it by focusing on specific problems?

What This Class Is Not

• A Balanced Introduction to AI
• Easy

Goals for Graduate AI

• Graduate students now encouraged to pass qualifying exams to demonstrate undergraduate-level mastery of breadth topics
• Graduate AI should:
  – be a more exciting class for people who are genuinely interested in more advanced material
  – prepare students for further study in AI
  – help students become effective researchers/computer scientists even if they aren’t focusing on AI
• Desire to align graduate AI with the WISENet program

How This Differs from Undergraduate AI

• Undergrad AI:
  – Covers most of AI
  – Covers things at a shallow level
  – Uses an encyclopedic textbook
  – Emphasizes programming, basic algorithms
• This course:
  – Focuses on fewer topics
  – Goes into depth
  – Uses no textbook – lectures and papers
  – Emphasizes theory, research papers
  – Insights from using algorithms
The Major Problem We’re fixing

• Students could pass graduate AI but still have no clue about how to start doing AI research

• There needs to be a transitional course from undergraduate problem solving to graduate research

Another Issue We’re Exploring

• What is the evolving role of the lecture?
• As lectures become commoditized (coursera, udacity, etc.), should class time:
  – Reproduce what is already available on the web
  – Augment what is available?
    • Make the most of in-person, real time interactions
    • Teach skills that aren’t easily addressed through lectures?

Learning Objectives

• Teach students to think outside the textbook
• Teach students to teach themselves:
  – Reading papers in the field
  – Trying, discussing

• Expose students to classic topics in AI as well as leading edge research

What If I’m not an AI student?

• AI papers tend to mix theory and application
• AI has been a source of interesting questions for theoreticians
• AI has useful applications across CS, engineering, biology, etc.

• Learning to read AI papers will help develop useful skills that transfer to other disciplines
What if I’m a WISeNet student?

- Sensing is central to sensor networks
- Sensing without planning is foolish
- Sensing is expensive
- No such thing as a “free” sensor reading
  - Cost of moving a resource to acquire data
  - Direct cost of acquiring data (power, time)
  - Cost of transmitting data
  - Cost of processing data

What if I’m not a Graduate Student?

- Hopefully you will be one some day
- Even if you don’t go to graduate school:
  - There is no textbook for the real world
  - Much of what is in your textbooks now will be outdated in a few years
- But...
  - You might be happier in 270
  - Make sure you’ve got enough background
  - We assume you know a lot of basic CS
  - Assume a certain level of sophistication “teach yourself Matlab”

Requirements

- Familiarity with programming
- Ability to do short proofs
- Basic probability concepts
- Basic algorithmic concepts
  - Complexity - $O()$
  - Analysis of algorithms
- Math
  - Basic calculus (partial derivatives)
  - Basic linear algebra

Major Topics Covered

See Syllabus on Class Web Page
Major Topics Not Covered

• Search – single player and games
• Constraint Satisfaction
• Natural Language – written, spoken language
• Logic and Knowledge Representation
• Machine Learning – we only scratch the surface
• Vision – object and activity recognition

Active Learning

• I will attempt to engage student in active learning experiences whenever possible
  – Discussion
  – Running/Writing code in class
• Will be challenging given class size!

Class Mechanics

See Grading Section of Class Web Page

Grading Scale

• This is a graduate course
• Grades are typically A’s and B’s
• Lower grades are rare, but they do occur

• If you are a young Ph.D. student, you probably need to rethink the importance of grades in your life
Academic Honesty

- You are encouraged to discuss papers and high level concepts with your friends
- Specific answers to questions must be your own
- You may not
  - ask your friends for specific answers to questions
  - use code from other sources without permission
  - search the internet for answers to questions
- Don’t push it; we take these things seriously here.

- More details in a separate presentation & academic honesty matrix on assignments section of web page

Things That Might Go Wrong

- Sometimes papers will be confusing
  - This may be the fault of the authors
  - This may be because the paper assumes something you don’t know yet
- Active learning could flop in a class this big
- Our TA is stuck in China
- I love to meet with students, but have very little time to do so because I am dept. chair 😊