CPS 570
Artificial Intelligence

Introduction

Ron Parr

Who is Ron?

• Professor of Computer Science
• Starting my 19th year at Duke
• A.B. in Philosophy (though I don’t use that much)
• Interests:
  – Robotics
  – MDPs & Reinforcement learning
  – Game theory
  – Sensing
Can I Get a Permission Number?

• We will not be increasing the cap (room is legally limited to ~50 students)

• Some students will drop

• If you are not prepared, please drop to make room for those who are

Am I Prepared?

• This is a **graduate computer science class**:  
  – We expect you to know undergraduate level computer science already  
  – Don’t think you can stumble into this and succeed without knowing CS

• Other expectations  
  – Ability to do short proofs  
  – Basic probability concepts (though we will review all of this)  
  – Basic algorithmic concepts  
    • Analysis of algorithms  
    • Complexity - O( )  
    • NP-hardness and the complexity hierarchy  
  – Math: Calculus and linear algebra
More AI at Duke

• In CS: Vince Conitzer (Computational Economics), Bruce Donald, Raluca Gordan & Alex Hartemink ( Computational Biology), Rong Ge (Machine Learning Theory), Cynthia Rudin (Machine Learning), & Carlo Tomasi (Vision)

• In Engineering: Larry Carin (Machine Learning), David Carlson (Machine Learning), Missy Cummings (Robotics), Kris Hauser (Robotics), Guillermo Sapiro (Vision), Michael Zavlanos (Robotics)

• In Statistics: Katherine Heller & Sayan Mukherjee (Machine Learning)

• (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

• 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)

Images from Wikipedia

Al after Turing

- Modern AI is ~60 years old
- “AI” term proposed at 1957, Dartmouth Conference
- Has been a subject of intense study since then
  - 1960’s: Logic, search, theorem proving, perceptron
  - 70’s: Robotic & perception
  - 80’s: Expert systems, 1st industrial interest, neural nets
  - 90’s: agents, uncertainty, “AI Winter”
  - 00’s: growth of ML, NLP, usable AI systems
  - 10’s: Deep learning, industrial/commodity AI, robotics
  - 20’s: Up to you!
AI in Your Life

- Game playing - chess, Go, jeopardy
- Voice recognition – siri, Alex, Google Now
- Recommender systems – netflix, amazon
- Handwriting recognition
- Scene, object, face recognition: iPhone X, MS seeing AI, image search (objects and faces)
- Automated logistics – UPS, US military
- Space exploration
- Automated science & medicine

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

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
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
  – Reflect interests and expertise of Duke CS AI faculty
  – Complement other related offerings at Duke

Learning Objectives

• Teach students to think outside the textbook

• Teach students to teach themselves from papers rather textbooks

• 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 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 quickly

• 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
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 in depth – we only scratch the surface of a few topics
- Vision – object and activity recognition
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

• This is a large graduate class with a diverse population (not just people laser focused on AI) – the approach of reading papers may not scale