Artificial Intelligence Methods for Social Good

M0-1: Introduction

08-537 (9-unit) and 08-737 (12-unit)
Instructor: Fei Fang
feifang@cmu.edu
Wean Hall 4126
What is AI?

- **AI in our daily lives**
  - Web search (Google, Bing)
  - And...

- **AI lead to transformation and evolution in domains and industries**
  - Finance (Loan, Insurance)
  - And…
What is AI?

- Founders: “Intelligence can be so precisely described that a machine can be made to simulate it”

- What’s your definition of AI?
Brief History of AI

- Early days
  - Founded in 1950s: Allen Newell (CMU), Herbert Simon (CMU), John McCarthy (Stanford), Marvin Minsky (MIT)
  - Single agent / deterministic
    - Play chess, prove theorems, solve puzzle
    - Logics and symbolic systems, heuristic reasoning, search
  - Integrated AI systems
    - Perception → learning/reasoning/planning → action

- AI winter (1990s)
  - Over-optimism → Over-persimissm
  - Interact with real world: uncertainty, multi-agent, real time
  - Easy for human, hard for AI: object recognition, understand speech
  - New tools from decision theory, optimization, game theory etc
New Era of AI

- Why?
  - Increasing computer power
  - And…

- Success of AI
  - Image classification
  - And…
Branches of AI

- Machine learning
- And…
How AI impact Society

- Benefits of AI to society
  - Reduce human labor
  - And...

- Concerns of AI to society
  - Job loss
  - And...
Artificial Intelligence Methods for Social Good

Module 0-2: Logistics

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Instructor and TA

- Instructor: Fei Fang ([feifang@cmu.edu](mailto:feifang@cmu.edu))
  - Office Hour: Tue/Thu 1pm-2pm or by appointment
  - Wean 4126

- TA: Chun Kai Ling ([chunkail@andrew.cmu.edu](mailto:chunkail@andrew.cmu.edu))
  - Office Hour: Wed/Fri 2pm-3pm or by appointment
  - GHC 6507
Basic Info

- Some overlap with other AI courses (quick poll)
  - 15-381/781: AI; 15-780: Graduate AI
  - 05-499/899: Computing for Good
  - 10-725/36-725: Convex Optimization; 10-703 Deep Reinforcement Learning or 10-707 Topics in Deep Learning; 10-708 Probabilistic Graphical Models
Basic Info

- This course
  - Broad coverage of AI methods
  - Recent advances applied to address societal challenges
  - In depth experience with one topic through course project

- Pre-requisite
  - (9 unit and 12 unit) Linear algebra, probability, calculus
  - (12 unit) Programming experience, basic AI
Basic Info

- **AI methods covered:**
  - Optimization: mathematical programming, robust optimization, influence maximization
  - Game Theory and Mechanism Design: security games, human behavior modeling, auction and market equilibrium, citizen science
  - Machine Learning: classification, clustering, probabilistic graphical models, deep learning
  - Sequential Decision Making: Markov Decision Processes (MDPs), partially observable MDPs, online planning, reinforcement learning

- **Societal challenges tackled:**
  - Healthcare
  - Social welfare
  - Security and privacy
  - Environmental sustainability
Class Format

- Modules focused on AI methods
  - Concepts, basic algorithms
  - May use white board heavily (please take notes or pictures)

- Modules focused on applications
  - Advanced techniques applied to address societal challenges
  - 8 guest lectures by distinguished researchers

- Paper discussion

- In-class quizzes (through Piazza)
Learning Objective

- Identify societal challenges, determine which AI methods can be applied

- Describe the AI methods: concepts, models, algorithms, implementation

- Model the societal challenges and propose how to apply AI techniques

- Describe evaluation criteria and methodologies of applying AI methods for social good

- Deliver written and oral presentation
Learning Objectives (Alternative Description)

- For lectures on methods:
  - Understand the part highlighted on the white board
  - Know where to find other useful information

- For lectures on applications:
  - Get a brief idea about the advanced techniques and the applications

- For course project:
  - Pick one topic and go in depth
Grading

<table>
<thead>
<tr>
<th>Course Component</th>
<th>Weight</th>
<th>Expected Workload</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class participation</td>
<td>10%</td>
<td>3 hours/week</td>
</tr>
<tr>
<td>Paper Summaries</td>
<td>20%</td>
<td>2 hours/week</td>
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<tr>
<td>Written Answers</td>
<td>20%</td>
<td>1 hour/week</td>
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<tr>
<td>Assignment</td>
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<tr>
<td>Final Project</td>
<td>50%</td>
<td>3 hours/week for 08-537</td>
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<td></td>
<td></td>
<td>6 hours/week for 08-737</td>
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Final Grade: Letter graded
Grading Criteria Overview

- **Class participation**
  - In-class quizzes (use Piazza or hand in on paper)
  - Asking and answering questions in class/on Canvas
  - Can skip up to 4 lectures

- **Paper reading assignments**
  - 14 assignments, No late days, Lowest score dropped
  - Submit: Summary + Questions + Brainstorming Ideas (peer reviewed)

- **Written Answers Assignment**
  - 8 assignments, No late days, Lowest score dropped
  - Submit: Answers (three attempts, auto-graded) + Explanations (peer reviewed)
  - Bonus score for best explanations
Grading Criteria Overview

- Final Project
  - In groups of 1-3. Allow to have team members from both sessions. Grading follow criteria of 08-737 if any member is from 08-737
- Due Dates
  - Determine group members, due 2/1
  - Project Proposal (5 points), due 2/15 (peer-reviewed)
  - Project Progress Report (5 points), due 3/20 (peer-reviewed)
  - Project Presentation (15 points), In class of 5/1 and 5/3
  - Full Project Report (25 points), due 5/10
Resources

- **Course webpage**

- **Canvas**
  - [https://canvas.cmu.edu/](https://canvas.cmu.edu/)
  - Questions, discussion, homework, grade
  - For all course content-related questions, please post on Canvas instead of writing emails to instructor/TA

- **Piazza**
  - Access through Canvas
  - Or [https://piazza.com/class](https://piazza.com/class)
  - Only for in-class quizzes
Textbook and Additional Reference

- No formal textbook

- List of additional resources will be provided (check Canvas and slides)
Waitlist

- We are trying our best to get everyone in!
Academic Integrity

- Be collaborative, give credits
  - If discuss with others, specify names and complete on your own
- Leverage resources
  - If use publicly available code packages, specify source
- If your complete submissions (including explanations) are the same, you will get zero score and the case will be reported
- Course project report should follow standard academic integrity policy. Plagiarism is not allowed.
- See CMU policy on academic integrity for general information
  - [https://www.cmu.edu/student-affairs/ocsi/academic-integrity/index.html](https://www.cmu.edu/student-affairs/ocsi/academic-integrity/index.html)
If you have a disability and require accommodations, please contact Catherine Getchell, Director of Disability Resources, 412-268-6121, getchell@cmu.edu

If you have an accommodations letter from the Disability Resources office, discuss with me as early as possibly
Student Well-Being

- Start early! Avoid last-minute panic.
- CMU services are available, and treatment does work
  - [http://www.cmu.edu/counseling/](http://www.cmu.edu/counseling/)
  - 412-268-2922
Mobile Device Policy

- Mobile devices are allowed in class
- Cellphones should be in silent mode
- Students who use tablet in upright position and laptops will be asked to sit in the back rows of the classroom
Homework for today

- Complete HW0 on Canvas
  - 0 point in final grade, unlimited trials, full score is required
  - Due 1/25
    - Probability, linear algebra, and calculus
    - Logistics
    - Course project idea

- Complete the poll on Piazza
  - Indicate your interest (not anonymous)
  - 0 point in final grade, required
  - Due 1/25

- Start finding group members (check the poll result)!
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Module 0-3: Course Project Overview

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Expectations

- You are expected to get a deep understanding of one topic of AI through the course project.

- You are expected to learn how to identify and model real-world challenges as problems that AI methods can apply.

- You are expected to make your results public to benefit others (e.g., submit paper to workshops, make code package available on GitHub etc).

- You are not expected to build an app with user interface etc (although it is good to have for some projects).
Different Types of Projects

- **9-unit**
  - Systematic literature review (no coding needed)
    - Application-centric
      - “AI Methods for Reducing Poverty”
    - AI method-centric
      - “Deep Learning for Social Good”
    - AI method + Application -centric
      - “Game Theory for Anti-Poaching”
  - Exploratory project
    - Data-centric
      - “Detecting Mining Sites from Satellite Imagery Using Faster R-CNN”
    - Model/algorithm-centric (no coding needed although encouraged)
      - “Optimizing Inspection Strategy to Reduce Air Pollution”
    - Solver/code package-centric
      - “A Python Package for Solving Security Games”
Different Types of Projects

- 12-unit
  - Research project
    - Data-centric
    - Model/algorithm-centric
  - For Ph.D. students: recommended to talk to your Ph.D. advisor and choose a project that is related to your research
Course Project Topics

- A list of suggested project topics is available (check Canvas, complete poll on Piazza)

- Can propose your own projects topics related to AI and Social Good, need consent from the instructor

- Even if you plan to work on a suggested project topic, try to propose one topic to enlighten other students (HW0)
Course Project Advisor

- **Advisor**
  - Faculty advisor is not required, will not be assigned
  - Encouraged to reach out to faculty members / senior students / domain experts, ask for feedback and advice (which papers to read, learn what happens in practice etc.)
  - May invite them to serve as faculty advisor or serve on the advisory board
  - For suggested course project topics A-L, I would like to provide guidance during office hours