CS 581 – Advanced Artificial Intelligence

Topic: Syllabus

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INSTRUCTOR

- Dr. Mustafa Bilgic
  - Associate Professor in CS
  - Director of Masters in AI
  - Director of the Machine Learning Laboratory
- Office hours
  - See Blackboard

TEACHING ASSISTANT

- Ruo Yang
  - PhD student at the Machine Learning Laboratory
- See Blackboard for office hours

AGENDA

- Brief introduction to AI

- Course syllabus

- Course logistics

- Q&A

- Adjourn

BRIEF INTRO TO AI

WEAK AI IS UBIQUITOUS

- Speech recognition
  - Siri, Alexa, Google Assistant, Cortona, …
- Text classification
  - Spam, topic, sentiment, …
- Image classification
  - Face recognition, object classification, medical image analysis, …
- Game playing
  - Chess, Go, Poker, …
- In-class examples
  - Anyone?

SUBFIELDS

- Search
  - Pretty much everything in AI is powered by search
  - Path finding, solving constraint satisfaction problems, parameter search for machine learning models, policy search for reinforcement learning, searching for moves in games, searching for most-probable translations, …

- Machine learning
  - Rather than hardcoding the rules, learn them from history and experience
  - Supervised learning, unsupervised learning, reinforcement learning

SUBFIELDS

- Probabilistic reasoning
  - Represent an uncertain world and act under uncertainty
  - Most decisions are based on probabilistic inference
  - Medical diagnosis, automated driving, …
- Knowledge representation
  - Common sense reasoning
  - Planning
  - Long-term / sequential acting rather than episodic actions

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Course Syllabus

Course Description

https://bulletin.iit.edu/search/?P=CS+581

Covers advanced topics in artificial intelligence. Topics include search and optimization, simulated annealing, evolutionary algorithms, gradient optimization, constraint optimization, A* search, alpha-beta search, Monte Carlo tree search, probabilistic reasoning, Bayesian networks, hidden Markov models, Kalman filters, decision-making under uncertainty, influence diagrams, Markov decision processes, bandit problems, supervised learning, classification, deep learning, reinforcement learning, knowledge representation, propositional and first-order logic, ontological engineering, AI ethics and safety, privacy, bias and fairness in machine learning, and explainable AI.

TEXTBOOK

- Textbook is not required

- You might find the following book useful

  - Artificial Intelligence: A Modern Approach by Stuart Russell and Peter Norvig

  - http://aima.cs.berkeley.edu/

POTENTIAL TOPICS

- Search and optimization
  - Hill climbing
  - Gradient ascent/descent
  - Constrained optimization
  - Genetic algorithms
  - Simulated annealing
  - Maximum likelihood estimation
  - Bayesian estimation
  - Expectation maximization
  - Specific algorithms
    - A-star
    - Alpha-beta search
    - Monte Carlo tree search
    - Backpropagation

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POTENTIAL TOPICS

- Probabilistic reasoning
  - Bayesian networks
  - Temporal models
  - Hidden Markov models
- Decision-making under uncertainty
  - Influence diagrams
  - Value of information
  - Markov decision processes
  - Bandit problems

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POTENTIAL TOPICS

- Learning
  - Supervised learning
    - Naive Bayes, logistic regression, deep learning, convolutional neural networks, recurrent neural networks
  - Reinforcement learning
    - Passive reinforcement learning, active reinforcement learning, temporal-difference learning, policy search

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POTENTIAL TOPICS

- Knowledge representation (if there is time)
  - Propositional logic
  - First-order logic
  - Conjunctive normal form
  - Resolution
  - Ontological engineering
- AI Safety and Ethics
  - AI safety
  - Privacy
  - Bias and fairness in machine learning
  - Explainable AI
- Other topics
  - Computer vision
  - Natural language processing

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POSSIBLE ORDER OF TOPICS

- Search
  - Hill climbing, uniform cost search, best-first search, A* search, simulated annealing, genetic algorithms, minimax, alpha-beta pruning, Monte-Carlo tree search
- Probability theory
  - Background, maximum likelihood estimation, Bayesian estimation
- Classification
  - Naïve Bayes, logistic regression
- Deep learning
  - Backpropagation, convolutional neural networks, recurrent neural networks
- Probabilistic decision making
  - Maximum expected utility, value of information, Bandit problems, Markov decision processes, value iteration, policy iteration
- Reinforcement learning
  - Temporal difference learning, Q-learning
- AI safety and ethics
  - Privacy, fairness, accountability, transparency

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WHAT THIS COURSE IS NOT

- Not a machine learning course

- Not a deep learning course

- Not a gaming course

- Not a specific-application course

RELATED CS COURSES

- http://bulletin.iit.edu/courses/cs/

- 400-level
  - CS 422, CS 429, CS 480, CS 481, CS 482, CS 484

- 500-level
  - CS 512, CS 522, CS 529, CS 577, CS 578, CS 579, CS 580, CS 582, CS 583, CS 584, CS 585

- Some courses are offered more frequently than others
  - http://www.cs.iit.edu/past_courses.html

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COURSE OBJECTIVES AND OUTCOMES

- Implement and evaluate search and optimization algorithms for various AI problems both in discrete and continuous spaces

- Carry out probabilistic inference for both episodic and sequential tasks

- Compute value of information using probabilistic reasoning and influence diagrams

- Design and implement an agent that can learn from feedback using reinforcement learning

- Develop and evaluate deep learning models of image and text classification

- Apply the resolution algorithm to answer logical entailment queries

- Summarize and critique bias and fairness definitions and solutions

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Course Logistics

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IN-PERSON, ONLINE, BEACON

- Live lectures (Section 01)
  - Tuesdays/Thursdays 10am-11:15am (US Central)
- Recordings (Sections 02 and 03)
  - Recorded lectures will be available on BB

WEBSITES

- Blackboard
  - Assignments, lecture videos, calendar
  - https://blackboard.iit.edu/
- GitHub
  - Slides, notebooks
  - https://github.com/CS581/CS581-S23
- Piazza
  - Questions & answers
  - https://piazza.com/iit/spring2023/cs581/home
- OneNote
  - Instructor's handwritten notes
  - See BB for the link

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GRADING

Assignments	30%
Midterm Exam	30%
Final Exam	40%

ASSIGNMENTS (30%)

- Written assignments
  - Tracing algorithms, calculating probabilities, logical reasoning, essay questions, …
- Discussions
  - Read and discuss a paper
- Programming assignments
  - Python 3.x
  - Implement and test an AI algorithm

POSSIBLE ASSIGNMENTS

- Search for traveling from a city to another; manual/no coding
  - A*, uniform cost search, greedy search
- Simulated annealing; Python
  - Toy problem
  - Traveling salesman
- Monte Carlo tree search; Python
  - A simple game
- Naïve Bayes, Logistic regression; Python
  - Explainable text classification
- Deep learning; Python
  - Image classification
  - A game board
- Reinforcement learning; Python
  - Toy problem
  - Game playing (Monte-Carlo tree search, deep learning, reinforcement learning); AlphaGo

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LATE SUBMISSION POLICY FOR ASSIGNMENTS

- 5-minute grace period, without any penalty

- After that, every late minute will cost

  - $\frac{100}{48 \times 60} \cong 0.03472$ points per minute

- Extensions for medical reasons: medical documentation is required

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EXAMS

- A midterm (30%) and a final (%40)
- Like written assignments
- Most likely via Blackboard
- Midterm exam date
  - Thursday, March 2nd
- Final exam date
  - May 1 – 6
  - The date is TBD by the university; per academic calendar (https://www.iit.edu/registrar/academic-calendar), the final exam date will be announced on March 8th

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ACADEMIC HONESTY

- https://www.iit.edu/student-affairs/student-handbook/fine-print/code-academic-honesty
- Violations
  - The misrepresentation of any work submitted for credit or otherwise as other than the product of a student's sole independent effort
  - The use of any unauthorized assistance in taking quizzes, tests or examinations
- Sanctions
  - Reduction in grade
  - Expulsion from the course with a grade of E
- Appeals
  - An appeal of a decision regarding academic honesty must be submitted in writing to the Dean of Students (dos@iit.edu)

TITLE IX

- https://www.iit.edu/title-ix

- Illinois Tech prohibits all sexual harassment, sexual misconduct, and gender discrimination by any member of our community.

- Illinois Tech encourages anyone experiencing sexual harassment or sexual misconduct to speak with the Office of Title IX Compliance for information on support options and the resolution process.

- For resources, including counseling and legal assistance, please vist https://www.iit.edu/title-ix/resources

ACCOMMODATIONS

- Reasonable accommodations will be made for students with documented disabilities.

- Reasonable accommodations include
  - Note taking, sign language interpretation, speech-to-text services, testing accommodations (e.g., large print, a reduced-distraction area), and housing accommodations
  - https://www.iit.edu/cdr/services/reasonable-accommodations

- To receive accommodations, students must obtain a letter of accommodation from the Center for Disability Resources
  - https://www.iit.edu/cdr

- All accommodations must be requested in advance

RELIGIOUS/CULTURAL/NATIONAL HOLIDAYS

- If you observe a holiday on which you cannot submit an assignment or take an exam, please let me know as soon as possible but no later than January 28th

- I will do my best to schedule the midterm and the assignment due dates accordingly (the final exam date is set by the university)

- Requests made after January 28th will not be accommodated

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QUESTIONS?