

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
 - 11:30am-12pm on Tuesdays/Thursdays

TEACHING ASSISTANT

- TBA

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

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

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

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

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

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

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

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

COURSE LOGISTICS

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

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

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

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

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 visit <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

QUESTIONS?