

CS 581 – ADVANCED ARTIFICIAL INTELLIGENCE

TOPIC: SYLLABUS

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INSTRUCTOR

- Dr. Mustafa Bilgic
 - Associate Professor in CS
 - Director of MAS-AI
 - Director of the Machine Learning Laboratory
- Office hours
 - 2pm-3pm on Thursdays
 - The Zoom link is available on BB

TA

- Juanyan Wang
 - PhD student at the Machine Learning Laboratory
- Office hours
 - 1pm-2pm on Tuesdays
 - The Zoom link is available on BB

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, ...
 - Hidden Markov models, recurrent neural networks
- Email classification
 - Spam, important, social, promotion, ...
 - Text classification, probabilistic models
- Image classification
 - Face recognition, object classification, medical image analysis, ...
 - SIFT features, support vector machines, deep learning
- Game playing
 - Chess, Go, Poker, ...
 - Alpha-beta pruning, supervised learning, deep learning, reinforcement learning, Monte-Carlo tree search, ...

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
 - Pretty much all decisions are based on probabilistic inference
 - Medical diagnosis, automated driving, face recognition, ...
- Knowledge representation
 - Common sense reasoning
 - Planning
 - Long-term / sequential acting rather than episodic actions

COURSE SYLLABUS

COURSE DESCRIPTION

<http://bulletin.iit.edu/search/?search=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

- There is no required textbook for this course
- You might find the following textbook useful
 - Artificial Intelligence: A Modern Approach by Stuart Russell and Peter Norvig
 - <http://aima.cs.berkeley.edu/>

WE'LL COVER

- 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

WE'LL COVER

○ Probabilistic reasoning

- Bayesian networks
- Temporal models
- Hidden Markov models

CS480
CS583

○ Decision-making under uncertainty

- Influence diagrams
- Value of information
- Markov decision processes
- Bandit problems

CS480

WE'LL COVER

○ Learning

- Supervised learning
- Naive Bayes
- Logistic regression
- Support vector machines
- Deep learning
- Convolutional neural networks, recurrent neural networks
- Reinforcement learning
- Passive reinforcement learning, active reinforcement learning, temporal-difference learning, policy search

AI - 480
ML 484 - 584
DL - 577
DM - 472/572

WE'LL COVER

- 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

- Searching for solutions in a discrete world with discrete set of actions
 - Algorithms
 - Hill climbing, uniform cost search, best-first search, A* search, simulated annealing, genetic algorithms, minimax, alpha-beta pruning, Monte-Carlo tree search
 - Examples
 - Route planning, N-queens, N-Puzzle, traveling salesman problem, game playing

POSSIBLE ORDER OF TOPICS

- Probabilistic reasoning
 - Representation
 - Bayesian networks, hidden Markov models, Kalman filters
 - Parameter estimation
 - Maximum likelihood estimation, Bayesian estimation, expectation maximization

POSSIBLE ORDER OF TOPICS

○ Learning

- Naïve Bayes, logistic regression, support vector machines, neural networks, deep learning, reinforcement learning
- Gradient optimization, Lagrange optimization, backpropagation, temporal difference learning
- Computer vision and natural language processing applications of deep learning

POSSIBLE ORDER OF TOPICS

- Decision-making under uncertainty
 - Influence diagrams, Markov decision processes, bandit problems
 - Value of information, value iteration, policy iteration

POSSIBLE ORDER OF TOPICS

- AI Safety and Ethics
 - AI safety
 - Privacy
 - Bias and fairness in machine learning
 - Explainable AI

POSSIBLE ORDER OF TOPICS

- Knowledge representation
 - Propositional logic, first-order logic, ontological engineering
 - Resolution

WHAT THIS COURSE IS NOT

- Not a machine learning course 584
- Not a deep learning course 577
- Not a gaming course
- Not a specific-application course 512, 585, 579

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
 - <https://docs.google.com/document/d/1kiI3FAEZFC4C1wilkYMJF-KHy-m4BG2jL-pbZNiXehI/edit>

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

ONLINE, IN-PERSON, SYNCHRONOUS, ...?

- Fully online the first two weeks
- Synchronous online lectures
 - Tuesdays/Thursdays 10am-11:15am (US Central)
 - “Zoom Meetings” on BB
- Recording
 - Lectures will be recorded and made available on BB

WEBSITES

- Blackboard
 - Assignments, lecture videos, calendar
 - <https://blackboard.iit.edu/>
- GitHub
 - Slides, notebooks
 - <https://github.com/CS581/CS581-S22>
- Piazza
 - Questions & answers
 - <https://piazza.com/iit/spring2022/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 apply an algorithm to a toy/real problem

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, SVM; Python
 - 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 3rd
- Final exam date
 - May 2 – 7
 - Exact date is TBD by the university

ACADEMIC HONESTY

- <https://web.iit.edu/student-affairs/handbook/fine-print/code-academic-honesty>

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.
- You can report sexual harassment electronically at <https://iit.edu/incidentreport>, which may be completed anonymously. You may additionally report by contacting the Title IX Coordinator, Virginia Foster at foster@iit.edu or the Deputy Title IX Coordinator at eespeland@iit.edu.
- For confidential support, you may reach Illinois Tech's Confidential Advisor at (773) 907-1062. You can also contact a licensed practitioner in Illinois Tech's Student Health and Wellness Center at student.health@iit.edu or (312)567-7550.
- For a comprehensive list of resources regarding counseling services, medical assistance, legal assistance and visa and immigration services, you can visit the Office of Title IX Compliance website at <https://www.iit.edu/title-ix/resources>.

ACCOMMODATIONS

- Reasonable accommodations will be made for students with documented disabilities. In order to receive accommodations, students must obtain a letter of accommodation from the Center for Disability Resources
- <https://web.iit.edu/cdr>

QUESTIONS?