CS 581 – Advanced Artificial Intelligence

Topic: Syllabus

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Course

- CS 581
- Advanced Artificial Intelligence

Instructor

- Dr. Mustafa Bilgic
  - Associate Professor in CS
  - Director of the BS-AI and MAS-AI programs
  - Director of the Machine Learning Laboratory

Agenda

- Brief introduction to AI
- Course syllabus
- Course logistics
- Pick an office hour that works for most students
- Answer your questions
- 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-probably 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 (OLD)

http://bulletin.iit.edu/search/?search=cs+581

Covers various advanced topics in AI, including both theory and practice. Content may vary by instructor. Possible topics include: Planning: STRIPs planning; Partial-order planning; Situation calculus; Theorem proving; GraphPlan/SatPlan; Transformational planning; Simulated annealing; Motion planning; Case-based reasoning; Multi-agent coordination; Negotiation planning; Representation and Reasoning: Logical representation; Frame problem; Probabilistic reasoning; Bayesian networks; Game Playing: Minimax search; Evaluation functions; Learning evaluation functions; Markov Decision Processes; Reinforcement learning for games; Developing AI agents; Multi-agent planning.

Course description (NEW)

https://github.com/CS581/CS581-S21

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 (2 weeks)
  - Hill climbing
  - Gradient ascent/descent
  - Coordinate 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 (2 weeks)
  - Bayesian networks
  - Temporal models
  - Hidden Markov models
  - Kalman filters
- Decision-making under uncertainty (3 weeks)
  - Influence diagrams
  - Value of information
  - Markov decision processes
  - Bandit problems

We'll Cover

- Learning (3 weeks)
  - 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

We'll Cover

- Knowledge representation (2 weeks)
  - Propositional logic
  - First-order logic
  - Conjunctive normal form
  - Resolution
  - Ontological engineering
- AI Safety and Ethics (1.5 weeks)
  - AI safety
  - Privacy
  - Bias and fairness in machine learning
  - Explainable AI
- Other topics (1.5 weeks)
  - Computer vision
  - Natural language processing

What this course is NOT

- Not a machine learning course
- Not a deep learning course
- Not a gaming course
- Not an applications 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
  - 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
- Synchronous online lectures
  - Tuesdays/Thursdays 9:40am-10:55am (US Central)
  - Blackboard collaborate ultra
- Recording
  - Lectures will be recorded and made available through Blackboard Collaborate Ultra

Websites

- Blackboard
  - Assignments, lecture videos, calendar
  - https://blackboard.iit.edu/
- GitHub
  - Slides
  - https://github.com/CS581/CS581-S21

GRADING

Assignments	30%
Midterm Exam	30%
Final Exam	40%

Assignments (30%)

- Written assignments
  - Tracing algorithms, calculating probabilities, logical reasoning, essay questions, …
- Programming assignments
  - Python 3.x
  - Implement and apply an algorithm to a toy/real problem

Late Submission Policy

- 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

Exams

- A midterm (30%) and a final (%40)
- Like written assignments
- Most likely via Blackboard

Office (Virtual) Hour

- Survey to pick an hour that works for most

Academic honesty

- If you violate the academic honesty (such as unauthorized/undocumented collaboration, cheating, etc.), then depending on the severity of the violation, it can result in
  - zero points on the respective assignment,
  - E in the course,
  - suspension of your enrollment at the university,
  - expulsion from the university.
- Full guidelines are available at: https://web.iit.edu/student-affairs/handbook/fine-print/code-academic-honesty

Americans with Disabilities Act (ADA) Policy

- 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?