

CSE 250A. Intro to AI

Probabilistic Reasoning and Decision-Making



CSE 250A. Principles of Artificial Intelligence: Probabilistic Reasoning and Decision-Making

Administrivia Syllabus Piazza Graderisce

Subject

Probabilistic methods for reasoning and decision-making under uncertainty. Topics include: inference and learning in directed graphical models; probabilistic inference in undirected graphical models; belief propagation; approximate inference; decision processes; applications to computer vision, robotics, speech recognition, natural language processing, and information retrieval.

Prerequisites

The course is aimed broadly at advanced undergraduates and beginning graduate students in computer science, statistics, and related fields. Prerequisites are elementary probability, multivariable calculus, linear algebra, and programming. Some knowledge of discrete mathematics such as C, Java, or Matlab. Programming assignments are completed in Python.

Relation to other courses

CSE 250A covers largely the same topics as CSE 150A, but at a faster pace. Students who have taken CSE 150A and CSE 250A will receive assignments and exams in CSE 250A are also longer and more challenging. Students who have taken CSE 150A and CSE 250A may have taken the undergraduate offering from me or Professor Alvarado.

Administrivia

Administrivia and announcements

- Teaching assistants:
Hamed Abdullah Ayubi (hayayeb@ucsd.edu)
Dinesh Chakrabarty (dinesh@cs.ucsd.edu)
Rishi Kumar (rishikumar@ucsd.edu)
David Lippman (lippman@cs.ucsd.edu)
Praveen Vaithyanathan (pvaithyanathan@cs.ucsd.edu)
Yuan Wang (yuanwang@cs.ucsd.edu)
Xinhan Wang (xwanga@cs.ucsd.edu)

Lectures

- [L] Tues/Thurs 3:30-4:50 pm, Sibley 107
[S] Tues/Thurs 5-6 pm, SDS 130

Office hours and office hours

- Office hours: TBA
- Grading: 10% homework, 10% assignments, 10% projects, 10% best of final or optional homeworks

Textbooks

This course does not closely follow a particular book; the lectures are meant to be self-contained. Nevertheless, the following texts (through their authors) are recommended for further reading:

- Artificial Intelligence: A Modern Approach (Russell & Norvig, 2010)
- Machine Learning: A Probabilistic Perspective (Murphy, 2012)
- Introduction to Statistical Relational Learning and Reasoning (Getoor & Taskar, 2007)
- Pattern Recognition and Machine Learning (Bishop, 2006)

Syllabus

Thu Sep 26	Administrivia and course overview. Modeling uncertainty, review of probability, explaining away.	HW 1 out.
Tue Oct 01	Belief networks: from probabilities to graphs.	HW 1 due.
Thu Oct 03	Conditional independence, d-separation, polytrees.	HW 2 due.
Tue Oct 08	Algorithms for exact and approximate inference.	HW 2 out.
Thu Oct 10	Maximum Likelihood estimation; Markov models of language; naive Bayes models of text.	HW 3 due.
Tue Oct 15	Linear and logistic regression. Numerical optimization.	HW 3 out.
Thu Oct 17	Latent variable modeling. Expectation-Maximization (EM) algorithm. Auxiliary functions.	HW 3 due.
Tue Oct 22	EM algorithm: derivation, proof of convergence.	HW 4 due.
Thu Oct 24	Examples of EM: matrix factorization, mixture modeling.	HW 4 out.
Tue Oct 29	Hidden Markov models, Viterbi algorithm.	HW 5 due.
Thu Oct 31	Forward-backward algorithm, Gaussian mixture models, Kalman filters.	HW 5 out.
Tue Nov 05	Reinforcement learning (RL), Markov decision processes.	HW 6 due.
Thu Nov 07	Policy evaluation, policy improvement.	HW 6 out.
Tue Nov 12	Policy iteration, value iteration.	HW 7 due.
Thu Nov 14	Stochastic approximation theory, temporal difference learning.	HW 7 out.
Tue Nov 19	Stochastic approximation theory, temporal difference learning.	HW 8 due.
Thu Nov 21	Q-learning, extensions of RL.	HW 8 out.
Tue Nov 26	Bonus topics or catch-up.	HW 9 due.
Thu Nov 28	Thanksgiving holiday	
Tue Dec 03	Bonus topics or catch-up.	
Thu Dec 05	Bonus topics or review.	
Sat Dec 07	Final exam, 3-6 pm, rooms TBA	

<http://cseweb.ucsd.edu/classes/fa19/cse250A-a/>

Welcome to CSE 250A!

"I've always considered the most boring 20 minutes of the semester the time I spend reading the syllabus on the first day of class.

Students come in, potentially excited about getting started, only to end up listening to me read aloud.

I imagine them paraphrasing in their heads one of my favorite Woody Allen lines: Thanks, but I've been doing my own reading since about the first grade."

<http://chronicle.com/article/The-Promising-Syllabus/46748/>

Enrollment priority

- CSE students
 - MS & PhD students
 - Undergraduates
- PhD students in other programs
 - Bioinformatics
 - Cognitive science
 - ECE
 - Linguistics
- MS and BS students in other programs

Instructors



Professor: Lawrence Saul

TAs: Hammad, Sameeksha, Rohit, Shimin, Piyush, Priyan, Vijay, Xinghan

Instructor office hour: Tue/Thu 5-6 pm, CSE 3214

Discussion sessions: Mon/Fri (TBA)

TA office hours: Mon-Fri (TBA)

We are here to help!

Web site

CSE 250A. Principles of Artificial Intelligence: Probabilistic Reasoning and Decision-Making

[Administrivia](#) [Syllabus](#) [Places](#) [Gradesource](#)

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Relation to other courses

CSE 250A covers largely the same topics as CSE 150A, but at a faster pace. Students who have taken CSE 150A are encouraged to take assignments and exams in CSE 250A are also longer and more challenging. Students who have taken CSE 150A are encouraged to apply for the undergraduate offering from me or Professor Alvarado.

Administrivia

Announcements

Teaching assistants:

Hammad Abdullah Ayubi ([hhammad.ayubi@ucsd.edu](#))
Sameeksha Chaturvedi ([sameeksha.chaturvedi@ucsd.edu](#))
Rohit Kumar ([rohit.kumar@ucsd.edu](#))
Shimin Li ([shimin.li@ucsd.edu](#))
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Vijay Venkatesan ([vijay.venkatesan@ucsd.edu](#))
Xinghan Wang ([xw2@engr.ucsd.edu](#))

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Discussion sections:

Instructor office hours:

Office hours:

Grading:

Homework:

Final exam:

Textbooks

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• Machine Learning: A Probabilistic Perspective (Murphy, 2012)

• Reinforcement Learning: An Introduction (Sutton & Barto, 1998)

• Pattern Recognition and Machine Learning (Bishop, 2006)

Syllabus

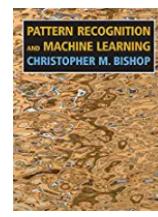
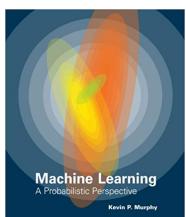
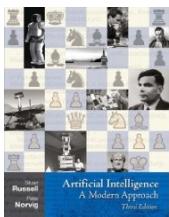
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Turing Prize 2011



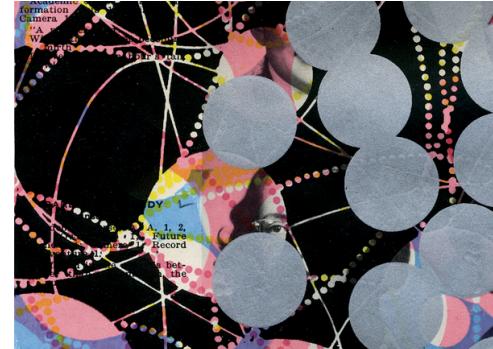
"Judea Pearl is credited with the invention of **Bayesian networks**, a mathematical formalism for defining complex probability models, as well as the principal algorithms used for inference in these models. This work not only revolutionized the field of AI but also became an important tool for many other branches of engineering and the natural sciences.

Who uses probabilistic methods in AI and ML?

- Search & Ads – Google, Microsoft, Yahoo
- Sales & Recommendations – Amazon, Etsy
- Social media – Facebook, Twitter, LinkedIn
- Gaming & HCI – XBox, Wii
- Forensics & signal analysis – FBI, NSA
- Data science & analytics

“Every company is a data company.”

Harvard
Business
Review



DATA

Data Scientist: The Sexiest Job of the 21st Century

Not in CSE 250A

- Things we won't cover
 - Mathematical logic
 - Traditional search (A*)
 - Theorem proving
 - Genetic algorithms
 - Philosophy of AI

Prerequisites

- Programming
 - Homeworks will involve coding.
 - Also: basic data analysis and visualization.
 - Solutions accepted in any language.
 - Python, MATLAB, C/C++, Java, etc.
 - No hand-holding with compiling, debugging.

Non-CS backgrounds are welcome.

Prerequisites

- Elementary probability
 - Random variables
 - Expected values
- Multivariable calculus
 - Chain rule
 - Gradients and partial derivatives
 - Computing maxima and minima
 - Constrained optimization
 - Lagrange multipliers

Prerequisites

- Linear algebra
 - Vectors and matrices
 - Matrix multiplication, inverse, determinants
 - Systems of linear equations
- Mathematical maturity
 - Patience and persistence
 - Willingness to fill in gaps
 - Not for “hackers”

Readings versus lectures

- Readings
 - No required texts.
 - Some handouts (on Piazza).
- Lectures
 - Designed to be self-contained.
 - Crucial for homework assignments.
 - Emphasis on mathematical development.
 - Blackboard, not powerpoint!

Grading

- Breakdown
 - 40% HW assignments (best 8 of 10)
 - 50% final exam
 - 10% best of final exam or optional HWs
- Academic dishonesty
 - Neither ethical nor in your self-interest.
 - Always credit your sources.
 - Plagiarism will be reported to campus.

Homework (40-50%)

- Rules of the game:

- Two assignments can be dropped.
- Final can count in place of 1-2 missing HWs.
- No extensions and no credit for late HWs.
- Extreme personal circumstances? **See me.**
- Submit in class (either one), not by email.

- Best practices

- Keep up, or lectures will be hard to digest.
- Handwritten solutions are fine (except for code).

Do's and don'ts

- What is allowed:

- You may work in groups to start problems (but not to finish them completely).
- Write up all your own work.
- You may consult published texts.

- What is not allowed:

- Using old course materials.
- Copying from current (or former) students.
- Uploading current materials to archives.

Academic dishonesty will not be tolerated.

Online resources

- Piazza

- Posting of homeworks, notes, handouts
- Link to audio podcasts
- Online Q/A and discussion boards

<https://piazza.com/eng.ucsd.edu/fall2019/cse250a/home>

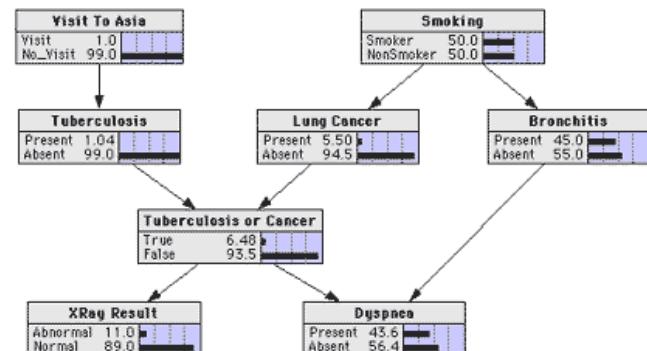
- Gradesource

- Scores on homeworks and final
- Please check routinely for accuracy

<http://www.gradesource.com>

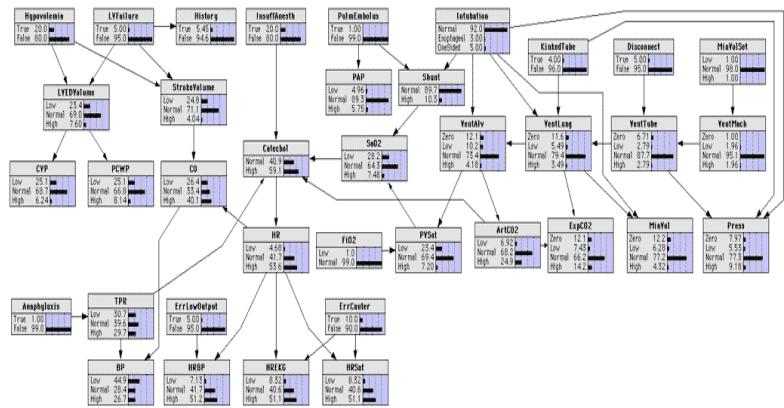
Medical diagnosis

(http://www.norsys.com/net_library.htm)



Medical diagnosis

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It can only be the thought of verdure to come, which prompts us in the autumn to buy these dormant white lumps of vegetable matter covered by a brown papery skin, and lovingly to plant them and care for them. It is a marvel to me that under this cover they are laboring unseen at such a rate within to give us the sudden awesome beauty of spring flowering bulbs. While winter reigns the earth reposes but these **colorless green ideas sleep furiously.**

— C. M. Street