CIS 410/510
Probabilistic Methods for Artificial Intelligence

Instructor:
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Logistics
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Office hours:
Wednesday 12:30-2:00pm
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Web: http://www.cs.uoregon.edu/classes/16S/cis410pm/
Piazza:
http://piazza.com/uoregon/spring2016/cis410510pm

Prerequisites
This course assumes a basic understanding of:
• Programming
• Algorithms
• Discrete mathematics
If you have weaknesses in any of these areas, plan to put in extra time.

Textbook
• D. Koller & N. Friedman, Probabilistic Graphical Models: Principles and Techniques, MIT Press.
• Complements:
  – Papers, etc.

Evaluation
• 6-8 homeworks: 45%
• Midterm: 20%
• Final: 30%
• Participation: 5%

You may discuss homeworks with other students, but please write up your answers independently.
Feel free to ask for help in office hours.

Expectations
• Study
  – Attend lecture. Take notes.
  – Read the book: Look at it before and after lecture.
  – Post questions on Piazza.
  – Recommended: Come to office hours.
  – Recommended: Watch videos on Coursera.
• Homeworks
  – Due weekly. Start early. Ask questions.
  – Late policy: You must ask in advance. Further in advance is better. I will usually say yes. Don’t abuse this policy, or I will start saying no.
  – Workload: 5-15 hours/week outside of class
Graduate vs. Undergraduate

Undergraduates: Understand how the methods work and when to use them.

Graduates: Understand why the methods work and how to adapt them.

Some of the homework and test questions will only be for graduate students to answer.

This Course in One Slide

We will learn to:
• Put probability distributions on everything
• Do inference with them
• Learn them from data

Applications

• Machine learning
• Data mining
• Automated reasoning and planning
• Vision and graphics
• Robotics
• Natural language processing and speech
• Information retrieval
• Databases and data management
• Networks and systems
• Ubiquitous computing
• Human-computer interaction
• Simulation
• Computational biology
• Computational neuroscience
• Etc.

Section 0: Probability

How do we formally describe and reason about uncertainty? (Focusing on discrete distributions over finite numbers of outcomes.)

• Sample spaces and events
• Random variables
• Conditional probability
• Bayes’ rule
• Independence and conditional independence

Section 1: Representation

How do we represent problems as probability distributions and encode them efficiently when there are many variables?

• Bayesian networks
• Markov networks
• Briefly, as time allows:
  – Template models (hidden Markov models, dynamic Bayesian networks, and relational models)
  – Mixture models and topic models
  – Tractable models (arithmetic circuits and sum-product networks)
  – Gaussian graphical models

Section 2: Inference

How do we use these probability distributions to answer questions efficiently?

• Why inference is hard
• Exact inference
  – Enumeration (brute force)
  – Variable elimination
• Approximate inference
  – Loopy belief propagation
  – Sampling methods
  – Variational inference (as time allows)
Section 3: Learning (if time)

How can we use data to automatically pick the model's structure and parameters?

- The basics of statistical estimation
- Learning Bayesian networks (parameters and structure)
- Learning Markov networks (parameters and structure)
- Learning with missing data

Relations to Other Classes

- CIS 471/571: Artificial Intelligence
- CIS 472/572: Machine Learning
- CIS 453/553: Data Mining
- Application classes (e.g., Bioinformatics)
- Statistics classes