

Statistical Methods in AI and ML

Nicholas Ruozzi

University of Texas at Dallas

The Course

One of the **most exciting** advances in AI/ML in the last decade

Judea Pearl won the Turing award for his work on Bayesian networks!
(among other achievements)

Prob. Graphical Models

Exploit **locality** and structural features of a given model in order to gain insight about **global properties**

The Course

- **What this course is:**
 - Probabilistic graphical models
 - Topics:
 - representing data
 - exact and approximate statistical inference
 - model learning
 - variational methods in ML

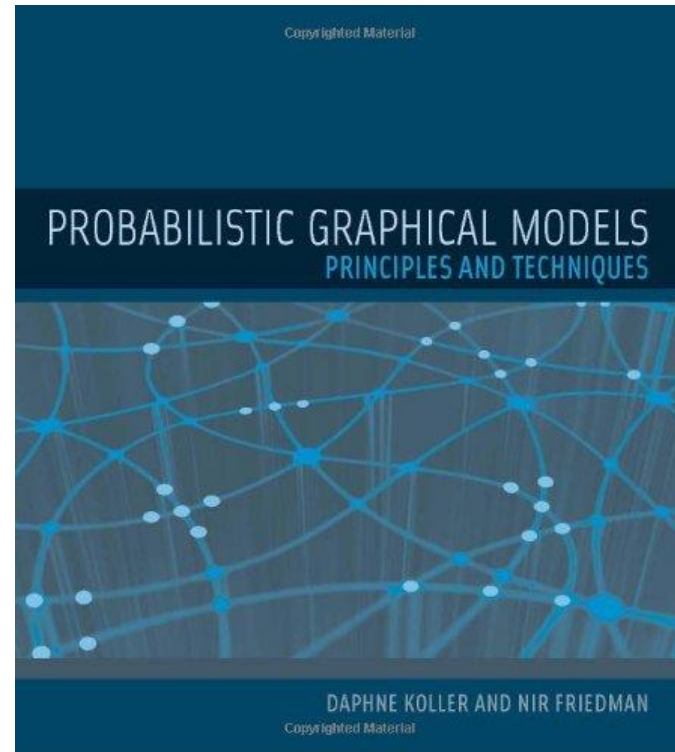
Prerequisites

- **CS 5343: Algorithm Analysis and Data Structures**
- **CS 3341: Probability and Statistics in Computer Science and Software Engineering**
- **Basically, comfort with probability and algorithms (machine learning is helpful, but not required)**

Textbook

Required readings will be posted online before each lecture

Check the course website for additional resources and papers



Grading

- 4-5 problem sets (70%)
 - See collaboration policy on the web
- Final project (25%)
- Class participation & extra credit (5%)

-subject to change-

Course Info.

- **Instructor: Nicholas Ruozzi**
 - Office: ECSS 3.409
 - Office hours: Tues. 11am - 12pm and by appointment
- **TA: Prasanna Kothalkar**
 - Office hours and location TBD
- **Course website: <http://www.nrouzzi.me/cs6347/>**

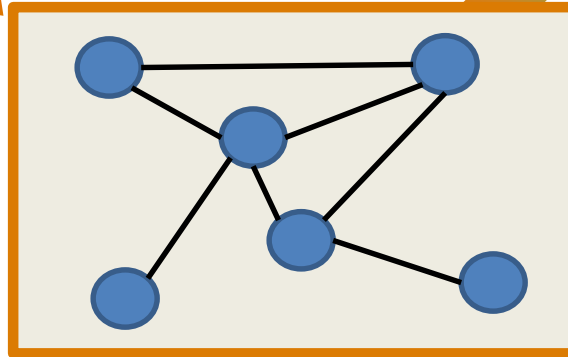
Main Ideas

- **Model the world (or at least the problem) as a collection of random variables related through some joint probability distribution**
 - **Compactly represent the distribution**
 - **Undirected graphical models**
 - **Directed graphical models**
- **Learn the distribution from observed data**
 - **Maximum likelihood, SVMs, etc.**
- **Make predictions (statistical inference)**

Inference and Learning

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Collect Data



**“Learn” a model
that represents the
observed data**

$$Z(\theta) = \sum_x p(x; \theta)$$

**Use the model to
do inference / make
predictions**

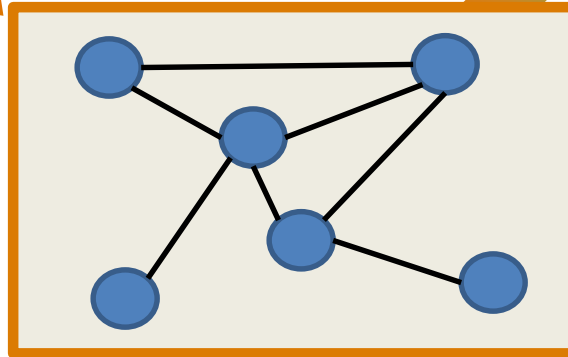
Inference and Learning

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**Data sets can
be large**

$$Z(\theta) = \sum_x p(x; \theta)$$

**Inference needs to
be fast**



**Data must be
compactly modeled**

Applications

- Computer vision
- Natural language processing
- Robotics
- Computational biology
- Computational neuroscience
- Text translation
- Text-to-speech
- Many more...

Graphical Models

- A graphical model is a graph together with "local interactions"
- The graph and interactions model a global optimization or learning problem
- The study of graphical models is concerned with how to exploit local structure to solve these problems either exactly or approximately

Optimization Problems on Trees

Time for a motivating example!

(chalk board)