ECE 175B - Probabilistic Reasoning and Graphical Models

Spring 2022 - Syllabus

We live in a world with rapidly increasing volumes of recorded data—possessing the knowledge as to how to extract value from such data is, therefore, an essential skill with growing importance. This course presents a unified treatment of data processing via graphical models facilitating the transference of machine learning concepts between science branches and applications. While Bayesian probability theory provides a "inference calculus" for reasoning and decision making in uncertain situations and environments, graphs can encode and structure relationships and interdependencies. Consequently, probabilistic graphical models are graphs that encode probabilistic relationships and dependencies. This class will use graphical models, conditional independence, and d-separation for complexity management and knowledge encoding. We will also employ probabilistic graphical models for efficient Bayesian decision-making. We also will explore selected applications in wireless communications and autonomous navigation.

Summary of topics discussed:

1. Bayesian belief networks and their properties
2. D-separation and conditional independence
3. Probabilistic graphical models and their properties
4. Inference on serial chains
5. Markov models
6. Factor graphs and the sum-product algorithm
7. Selected applications in wireless communications and autonomous navigation

Time and place: Lectures are Tuesdays and Thursdays 12:30PM – 1:50PM in WLH 2205. The discussion sessions are Mondays 12:00 – 12:50 in PETER 102.

Instructor:

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Course Website: Handouts and homework assignments will be posted on the Canvas website.

Prerequisites: The suggested prerequisites for this course are linear algebra and basic probability (e.g., ECE 109 and ECE 174), basic pattern recognition (ECE 175A), as well as Matlab programming experience.

Bibliography: This course is based on lecture notes developed by Prof. Kenneth Kreutz-Delgado. The main required textbook is

- *Bayesian Reasoning & Machine Learning*, David Barber, Cambridge Univ. Press, 2012

Further lecture notes and research papers will be used, which will be posted on this course website. Whenever possible, a reference to a source (text and pages) for the lecture will be given in class.

Grades: Homework 30%, Mid-Term Exam 30%, Final Exam 40%.

Homework: Homework problems will be posted approximately every 2-3 weeks on the course website and will be due one week later. It is expected that all completed problems are turned in on time. Homework is graded using an "A for effort" scheme. Individual homework problems are not corrected. Points are assigned proportionally to the percentage of work done. Because homework is not graded for correctness, students must read the solutions to determine if they performed the homework correctly or not.

Exams: The mid-term and final exams are graded in the traditional manner. Both exams are closed book and notes. Only nonprogrammable calculators can be used. All other electronic storage and communication devices are banned. Cheating will result in penalties.

Office Hours: Office hours are every Friday at 3 PM via Zoom.

Collaboration Policy: The goal of homework is to give you practice in mastering the course material. Consequently, you are encouraged to form study groups to discuss the course material and problem sets. However, the developed solutions you hand in should reflect your own understanding of the course material. It is not acceptable to copy a solution that somebody else has written. You must develop each problem solution by yourself without assistance.