CS573: Probabilistic Reasoning

Objective:
The chief objective is to teach modern methods of probabilistic reasoning that are commonly used in many parts of computer science, including but not limited to artificial intelligence. Such methods have become extremely important and transforming the approach to a great variety of computational problems, in the field of computer science itself, and broadly across many application fields.

The course is aimed at first or second year M.S. and Ph.D. students in Computer Science (CS) though students in related disciplines such as Electrical Engineering (EE) and Industrial and Systems Engineering (ISE) may also find it beneficial.

The objective of the course is to provide an in-depth understanding of the topics covered. After the course, students should be able to read the relevant research literature as well as apply the methods to the myriad applications in computer science and other disciplines where reasoning (inferencing and decision making) under uncertainty is important. However, the course is not designed to cover recent, research literature.

Recommended preparation:
Undergraduate training in probability theory (such as in Math 208x); basic knowledge of computer programming, data structures and algorithms (such as found in CS 201 and 301). Basic mathematics such as calculus and linear algebra.

Grading: Based on exams and assignments. There will be a total of five or six assignments. Most of the problems will be “quantitative” or “mathematical”, requiring students to apply the learned problems to specific examples or new results. The assignments may also contain programming exercises that involve implementation and testing of algorithms that are too complex to apply manually but major programming projects will not be required; any programming language may be used for these assignments. The combined weights of the assignments will be 30% of the course total; two in-class, closed book exams will count for 30% of the grade each. Remaining 10% will be based on class attendance and participation. Neither attendance nor assignments are optional.

Instructor: Prof. Nevatia.

Schedule: MW 9:30-10:50

Textbook:

Probabilistic Graphical Models, by Daphne Koller and Nir Friedman, MIT Press, 2009.

Details of Content:

We will follow the coverage in the textbook closely. Following is a list of chapters and sections that were covered (and in given order) in the course offering 2 years ago. It is expected that the coverage will be similar this year but some changes are likely, based on the pace of the class and the interest of the students.

Representations: Chapters 2-4 except for sections 3.4.3, 4.4.2, 4.6.2; chapter 5, focus on 5.4 (exclude 5.4.4)

Inference: Chapter 9, excluding 9.5 and 9.6; Chapter 10: All (almost); Chapter 11: 11.3 (except 11.3.4 and 11.3.7)

Gaussian Networks: Ch. 7, 14.2

MAP inference: 13.1, 13.2 and 13.3

Sampling: 12.1, 12.2 and 12.3 (including Metropolis-Hastings algorithm)

Temporal Models: 6.2, 15.1, 15.2, additional algorithms for HMMs (filtering, smoothing, Viterbi)

Utility/Decision Theory: 22.1, 22.2, Influence Diagram Notes

Parameter Estimation: 17.1, 17.2 (exclude 17.2.4, 17.2.5), 17.3

Chapter 20: 20.1, 20.2, 20.3.1, 20.3.2

Chapter 19: 19.1, 19.2 (except 19.2.2.5 and 19.2.2.6, 19.2.4)