CS B553: Probabilistic approaches to Artificial Intelligence, Spring 2013

(**This course is officially known in the University Registrar’s system as Neural and Genetic Approaches to Artificial Intelligence, but that is not an accurate description of the course content this semester.)

Course staff:

Prof. David Crandall
227 Informatics West
Office hour: Tuesdays 2-3 (tentative)

AI: Alex Rudnick
330I Lindley Hall
Office hour: Wednesdays 10:00-11:00am (tentative)

Lecture: Tuesday Thursday 11:15-12:30 in 1225 Wendell Wright Education Building

Course content:
Uncertainty is a fact of everyday life, caused in part by incomplete and noisy observations, imperfect models, and (apparent) nondeterminism of the social and physical world. Much (and in some cases most) recent work across a range of computing disciplines (including artificial intelligence, robotics, computer vision, natural language processing, data mining, information retrieval, bioinformatics, etc.) has used probabilistic frameworks to explicitly address this uncertainty. This course will introduce the statistical, mathematical, and computational foundations of these frameworks, with a particular focus on a popular and very general framework called Probabilistic Graphical Models. We will also cover related topics in optimization and probability theory. We will study applications of these techniques across a range of AI disciplines, with perhaps a bias towards computer vision, and students will be encouraged to choose a final project that aligns with their own research interests.

Topics will include:

- Review of probability theory and basic calculus
- Graphical model frameworks: Bayes networks, Markov networks
- Exact inference: Variable elimination, conditioning, clique trees
- Approximate inference: Belief propagation, graph cuts, particle-based inference
- Inference as optimization
- Optimization techniques: Gradient descent, Newton methods, constrained optimization, stochastic optimization, genetic algorithms
- Learning: maximum likelihood and MAP parameter estimation, structure learning, Expectation-Maximization
- Temporal models: Markov chains, Hidden Markov Models
- Applications

Prerequisites:
CS B551 (Introduction to Artificial Intelligence), or permission of the instructor. The course will require some level of mathematical maturity, especially with linear algebra, probability theory, and basic calculus, although we will review the key mathematical concepts as we go along. The course will assume proficiency with some modern general-purpose programming language like Python, Java, or C.

Grading:
Approximately 6 assignments (50% of grade), a final project (20% of grade), and occasional in-class quizzes (30% of grade). The assignments will include both programming and pen-and-paper problems.

Text and resources:
Koller and Friedman, Probabilistic Graphical Models, MIT Press, 2009. We will also read research papers and selected chapters from other books.

Schedule:
A schedule for the class, with links to readings, assignments, and other resources, will be available via OnCourse: http://oncourse.iu.edu/

Academic Integrity Policy:
We take academic integrity very seriously. You are required to abide by the Indiana University policy on academic integrity, as
described in the Code of Student Rights, Responsibilities, and Conduct, as well as the Computer Science Statement on Academic Integrity (http://www.cs.indiana.edu/Academics/integrity.html). It is your responsibility to understand and follow these policies.

Briefly summarized, these policies require that the work you submit for course assignments, projects, quizzes, and exams must be entirely your own (or entirely that of your group, if groupwork is permitted). You may use the ideas of others but you must give proper credit. You may discuss assignments with other students (or students in other groups) at a high level, by for example discussing general methods or strategies to solve a problem, but you must cite the other student in your submission. We will respond to acts of academic misconduct according to university policy concerning plagiarism; sanctions for plagiarism can include a grade of F for the assignment in question and/or for the course and must include a report to the Dean of Students Office.

Religious Holidays:
Indiana University respects the right of all students to observe religious holidays and will make reasonable accommodation, upon request, for such observances. Each year, instructors are provided with the dates of major religious holidays for which students may request accommodation. Students must submit written requests for accommodation in writing by the end of the second week of the semester. Instructors are expected to give students the opportunity to do appropriate make-up work that is intrinsically no more difficult than the original exam or assignment. (Source: Indiana University Academic Guide, https://www.indiana.edu/~vpfaa/academicguide/).