School of Computer Science

Uncertain Reasoning in Intelligent Systems

CIS*6120 - 2018 Fall Semester

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Neither human nor computer agents know all relevant things that are true in their environment. However, they need to make decisions even though they don't know the exact state of the environment. This course studies how to build intelligent systems that use uncertain knowledge to make decisions rationally as well as efficiently.

The field of uncertain reasoning with probabilistic and decision-theoretic graphical models has experienced fruitful advances since 1980s. Graphical models have been applied to a wide range of applications. This course introduces the fundamental principles underlying these advances, the knowledge representation formalisms and inference algorithms, and issues involved in applications. Sufficient emphasis will be placed on formal analysis used in the uncertain reasoning literature for establishing the validity of new representations or algorithms.

`Lecture topics:` Fundamentals of Bayesian probability theory and decision theory; graphical models: Bayesian networks, decomposable Markov networks, influence diagrams and decision networks; knowledge acquisition by elicitation and learning; centralized and distributed reasoning algorithms; and applications of graphical models.

`Evaluation:` Two assignments (A1: 15%; A2: 15%) and a project (70%). Assignments include written (must be typed) and programming problems (A1: weeks 3-6; A2: weeks 7-9). Late submissions are subject to 20% deduction of the total mark per day up to 2 calendar days. The project consists of programming a general operation of a probabilistic graphical model (30%), a written project report (25%), and an oral presentation (15%). Each student should complete assignments and the project independently.

`Prerequisites:` Undergraduate Discrete Mathematics, Artificial Intelligence, and Probability and Statistics. Java programming.

`Main Text:`

- Y. Xiang, Probabilistic Reasoning in Multiagent Systems: A Graphical Models Approach, Cambridge, 2002.

`References:`

- J. Pearl, Probabilistic Reasoning in Intelligent Systems: Networks of Plausible Inference, Morgan Kaufmann, 1988.
- R. E. Neapolitan, Probabilistic Reasoning in Expert Systems: Theory and Algorithms, Wiley, 1990.
- E. Castillo, J. Gutierrez and A. Hadi, Expert Systems and Probabilistic Network Models, Springer, 1997.
- F. Jensen and T.D. Nielsen, Bayesian Networks and Decision Graphs (2nd Ed.), Springer, 2007.
- A. Darwiche, Modeling and Reasoning with Bayesian Networks, Cambridge, 2009.
- D. Koller and N. Friedman, Probabilistic Graphical Models: Principles and Techniques, MIT Press, 2009.
- S. Russel and P. Novig, Artificial Intelligence: A Modern Approach, 3rd Ed., Prentice Hall, 2010.
- N. Fenton and M. Neil, Risk Assessment and Decision Analysis with Bayesian Networks, CRC Press, 2012.