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Part A:
The title of our advanced lecture will be 'Statistical Learning Methods for Reasoning in Games'. In this lecture, we will cover a number of leading techniques currently used to reason about games, with an emphasis on those techniques that model uncertainty. In particular, we will focus on the use of Hidden Markov Models and Bayesian Inference. If time permits, we may explore the use of neural networks.

Part B:
L. R. Rabiner. *A tutorial on Hidden Markov Models and selected applications in speech recognition*. Proceedings of the IEEE, 77(2):257--286, 1989. http://ieeexplore.ieee.org/iel5/5/698/00018626.pdf?arnumber=18626

Friedman, N., Nachman, I., & Pe'er, D. (1999). Learning bayes network structure from massive datasets: The "sparse candidate" algorithm. UAI 15 (p. 206:215). http://delivery.acm.org/10.1145/1020000/1015406/p257-goldenberg.pdf?key1=1015406&key2=7349490111&coll=GUIDE&dl=GUIDE&CFID=40820774&CFTOKEN=96558387

Part C:
We will present an overview of two modern techniques used to reason about games, both falling under the class of methods known as Statistical Learning Methods. In particular, we will demonstrate the use of Bayesian Nets and Hidden Markov Models (HMMs) to reason about games. These methods were selected for their power to express models of games with hidden state information.

For Bayesian Nets, the key challenge lies in abstracting all information about a game's state into a set of relevant variables, then specifying the relationships between those parameters. This process becomes increasingly difficult as the training data set scales to larger sizes, which frequently occurs in mined data sets. We will demonstrate the key techniques from literature to combat these issues of scaling.

HMMs occur when information about an underlying state of a system is hidden and only observations generated by the system are known. From this potentially noise data, the Viterbi and EM algorithms can be used to extract useful information, including the likely underlying state, the time history of states, and the likelihood of the next observation.

Drawing examples from a number of games including Texas Holdem Poker, this lecture will provide an introduction to the key concepts that will be incorporated into our final design project.

Part D:
This paper presents the use of statistical learning methods to the medical field. This is another key application for these techniques, and a topic of large debate because of its quantitative approach to medicine:

Ennis M, Hinton G, Naylor D, Revow M, Tibshirani R. A comparison of statistical learning methods on the GUSTO database. *Stat Med.* 1998; 17 (21): 2501-2508.

http://www-stat.stanford.edu/~tibs/ftp/gusto.ps

This is an extremely informative tutorial on Bayes Nets, given by Andrew Moore from CMU. Basically, a must-read for students:
http://www-2.cs.cmu.edu/~awm/tutorials/bayesstruct05.pdf

This paper gives a review of several machine learning methods for statistical methods. It attempts to formalize the use of statistical learning techniques in fields that use sequential data. The statistical methods review with a focus on sequential data relates well to our topic.

Dietterich, T. G. (2002). Machine Learning for Sequential Data: A Review. In T. Caelli (Ed.) *Structural, Syntactic, and Statistical Pattern Recognition; Lecture Notes in Computer Science, Vol. 2396.* (pp. 15-30). Springer-Verlag.
http://web.engr.oregonstate.edu/~tgd/publications/mlsd-ssspr.pdf

This paper covers everything from what an HMM is to how it can be applied, what its limitations are, and ways around those limitations with novel conceptualizations about HMMs.

Bilmes, Jeff. What HMMs Can Do. UWEE Technical Report Number UWEETR-2002-0003. January 2002.

Part E:
We plan to divide up the tasks as equitably as possible. We had success with this in the implementation of the tree decomposition algorithm, so we are confident that this can happen again. Specifically, Mike will research Bayesian Nets and Brian will research HMMs. Each person will develop the slides for those topics individually, with help provided by the other person as needed. Then, we will collaborate on the remaining slides, including giving a background in regards to how these topics fit into game theory and perhaps a foreshadowing of our final project.