ORI 397 - Markov Decision Processes - Fall 2009

- **Time & Place:** Tue & Thurs 11:00am-12:30pm, ETC 7.146
- **Professor:** John J. Hasenbein
  - **Office:** ETC 5.128B
  - **Phone:** 471-3079
  - **Email:** *jhas@mail.utexas.edu* (This is the best way to contact me.)
  - **Office Hours:** Mondays, 10:30am-noon. You can also email me for an appointment.
- **Class Web Page:** All class materials will be posted on *Blackboard*.
- **Required Text:** *Dynamic Programming and Optimal Control, Volume II* by Dimitri P. Bertsekas (Athena Scientific).
- **Grading:** Problem sets will be assigned approximately every two weeks. There will be one mid-term exam and one final presentation. The exam is worth 35% of the final grade, the homework is worth 35%, and the presentation is worth 30%. The presentations will occur during the last week of classes.

  For the problem sets, you may discuss problems with your classmates and in fact are encouraged to do so. However, you should understand the solutions submitted by your group. A good rule of thumb is that you should be able to explain to me the solutions you have submitted.
- **Exams:** You are required to take the exam at the scheduled time. Make-up exams will not be given without a valid medical excuse. Exam #1 will be given in class on Tuesday, October 20th.
- **Prerequisites:** Students should have knowledge of discrete-time and continuous-time Markov chains, and linear programming. Preferably, students should have taken ORI 390R.5 and ORI 391Q.5, or equivalent courses.
- **Email Communication**: For this class, email will be used as an official form of communication for notifying you of new homework assignments and other class updates. The University of Texas email policy can be found at `http://www.utexas.edu/its/policies/emailnotify.html`.
- **Students with disabilities:** The University of Texas at Austin provides upon request appropriate academic accommodations for qualified students with disabilities. For more information, contact the Office of the Dean of Students at 471-6259, 471-4641 TTY.
- **Course Evaluation:** Near the end of the course you will have an opportunity to anonymously evaluate the course and instructor using the standard College of Engineering evaluation form.
- **Class Web Site and Privacy:** For this class, web-based, password-protected class sites will be available via the *Blackboard* system. The syllabus, handouts, assignments and other

resources are types of information that may be available within this site. Site activities could include exchanging e-mail, engaging in class discussions and chats, and exchanging files. In addition, a class e-mail roster will be a component of the site. Students who do not want their names included in this electronic class roster must restrict their directory information in the Office of the Registrar, Main Building, Room 1. For information on restricting directory information see:
`http://www.utexas.edu/student/registrar/catalogs/gi00-01/app/appc09.html`.

Additional References

- *Dynamic Programming and Optimal Control, Volume I*, by Dimitri P. Bertsekas (Athena Scientific 2007).
- *Markov Decision Processes*, by Martin L. Puterman (Wiley 1994).
- *Introduction to Stochastic Dynamic Programming*, by Sheldon M. Ross (Academic Press 1983).
- *Stochastic Dynamic Programming and the Control of Queueing Systems*, by Linn I. Sennott (Wiley 1999).
- *Constrained Markov Decision Processes*, by Eitan Altman (Chapman & Hall 1999).
- *Great Expectations: The Theory of Optimal Stopping*, by Y. S. Chow, Herbert Robbins, and David Siegmund (Houghton Mifflin 1971)
- *Approximate Dynamic Programming: Solving the Curses of Dimensionality* by Warren B. Powell (Wiley 2007). This book is available as an e-book from the UT library online system.

Course Summary

The goal of this course is to introduce Markov decision processes (MDPs). MDPs are sometimes also referred to as controlled Markov chains and the underlying theory is called stochastic dynamic programming. MDPs have applications in many areas including revenue management (e.g., hotel, airline, and rental car pricing), control of queues, financial engineering, telecommunications, manufacturing, and economics.

The course will examine the models, theory, and applications of MDPs. MDPs may have countable or uncountable state and action spaces, and may be framed in discrete or continuous time. We will focus on countable state and action spaces, and the discrete time setting. In going through the topics below, I will introduce various examples in different application areas.

Course Outline

I. Introduction to MDPs
   - Model outline
   - Applications, examples

II. Finite Horizon Models
   - The basic framework
   - Dynamic programming algorithm
   - The principle of optimality

III. Infinite Horizon Discounted Problems
   - Classification of policies
   - Convergence of the DP algorithm and Bellman's equation
   - Policy iteration and value iteration
   - Linear programming methods
   - Contraction mappings and fixed point theorems

IV. Infinite Horizon Average Cost Problems
   - Finite space models
   - Blackwell optimality
   - Multichain and unichain conditions
   - Value iteration and policy iteration
   - Linear programming solutions
   - Infinite state space problems

V. Continuous-time MDPs
   - Uniformization
   - Queueing Applications
   - Semi-Markov decision processes

VI. Approximate Dynamic Programming
   - The curses of dimensionality
   - The basics of ADP