OR 674/SYST 674 Dynamic Programming for Spring 2018
Pre Req: OR 442 or OR 542 or Permission of Instructor

Instructor: Rajesh Ganesan, Ph.D.
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ENGR 2217 Office Hrs: W 1 - 2:45

Course Description:
This is a course on the theory and practice of dynamic programming, i.e. optimal sequential
decision making over time in the presence of uncertainties. The course will stress intuition, the
mathematical foundations being for the most part elementary. It will introduce the theory,
applications (finance, engineering, and biology), and computational aspects of dynamic
programming for deterministic and stochastic problems. The course will use some Matlab and
spread sheets to solve DP problems, however prior knowledge of Matlab or spread sheet use is not
needed.

Course Objectives:
At the conclusion of this course the student will have learned the art of formulating recursive
equations, and how and why dynamic programming is the only method that can solve many of
the large scale optimization problems involving sequential decision making. The student will
also have advanced knowledge of solving optimization problems that involve sequential decision
making in both deterministic and stochastic environment.

The field of dynamic programming provides alternate approaches to solving many optimization
and control problems. Large scale optimization and control has become very important in recent
years, which involve complexity and are often model free. Also adaptive systems with sequential
decision making powers are sought after for effective real time optimization and control. The
above is achievable only via dynamic programming, which is often solved using artificial
intelligence (stochastic approximation methods). Many large scale industrial and defense
applications such as airline pricing, optimal power flow, helicopter control, and missile control
use approximate dynamic programming approaches, which has created a demand for this
knowledge.

This course has been designed to provide a wealth of knowledge that is directly applicable to the
needs of applications that are complex, adaptable, and large scale. The course compliments the
fundamentals learnt in OR441/OR541 and OR442/OR542 and introduces a new and powerful
alternate method to solve many optimization problems that involve sequential decision making.


Problems from Operations Research by Winston. W. L. (Chapters 18 and 19). This book is the
same book that you have used for OR 541 and OR 542.

Notes from References Books
- Applied Probability and Stochastic Processes by Feldman & C. Valdez-Flores
- Introduction to Mathematical Programming : Applications and Algorithms Wayne L.
  Winston, Munirpallam Venkataramanan
• Dynamic Programming by Richard Bellman
• Dynamic Programming and Optimal Control (Volumes 1 and 2) by Dimitri P. Bertsekas
• Introduction to Stochastic Dynamic Programming by Sheldon M. Ross
• Neuro-Dynamic Programming (Optimization and Neural Computation Series, 3) by Dimitri P. Bertsekas, John N. Tsitsiklis
• Markov Decision Processes: Discrete Stochastic Dynamic Programming by Martin L. Puterman

**Deterministic Dynamic Programming:**

Week 1  Course introduction, Finite Decision Trees
Week 2  Dynamic Programming Networks and the Principle of Optimality
Week 3  Formulating dynamic programming recursions, Shortest Path Algorithms, Critical Path Method, Resource Allocation (including Investments)
Week 4  Knapsack Problems, Production Control, Capacity Expansion, and Equipment Replacement
Week 5  Infinite Horizon Optimization including Equipment Replacement over an Unbounded Horizon
Week 6  Infinite Decision Trees and Dynamic Programming Networks
Week 7  Midterm

**Stochastic Dynamic Programming**

Week 8  Stochastic Shortest Path Problems with examples in Inventory Control
Week 9  Markov Decision Processes, value and policy iteration for average cost criteria
Week 10 Markov Decision Processes, value and policy iteration for discounted cost criteria
Week 11 Markov Decision Processes, value and policy iteration for discounted cost criteria
Week 12 MDP with examples in Equipment Replacement and inventory problems
Week 13 Semi-Markov Decision Process
Week 14 Semi-Markov Decision Process
Week 15 Final exam (exam week)

**Student Evaluation Criteria**

- Mid-term: 40%
- Project: 20% (Due on May 14th)
- Final Exam: 40% (Due on May 14th)

**Academic Policy:**

All academic policies as given in the Honor System and code will be strictly followed. Visit URL http://catalog.gmu.edu

**Grades:**

Letter grades will be decided as follows:

- 97% and above – A+
- 94-96% - A
- 90-93% - A-
- 86-89% - B+
- 83-85% - B
- 80-82% - B-
- 76-79% - C+
- 73-75% - C
- 70-72% - C-
- 66-69% - D+
- 63-65% - D
- 60-62% - D-
- at or below 59% - F

Class Website: [http://mason.gmu.edu/~rganesan/class](http://mason.gmu.edu/~rganesan/class) For final grades check patriotweb