26:711:557 Dynamic Programming

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Time and place: Fall 213. Wednesday, 1:40—4:40, BRR 3031, RBS Building (new), Livingston Campus (100 Rockefeller Road, Piscataway)

Topic outline

Week	Topic
1	The shortest path problem. The principle of optimality. Examples
2	Label correcting algorithms
3	Controlled Markov chains. Finite horizon stochastic problems
4	Dynamic programming equations. Applications
5	Discounted infinite horizon problems
6	Value and policy iteration methods. Linear programming approach
7	Applications in inventory control, scheduling, logistics
8	The multi-armed bandit problem
9	Undiscounted infinite horizon problems. Stochastic shortest paths
10	Methods for solving undiscounted problems
11	Optimal stopping; asset pricing
12	Average cost problems
13	Methods for solving average cost problems
14	Introduction to approximate dynamic programming. TD(λ).
15	Aggregation. Q-learning. Examples.

Textbooks

Main

D. Bertsekas, *Dynamic Programming and Optimal Control, Vol. I*, Athena Scientific; 3rd edition , 2005

D. Bertsekas, *Dynamic Programming and Optimal Control, Vol. II (Approximate Dynamic Programming)*, Athena Scientific; 4th edition, 2012

Supplementary

M.L. Puterman, *Markov Decision Processes*, John Wiley & Sons, 2005

W. B. Powell, *Approximate Dynamic Programming*, John Wiley & Sons, 2007

None of the books is required. The lecture will draw from many sources, and many books provide similar information, with some differences in notation. Bertsekas will be the main source, though.

Grading

The final grade will be based on homework and project assignments, involving theoretical problems and computational projects.

Prerequisites

Basic knowledge of calculus, linear algebra, and probability is necessary. Large portion of the class will deal with controlled Markov chains, and thus knowledge of fundamental notions and results of the theory of Markov chains is useful. The students who need a review of the theory of Markov chains may consult the following textbooks:

E. Çinlar: "Introduction to Stochastic Processes", Prentice Hall, 1975 (chapters 5 and 6)

G. R. Grimmett and D.R. Stirzaker, "Probability and Random Processes", Oxford 1992 (chapter 6)

In fact, almost any book on stochastic processes will do, but I am recommending these two because of their rigor and clarity of presentation.