ODA 75200: Stochastic Optimization: Dynamic Models

Semester	Fall 2024
Class Days/Times	Wed 1:00 PM – 4:00 PM
Classroom	NVC 9-215
Department	Narendra Paul Loomba Department of Management
Instructor	Yuan-Mao Kao
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Office Hours	By appointment

Course Description

The course concerns the optimization of stochastic models of sequential decision processes. It is an overview of Markov Decision Processes (MDP), Multi-Armed Bandit (MAB) formulations, and stochastic programming applications. The course also introduces several sequential stochastic optimization solution methods, including exact and approximate stochastic dynamic programming. Application areas include operations management (various manufacturing and service settings including retail, healthcare, and supply chains), computer science (networks), and Economics (marketplaces).

Prerequisites

1. ODA 75100 or a calculus-based course in probability/stochastic models
2. The knowledge about ODA 74100 or a graduate-level (deterministic) optimization course is suggested
3. A high-level programming language (e.g., C, C++, C#, VB, Python, MATLAB, …)

Learning Goals:

1. Know the mathematical foundations of sequential stochastic optimization and its applications, as well as state and prove relevant theoretical results.
2. Develop and analyze advanced stochastic models to represent dynamic business phenomena in relevant manufacturing and service settings and distinguish sequential stochastic optimization applications at the interface of decision analytics and other disciplines.
3. Characterize Markov Decision Processes (MDPs) and Multi-Armed Bandit (MAB) formulations to model and solve sequential optimization problems, and correctly identify which variations of MDPs and/or MAB formulations are appropriate to analyze specific business settings.
4. Employ widely used methods such as exact or approximate stochastic dynamic programming and/or two-stage stochastic programs and develop computer code to formulate, solve, and manipulate sequential stochastic optimization models.

Course Materials

- *Dynamic Programming and Optimal Control* by D. P. Bertsekas, Athena Scientific, 4th Edition, 2012 (ISBN: 1886529086/ 978-1886529083)
  - Volume 1 will be the main textbook, but some materials in volume 2 may also be used.
  - 3rd edition is fine, but the 4th edition is strongly suggested.
- Lecture notes on Blackboard

Optional Textbooks

- *Markov Decision Processes: Discrete Stochastic Dynamic Programming* by M. L. Puterman, Wiley, 1st Edition, 2005
- *Optimal Learning* by W. B. Powell and I. O. Ryzhov, Wiley, 1st Edition, 2012
- *Bandit Algorithms* by T. Lattimore and C. Szepesvári, Cambridge University Press, 1st Edition, 2020
- *Introduction to Stochastic Programming* by J. R. Birge and F. Louveaux, Springer, 2nd Edition, 2012
- *Introduction to Probability Models* by S. Ross, Academic Press, 12th Edition, 2019 (or any newer versions).

Grading Policy and Course Requirements

The course requirements are weighted as follows:

Components	Weights
Individual Assignments	40%
Paper Presentation	10%
Final Proposal	15%
Class Participation	5%
Final Exam (In-class)	30%
TOTAL GRADE POINTS	100%

Individual Assignments: There will be four individual assignments in this course. The assignments may require solving optimization problems, proving theoretical results, or providing some computation results. Therefore, students must be familiar with at least one programming language and mathematical proof.

Paper Presentation: Each student will be assigned to present one paper. The presentations must contain details of the model, motivation, contributions, a summary of the results, insights, and conclusions.

Final Proposal: Students will submit a proposal of a research idea related to stochastic optimization (two or three pages). The proposal should contain the research background, a brief literature review, and a model of the problem. Preliminary numerical results are encouraged but not required.

Academic Integrity

Learning involves the pursuit of truth, which cannot be pursued by presenting someone else's work as your own. Our goal is to help you become an excellent professional candidate. Therefore, cheating and plagiarism are serious offenses. The following definitions are based on the College's Academic Honesty website at http://www.baruch.cuny.edu/academic/academic_honesty.html

Students with Disabilities

Students with disabilities may be eligible for a reasonable accommodation to enable them to participate fully in courses at Baruch. If you feel you may be in need of accommodation, please contact the staff at the Office of Services for Students with Disabilities, Newman Vertical Campus, Room 2-271, in person or by phone at (646) 312-4590.

For more information, see

http://www.baruch.cuny.edu/studentaffairs/ossd/disabilityServices.htm.

Tentative Course Schedule and Topics

Date	Class Topic	References
08/28/2024	Basic Structure of Dynamic Programming	Ch 1
09/04/2024	Review of Probability and Stochastic Models	Ross Textbook
09/11/2024	Deterministic Models and Shortest Path Problems	Ch 2
09/18/2024 09/25/2024	Structured Policies with Perfect State Information	Ch 3
10/09/2024	Imperfect State Information	Ch 4
10/16/2024 10/30/2024 11/06/2024	Infinite Horizon Problems	Ch 5
11/13/2024	Approximate Dynamic Programming	Ch 6
11/20/2024	Continuous-Time Optimal Control	Ch 7
12/04/2024	Multi-Armed Bandit Problems (Tentative)	Supplement
12/11/2024	Applications of Stochastic Optimization	Supplement
12/18/2024	Final Exam	

* No classes on:

- 10/02 (GC Closed)
- 10/23 (INFORMS Annual Meeting)
- 11/27 (Friday Schedule)