STOCHASTIC MODELING AND OPTIMIZATION, 2023/24

1. Overview and Objectives

The main objective of the course is to introduce students to sequential decision making under uncertainty through the framework of Dynamic Programming. Along the way, it presents mathematical formulations and solution concepts for fundamental problems such as inventory management, asset selling, portfolio selection, dynamic pricing, and trajectory tracking; an introduction to state estimation and dynamic learning problems; as well as a primer in infinite-horizon discounted problems.

2. Course Outline

Introduction to Dynamic Programming
Stochastic Optimization Problems
Dynamic Programming Algorithm

Inventory Management
Newsvendor Model
(s, S) Inventory Replenishment Policy

Asset Selling
Optimal Stopping Problems
One-Step Lookahead Policy

Portfolio Selection
Capital Allocation Line
Portfolio Diversification

Dynamic Pricing
Optimality Conditions
Bounds and Asymptotics via Static Pricing

Trajectory Tracking
Linear-Quadratic Control
Ricatti Equation

State Estimation
Markov Chains and Hidden Markov Models
Viterbi Algorithm

Sequential Hypothesis Testing
Sufficient Statistics
Sequential Probability Ratio Test

Infinite-Horizon Discounted Problems
DP Mapping: Monotonicity, Contraction, Fixed Point
Value and Policy Iteration
Applications

3. Schedule of Classes

TBD

4. Instructor

Mihalis Markakis (OIT Department)

Email: MMarkakis@iese.edu

Website: https://www.iese.edu/faculty-research/faculty/mihalis-markakis/

5. Evaluation

Three problem sets account for 50% of the final grade, while the remaining 50% comes from a final project. Both the problem sets and the final project are carried out by each student individually, and are submitted to the instructor via email.

Typically, final projects are applied and computational in nature, and each student is free to choose any application domain for their project as long as it uses knowledge acquired during the course in a meaningful way. The deliverable for the final project is a technical report (8 pages maximum, excluding appendices) elaborating on the motivation, the methodology, and implementation details of the project. The grade of the final project is broken down as follows: 20% innovation/sophistication of methodological approach, 15% implementation, 15% presentation style.

6. Textbook

Although class notes are reasonably self-contained, the course relies heavily on the two-volume textbook by D.P. Bertsekas, "Dynamic Programming and Optimal Control," 4^{th} Ed., *Athena Scientific*.