MGT-484

Applied probability & stochastic processes

Cristi Andrés

Cursus	Sem.	Type
Life Sciences Engineering	MA2, MA4	Opt.
Management of technology		Opt.
Management, Technology and Entrepreneurship minor	E	Opt.
Managmt, tech et entr.	MA2, MA4	Obl.
Neuro-X minor	E	Opt.
Neuro-X	MA2, MA4	Opt.
Systems Engineering minor	E	Opt.

Language of teaching	English
Credits	4
Session	Summer
Semester	Spring
Exam	Written
Workload	120h
Weeks	14
Hours	**4 weekly**
Courses	2 weekly
Exercises	2 weekly
Number of positions	

Summary

This course focuses on dynamic models of random phenomena, and in particular, the most popular classes of such models: Markov chains and Markov decision processes. We will also study applications in queuing theory, finance, project management, etc.

Content

- Discrete Markov chains, transition matrix, Markov property.
- Classification of states.
- Strong Markov property, hitting probabilities and hitting times.
- Stationary distributions and long-term behavior.
- Markov chain simulation.
- Markov decision processes and stochastic control.
- Dynamic programming and Bellman equation.
- Infinite horizon problems, value-iteration and policy-iteration algorithms.
- Applications to inventory management, optimal stopping, and portfolio selection.

Keywords

Markov chains, Markov decision processes, dynamic programming, optimal control

Learning Prerequisites

Required courses

An engineering-level course on Probability/Statistics.

Important concepts to start the course

Basic concepts of Probability theory: random events, probability measure, random variable, expectation, cummulative distribution function, probability density function, independence, conditional probability, Bayes rule.
Basic concepts of Linear Algebra: vector, matrix, matrix multiplication, linear equations, eigenvalues.
Basic notions of Optimization: formulation of an optimization problem, objective function, constraints, first-order conditions.

Learning Outcomes

By the end of the course, the student must be able to:

• Understand the concept of a discrete-time Markov chain and know how Markov chains are used to model random phenomena

- Compute several properties of a given Markov chain, such as hitting probabilities, expected hitting times, invariant distributions and the long-run proportion of time spent in a given state
- Formalize decision problems under uncertainty as optimal control models
- Solve optimal control models via dynamic programming
- Be able to read the technical literature in applied probability and to undertake independent self-study (or research) in the future
- Reason about the concept of a discrete-time Markov chain and understand how Markov chains are used to model random phenomena
- Analyze the technical literature in applied probability and to undertake independent self-study (or research) in the future
- Structure real decision-making situations using these models.
- Formulate Markov chain models for dynamic uncertain phenomena.
- Formulate Markov decision process models for dynamic decision problems under uncertainty.
- Use and understand the concept of a discrete-time Markov chain and know how Markov chains are used to model random phenomena

Transversal skills

- Communicate effectively, being understood, including across different languages and cultures.
- Assess one's own level of skill acquisition, and plan their on-going learning goals.
- Use a work methodology appropriate to the task.
- Demonstrate the capacity for critical thinking

Teaching methods

Classical formal teaching interlaced with practical exercices.

Expected student activities

Active participation in exercise sessions is essential.

Assessment methods

- 40% midterm exam
- 60% final exam

Supervision

Office hours	Yes
Assistant.e.s	Yes
Forum	No

Resources

Bibliography

Introduction to Probability Models, 10th edition. Sheldon M. Ross, Academic Press, 2009.
Dynamic Programming and Optimal Control, 3rd edition. Dimitri P. Bertsekas, Athena Scientific, 2005.
Introduction to Probability. Dimitri P. Bertsekas and John N. Tsitsiklis, Athena Scientific, 2002.
Applied Probability Models with Optimization Applications. Sheldon Ross, 1992.

Ressources en bibliothèque

- Find the references at the Library

Moodle Link

- https://go.epfl.ch/MGT-484

Prerequisite for

Advanced MTE courses