UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Decision Models

2122-1-F9101Q005-F9101Q006M

Aims

This module will emphasizes the relevance of data in decision making. The general aim is to develop skills in mathematical modeling and in algorithms and computational methods to solve and analyze decision problems. The course will illustrates how to formulate real world problems using case studies and examples; how to use efficient algorithms – both old and new – for solving these models; and how to evaluate, draw useful conclusions and derive useful planning information from the output of these algorithms.

Specific aims of the course module are:

1. To give students the basic concepts of decision theory, modeling and solution methods of decision making problems with applications
2. Guide the students in using different mathematical modeling techniques with OR,
3. Teach students different methods that are used for numerical decision making,
4. Make students gain skills in finding optimal solutions to problems
5. use and integrate open source platforms and programming languages as R or Python

Contents

1. Types of decisions
2. Model driven and Data driven methods
3. Decision trees: Value of information and value of perfect information (with case studies)
4. Basic mathematical programming models: linear programming and sensitivity analysis, non linear programming, integer programming
5. Networks models

6. Markov decision processes and Reinforcement Learning

Detailed program

1. Types of decisions

- Structured and programmed decision
- Unstructured and non-programmed decision
- Descriptive, predictive and prescriptive analytics

- Decision making conditions: certainty, uncertainty

2. Types of decision models: Model driven and Data driven models
- a case study using linear regression
- a case studi using logistic regression
- a case study using classification trees

3. Decision trees
- Basic definitions and examples
- Value of information: value of sampled information and value of perfect information

4. Basic mathematical programming models:
- examples of linear programming problems and their formulation
- solution of linear programming problems
- sensitivity analysis
- the use of heuristics

4. Networks models
- transportation problems
- the shortest path LP formulation
- shortest path dynamic programming solution

5. Markov decision processes and Reinforcement Learning

- dynamic programming and approximate dynamic programming

- Markov decision problem

- Value iteration

- Policy iteration

- Basic principles of reinforcement learning

Prerequisites

Basic R programming

Teaching form

The course will be held in english.

The course is hands-on. In particular, we use different case studies to show how to formulate and solve different types of problems.

Case studies will be the starting point to illustrate how the decision problem can be formulated and solved

Practical exercises using sw (basically R)

Assignments will be given periodically to access the student critical thinking skills

Textbook and teaching resource

Textbooks
[AE] Dimitris Bertsimas, Allison O'Hair ,and William Pulleyblank, The Analytics Edge, Dynamic Ideas LLC,

1st edition, 2016.
[BT] Dimitris Bertsimas and Robert Freund, Data, models, and decisions : the fundamentals of management science, Dynamic Ideas, 2004. Software

[DA] Cliff Ragsdale, Spreadsheed modeling and decision analysis, any edition.

[R-optimx] Optimization in R: https://cran.r-project.org/web/packages/optimx/optimx.pdf

Instructors make available slides, in-class exercises data and models, additional reading papers.

Semester

II semester

Assessment method

Assignments +Written Exam+ oral (optional)

- Along the course there will be proposed four assignments to be resolved individually. We only allow ”Type 1 collaboration”. This means that collaboration is allowed, but the final product must be individual. You are allowed to discuss the assignment with other team members and work through the problems together. What you turn in, however, must be your own product, written in your own handwriting, or in a computer file of which you are the sole author. Copying another’s work or electronic file is not acceptable.
- Assignment must to be delivered on the established date. No assignment will be considered after deadline. Assignments are valid until July 2022.

- A written exam with closed and open questions about the topics presented during thee course to assess: Knowledge of Fundamental Concepts, Overall Understanding, Knowledge of specific models and methods.

- Finally, in order to improve the grade, students can take an oral exam (optional) to assess also the students' Argumentation ability

- A written exam with closed and open questions about the topics presented during thee course to assess: Knowledge of Fundamental Concepts, Overall Understanding, Knowledge of specific models and methods.

- An oral examination will evaluate knowledge and argumentation ability.

For more detail about the assessment methods refer to the related document in the introductory part of the course.

Office hours

By appointment