UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Mathematics for Data Analysis

2627-1-F7603Q032-F7603Q03202

Aims

This is one of the two modules of the “Advanced data analysis and statistics” course. This module grants 3 CFUs and its aim is to provide the mathematical knowledge and methodological basis that will be used in subsequent courses. The course is based on a theoretical as well as applied approach.

Students are invited to consult the syllabus of the entire course for details regarding learning- and skill-related objectives.

Learning Objectives:
Knowledge and Understanding: students will become familiar with linear algebra (vectors, matrices, eigenvalues, and quadratic forms) and differential calculus of several variables (partial derivatives, optimization, and Lagrange multipliers).

Applying Knowledge and Understanding: students will be able to apply mathematical techniques, including matrix algebra, systems of linear equations, and constrained optimization, to solve problems in data analysis.

Making Judgements: students will develop the ability to critically assess the suitability of mathematical methods for real-life problems, evaluating the validity of solutions and their implications in analytical contexts.

Communication Skills: students will be able to clearly present mathematical solutions and their interpretations in written exams, using precise mathematical language and formal reasoning.

Learning Skills: students will gain the skills to independently study advanced mathematical topics relevant to data analysis, enabling them to succeed in subsequent courses and pursue further academic or professional development.

Contents

• Linear algebra with applications.
• Differential calculus of several variables with applications.

Detailed program

Linear Algebra:
• vectors and matrices;
• matrix algebra;
• determinant and rank of a matrix;
• systems of linear equations;
• consistent and inconsistent linear systems;
• eigenvalues and eigenvectors;
• matrix decomposition;
• quadratic forms.

Differential calculus of several variables:
• partial derivatives, gradient, Jacobian and Hessian matrices;
• implicit function theorem;
• unconstrained optimization:
• necessary and sufficient conditions;
• constrained optimization: the Lagrange multipliers methodology;
• introduction to linear programming.

Prerequisites

• Basic algebra.
• A fair knowldege of calculus for functions of one real variable.
• Elementary functions, limits and continuity, differentiation, optimization.

These topics can be reviewed using any basic or intermediate level mathematics for economics book. An example is: K. Sydsaeter, P. Hammond, A. Strom and A. Carvajal: Essential Mathematics for Economics Analysis. According to the fourth edition, chapters to be covered are from 1 to 8 and 15. In case of a different edition, verify in which chapters the required notions are covered.

Teaching form

3 CFUs of in-class lessons (24 hours):
• 12 two-hour lectures, in person, Delivered Didactics.

Attendance to lectures and interactive exercises is highly recommended.

Textbook and teaching resource

• Lecture notes and additional slides covering examples, exercises and insights presented during classes.
• Lorenzo Peccati , Sandro Salsa, Annamaria Squellati: Mathematics – Corso di International Economics – Università Milano-Bicocca – EGEA.
This book is available only in .pdf format (https://www.egeaonline.it/ita/prodotti/metodi-quantitativi/mathematics.aspx)

Semester

I semester (October - November)

Assessment method

The final exam at the end of module consists of a written test covering all topics listed above.

The final score will be between 18/30 and 30/30 *cum laude*, based on the overall assessment considering the following criteria:
(1) knowledge and understanding;
(2) ability to connect different concepts;
(3) autonomy of analysis and judgment;
(4) ability to correctly use scientific language.

Office hours

Due to frequent changes, please refer to the lecturer's webpage: https://en.unimib.it/enrico-moretto

Sustainable Development Goals

QUALITY EDUCATION