Syllabus

Course Description

Course Title	Optimization methods for decision making
Course Code	27511
Course Title Additional	
Scientific-Disciplinary Sector	NN
Language	English
Degree Course	Master in Data Analytics for Economics and Management
Other Degree Courses (Loaned)	
Lecturers	Prof. Dr. rer. nat. habil. Andreas Heinrich Hamel, Andreas.Hamel@unibz.it https://www.unibz.it/en/faculties/economics-management/academic-staff/person/33708 Prof. Davide Ferrari, Davide.Ferrari2@unibz.it https://www.unibz.it/en/faculties/economics-management/academic-staff/person/39001 dr. Giulia Bertagnolli, Giulia.Bertagnolli@unibz.it https://www.unibz.it/en/faculties/economics-management/academic-staff/person/49312
Teaching Assistant	
Semester	All semesters
Course Year/s	2
CP	12
Teaching Hours	M1: - 24 hours of in-person lectures - 12 hours of video lectures (counted as 24 hours to account for re-watching) M2: - 24 hours of in-person lectures 12 hours of video lectures (counted as 24 hours to account for re-watching)

Lab Hours	-
Individual Study Hours	-
Planned Office Hours	M1: 18 hours M2: 18 hours
Contents Summary	Module 1 deals with: • Linear optimization techniques • Nonlinear optimization techniques • Combinatorial optimization techniques • Multicriteria optimization and decision making • Decision making under uncertainty Module 2 focuses on the application of data science techniques to optimize resources, evaluate risks, and support sustainable decision-making in business and economic contexts. Students will work with spatio-temporal data, applying models for trend-surface estimation, spatial and temporal correlation, and prediction. The course also introduces robust statistical methods and outlier detection techniques to ensure reliability under data contamination and heavy-tailed distributions. Additional topics include tail dependence, extreme value modeling, and multivariate risk assessment, with real-world applications in finance, environmental planning, and policy evaluation. Emphasis is placed on interpreting results from empirical analyses and implementing solutions using modern statistical software.
Course Topics	M1: • Linear optimization techniques • Nonlinear optimization techniques • Discussion of combinatorial optimization problems • Multicriteria optimization and decision making • Decision making under uncertainty M2: Spatio-Temporal Data Analysis: Trend-surface estimation, spatial and temporal correlation, forecasting methods Robust Statistics & Outlier Detection: Data contamination and heavy tails, robust estimation and outlier analysis. Risk Modeling & Dependence Structures: Extreme value methods, multivariate risk assessment Applications: Finance and risk evaluation, environmental planning,

	policy and resource optimization
Keywords	Optimization and decision making Decision making under uncertainty Spatio-temporal data analysis Robust statistics and outlier detection Risk modeling and extreme value analysis Multivariate dependence and risk assessment
Recommended Prerequisites	
Propaedeutic Courses	
Teaching Format	The course adopts a blended, student-centered approach that emphasises problem-based learning and active engagement. A portion of the lecture content is made available online in advance, allowing students to explore key concepts independently and at their own pace before attending class. This preparatory work enables in-person sessions to focus on the application of knowledge through real-world problems, collaborative activities, and guided discussions — fostering critical thinking and deeper learning. The course is fully aligned with the principles of the Italian Universities Digital Hub (EDUNEXT) initiative (https://edunext.eu), which promotes the integration of digital resources and active learning strategies within university teaching.
Mandatory Attendance	Recommended, but not required.
Specific Educational Objectives and Learning Outcomes	M1: ILO 1 Knowledge and understanding: ILO 1.1 The student acquires knowledge of the analytical techniques and tools required to understand and quantitatively analyse economic and business phenomena in order to support decision-making processes. ILO 1.2 The student consolidates knowledge of statistical inference, linear models and their generalisations, linear algebra, and optimisation techniques. ILO 3 Making judgements:

	ILO 3.1 The student acquires the ability to apply acquired knowledge to interpret data in order to make directional and operational decisions in a business context. ILO 3.2 The student acquires the ability to apply acquired knowledge to support processes related to production, management and risk promotion activities and investment choices through the organisation, analysis and interpretation of complex databases. ILO4 Communication skills: ILO 4.1 The student acquires the ability to communicate effectively in oral and written form the specialised content of the individual disciplines, using different registers, depending on the recipients and the communicative and didactic purposes, and to evaluate the formative effects of his/her communication. ILO 5 Learning skills: ILO 5.1 The student acquires knowledge of scientific research tools. He/she will also be able to make autonomous use of information technology to carry out bibliographic research and investigations both for his/her own training and for further education. Furthermore, through the curricular teaching and the activities related to the preparation of the final thesis, she will be able to acquire the ability - to identify thematic connections and to establish relationships between methods of analysis and application contexts; - to frame a new problem in a systematic manner and to implement appropriate analysis solutions; - to formulate general statistical-econometric models from the phenomena studied. M2: ILO 1 Knowledge and understanding: ILO 1.1 The student acquires knowledge of the analytical techniques and tools required to understand and quantitatively analyse economic and business phenomena in order to support decision-making processes. ILO 1.2 The student consolidates knowledge of statistical inference, linear models and their generalisations, linear algebra, and optimisation techniques.

	ILO 1.3 The student acquires an in-depth knowledge of the main techniques of supervised and unsupervised statistical learning, which are instrumental in the development of analysis and visualisation of economic and business data. ILO 2 Applying knowledge and understanding: ILO 2.1 Ability to apply and implement analysis techniques focusing on different types of datasets such as streaming data, tabular data, documents and images and analysis on joint datasets. ILO 2.2 Ability to apply supervised and unsupervised learning, and knowledge modelling, extraction, integration, analysis and exploitation; these skills are declined in various application domains of interest to companies and public and private organisations. ILO 3 Making judgements: ILO 3.1 The student acquires the ability to apply acquired knowledge to interpret data in order to make directional and operational decisions in a business context. ILO 3.2 The student acquires the ability to apply acquired knowledge to support processes related to production, management and risk promotion activities and investment choices through the organisation, analysis and interpretation of complex databases. ILO4 Communication skills: ILO 4.1 The student acquires the ability to communicate effectively in oral and written form the specialised content of the individual disciplines, using different registers, depending on the recipients and the communicative and didactic purposes, and to evaluate the formative effects of his/her communication. ILO 5 Learning skills: ILO 5.1 The student acquires knowledge of scientific research tools. He/she will also be able to make autonomous use of information technology to carry out bibliographic research and investigations both for his/her own training and for further education. Furthermore, through the curricular teaching and the activities related to the preparation of the final thesis, she will be

	able to acquire the ability - to identify thematic connections and to establish relationships between methods of analysis and application contexts; - to frame a new problem in a systematic manner and to implement appropriate analysis solutions; - to formulate general statistical-econometric models from the phenomena studied.
Specific Educational Objectives and Learning Outcomes (additional info.)	
Assessment	The overall exam mark will be determined by the assessment of the two modules (M1+M2) M1: A written exam and a project presentation including an oral presentation (ILOs 1.1, 1.2, 3.1, 3.2, 4.1, 5.1). M2: Written exam: combination of multiple choice and essay questions (ILOs 1, 2, 3 and 4). Project work: development of an individual project related to the methodologies studied, their implementation in statistical software, and their applications to empirical data (ILOs 1, 2, 3, 4 and 5).
Evaluation Criteria	M1: The written exam of 1 hour counts 50%, the project 50% towards the final grade. Evaluation criteria are understanding of modeling features, capability of applying solution methods (only small scale for the written exam) problems and the capability to interpret/discuss the results w.r.t. economic/managerial decision making. M2: To pass the M2 module exam students must obtain a positive evaluation on both final exam (50% of the grade) and project (50% of the grade).
Required Readings	M1: Video lectures and slides provided during the course.

	M2: Lecture notes and selected readings from the following books: Wikle, Christopher K., Andrew Zammit-Mangion, and Noel Cressie. *Spatio-temporal statistics with R*. Chapman and Hall/CRC, 2019. Kolaczyk, Eric D., and Gábor Csárdi. *Statistical analysis of network data with R*. Vol. 65. New York: Springer, 2014.
Supplementary Readings	M1: Boyd/Vandenberghe, Convex Optimization, Wright/Recht, Optimization for Data Analysis, Sundaram, A First Course in Optimization Theory.
Further Information	
Sustainable Development Goals (SDGs)	No poverty, Partnerships fot the goals, Good health and well-being, Quality education, Gender equality, Clean water and sanitation, Affordable and clean energy, Decent work and economic growth, Industry, innovation and infrastructure, Reduced inequalities, Sustainable cities and communities, Responsible consumption and production, Climate action, Life below water, Life on land, Peace, justice and strong institutions, Zero hunger

Course Module

Course Constituent Title	M1 - Optimization methods for economics and business
Course Code	27511A
Scientific-Disciplinary Sector	MATH-03/B
Language	English
Lecturers	Prof. Dr. rer. nat. habil. Andreas Heinrich Hamel, Andreas.Hamel@unibz.it https://www.unibz.it/en/faculties/economics-management/academic-staff/person/33708
Teaching Assistant	

Semester	First semester
CP	6
Responsible Lecturer	
Teaching Hours	- 24 hours of in-person lectures - 12 hours of video lectures (counted as 24 hours to account for re-watching)
Lab Hours	-
Individual Study Hours	-
Planned Office Hours	18
Contents Summary	The module deals with: • Linear optimization techniques • Nonlinear optimization techniques • Combinatorial optimization techniques • Multicriteria optimization and decision making • Decision making under uncertainty
Course Topics	• Linear optimization techniques • Nonlinear optimization techniques • Discussion of combinatorial optimization problems • Multicriteria optimization and decision making • Decision making under uncertainty
Teaching Format	The module adopts a blended, student-centered approach that emphasizes problem-based learning and active engagement. A portion of the lecture content is made available online in advance, allowing students to explore key concepts independently and at their own pace before attending class. This preparatory work enables in-person sessions to focus on the application of knowledge through real-world problems, collaborative activities, and guided discussions — fostering critical thinking and deeper learning. The course is fully aligned with the principles of the Italian Universities Digital Hub (EDUNEXT) initiative (https://edunext.eu), which promotes the integration of digital resources and active learning strategies within university teaching.
Required Readings	Video lectures and slides provided during the course.
Supplementary Readings	Boyd/Vandenberghe, Convex Optimization, Wright/Recht, Optimization for Data Analysis,

	Sundaram, A First Course in Optimization Theory.

Course Module

Course Constituent Title	M2 - Data science applications for resource optimization, risk evaluation and sustainability
Course Code	27511B
Scientific-Disciplinary Sector	STAT-01/A
Language	English
Lecturers	Prof. Davide Ferrari, Davide.Ferrari2@unibz.it https://www.unibz.it/en/faculties/economics-management/academic-staff/person/39001 dr. Giulia Bertagnolli, Giulia.Bertagnolli@unibz.it https://www.unibz.it/en/faculties/economics-management/academic-staff/person/49312
Teaching Assistant	
Semester	Second semester
CP	6
Responsible Lecturer	
Teaching Hours	- 24 hours of in-person lectures - 12 hours of video lectures (counted as 24 hours to account for re-watching)
Lab Hours	-
Individual Study Hours	-
Planned Office Hours	18
Contents Summary	This module focuses on the application of data science techniques to optimize resources, evaluate risks, and support sustainable decision-making in business and economic contexts. Students will work with spatio-temporal data, applying models for trend-surface estimation, spatial and temporal correlation, and prediction. The course also introduces robust statistical methods and outlier detection techniques to ensure reliability under data contamination and heavy-tailed distributions. Additional topics include tail

	dependence, extreme value modeling, and multivariate risk assessment, with real-world applications in finance, environmental planning, and policy evaluation. Emphasis is placed on interpreting results from empirical analyses and implementing solutions using modern statistical software.
Course Topics	Spatio-Temporal Data Analysis: Trend-surface estimation, spatial and temporal correlation, forecasting methods Robust Statistics & Outlier Detection: Data contamination and heavy tails, robust estimation and outlier analysis. Risk Modeling & Dependence Structures: Extreme value methods, multivariate risk assessment Applications: Finance and risk evaluation, environmental planning, policy and resource optimization
Teaching Format	The module adopts a blended, student-centered approach that emphasizes problem-based learning and active engagement. A portion of the lecture content is made available online in advance, allowing students to explore key concepts independently and at their own pace before attending class. This preparatory work enables in-person sessions to focus on the application of knowledge through real-world problems, collaborative activities, and guided discussions — fostering critical thinking and deeper learning. The course is fully aligned with the principles of the Italian Universities Digital Hub (EDUNEXT) initiative (https://edunext.eu), which promotes the integration of digital resources and active learning strategies within university teaching.
Required Readings	Lecture notes and selected readings from the following books: Wikle, Christopher K., Andrew Zammit-Mangion, and Noel Cressie. *Spatio-temporal statistics with R*. Chapman and Hall/CRC, 2019. Kolaczyk, Eric D., and Gábor Csárdi. *Statistical analysis of network data with R*. Vol. 65. New York: Springer, 2014.
Supplementary Readings	