

# Syllabus

## *Course Description*

<b>Course Title</b>	Optimization methods for decision making
<b>Course Code</b>	27511
<b>Course Title Additional</b>	
<b>Scientific-Disciplinary Sector</b>	NN
<b>Language</b>	English
<b>Degree Course</b>	Master in Data Analytics for Economics and Management
<b>Other Degree Courses (Loaned)</b>	
<b>Lecturers</b>	<p>Prof. Dr. rer. nat. habil. Andreas Heinrich Hamel,          Andreas.Hamel@unibz.it  <a href="https://www.unibz.it/en/faculties/economics-management/academic-staff/person/33708">https://www.unibz.it/en/faculties/economics-management/academic-staff/person/33708</a></p> <p>Prof. Davide Ferrari,          Davide.Ferrari2@unibz.it  <a href="https://www.unibz.it/en/faculties/economics-management/academic-staff/person/39001">https://www.unibz.it/en/faculties/economics-management/academic-staff/person/39001</a></p> <p>dr. Giulia Bertagnolli,          Giulia.Bertagnolli@unibz.it  <a href="https://www.unibz.it/en/faculties/economics-management/academic-staff/person/49312">https://www.unibz.it/en/faculties/economics-management/academic-staff/person/49312</a></p>
<b>Teaching Assistant</b>	
<b>Semester</b>	All semesters
<b>Course Year/s</b>	2
<b>CP</b>	12
<b>Teaching Hours</b>	<p>M1:</p> <ul style="list-style-type: none"> <li>- 24 hours of in-person lectures</li> <li>- 12 hours of video lectures (counted as 24 hours to account for re-watching)</li> </ul> <p>M2:</p> <ul style="list-style-type: none"> <li>- 24 hours of in-person lectures</li> <li>- 12 hours of video lectures (counted as 24 hours to account for re-watching)</li> </ul>

<b>Lab Hours</b>	-
<b>Individual Study Hours</b>	-
<b>Planned Office Hours</b>	M1: 18 hours M2: 18 hours
<b>Contents Summary</b>	<p>Module 1 deals with:</p> <ul style="list-style-type: none"> <li>• Linear optimization techniques</li> <li>• Nonlinear optimization techniques</li> <li>• Combinatorial optimization techniques</li> <li>• Multicriteria optimization and decision making</li> <li>• Decision making under uncertainty</li> </ul> <p>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.</p>
<b>Course Topics</b>	<p>M1:</p> <ul style="list-style-type: none"> <li>• Linear optimization techniques</li> <li>• Nonlinear optimization techniques</li> <li>• Discussion of combinatorial optimization problems</li> <li>• Multicriteria optimization and decision making</li> <li>• Decision making under uncertainty</li> </ul> <p>M2:</p> <p>Spatio-Temporal Data Analysis: Trend-surface estimation, spatial and temporal correlation, forecasting methods</p> <p>Robust Statistics &amp; Outlier Detection: Data contamination and heavy tails, robust estimation and outlier analysis.</p> <p>Risk Modeling &amp; Dependence Structures: Extreme value methods, multivariate risk assessment</p> <p>Applications: Finance and risk evaluation, environmental planning,</p>

	policy and resource optimization
<b>Keywords</b>	<p>Optimization and decision making</p> <p>Decision making under uncertainty</p> <p>Spatio-temporal data analysis</p> <p>Robust statistics and outlier detection</p> <p>Risk modeling and extreme value analysis</p> <p>Multivariate dependence and risk assessment</p>
<b>Recommended Prerequisites</b>	
<b>Propaedeutic Courses</b>	
<b>Teaching Format</b>	<p>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 (<a href="https://edunext.eu">https://edunext.eu</a>), which promotes the integration of digital resources and active learning strategies within university teaching.</p>
<b>Mandatory Attendance</b>	Recommended, but not required.
<b>Specific Educational Objectives and Learning Outcomes</b>	<p>M1:</p> <p>ILO 1 Knowledge and understanding:</p> <p>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.</p> <p>ILO 1.2 The student consolidates knowledge of statistical inference, linear models and their generalisations, linear algebra, and optimisation techniques.</p> <p>ILO 3 Making judgements:</p>

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

	<p>able to acquire the ability</p> <ul style="list-style-type: none"> <li>- to identify thematic connections and to establish relationships between methods of analysis and application contexts;</li> <li>- to frame a new problem in a systematic manner and to implement appropriate analysis solutions;</li> <li>- to formulate general statistical-econometric models from the phenomena studied.</li> </ul>
<b>Specific Educational Objectives and Learning Outcomes (additional info.)</b>	
<b>Assessment</b>	<p>The overall exam mark will be determined by the assessment of the two modules (M1+M2)</p> <p>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).</p> <p>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).</p>
<b>Evaluation Criteria</b>	<p>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.</p> <p>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).</p>
<b>Required Readings</b>	<p>M1: Video lectures and slides provided during the course.</p>

	<p>M2:</p> <p>Lecture notes and selected readings from the following books:</p> <p>Wikle, Christopher K., Andrew Zammit-Mangion, and Noel Cressie. <i>Spatio-temporal statistics with R</i>. Chapman and Hall/CRC, 2019.</p> <p>Kolaczyk, Eric D., and Gábor Csárdi. <i>Statistical analysis of network data with R</i>. Vol. 65. New York: Springer, 2014.</p>
<b>Supplementary Readings</b>	<p>M1:</p> <p>Boyd/Vandenberghe, Convex Optimization,</p> <p>Wright/Recht, Optimization for Data Analysis,</p> <p>Sundaram, A First Course in Optimization Theory.</p>
<b>Further Information</b>	
<b>Sustainable Development Goals (SDGs)</b>	<p>No poverty, Partnerships for 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</p>

## *Course Module*

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

<b>Semester</b>	First semester
<b>CP</b>	6
<b>Responsible Lecturer</b>	
<b>Teaching Hours</b>	<ul style="list-style-type: none"> <li>- 24 hours of in-person lectures</li> <li>- 12 hours of video lectures (counted as 24 hours to account for re-watching)</li> </ul>
<b>Lab Hours</b>	-
<b>Individual Study Hours</b>	-
<b>Planned Office Hours</b>	18
<b>Contents Summary</b>	<p>The module deals with:</p> <ul style="list-style-type: none"> <li>• Linear optimization techniques</li> <li>• Nonlinear optimization techniques</li> <li>• Combinatorial optimization techniques</li> <li>• Multicriteria optimization and decision making</li> <li>• Decision making under uncertainty</li> </ul>
<b>Course Topics</b>	<ul style="list-style-type: none"> <li>• Linear optimization techniques</li> <li>• Nonlinear optimization techniques</li> <li>• Discussion of combinatorial optimization problems</li> <li>• Multicriteria optimization and decision making</li> <li>• Decision making under uncertainty</li> </ul>
<b>Teaching Format</b>	<p>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 (<a href="https://edunext.eu">https://edunext.eu</a>), which promotes the integration of digital resources and active learning strategies within university teaching.</p>
<b>Required Readings</b>	Video lectures and slides provided during the course.
<b>Supplementary Readings</b>	<p>Boyd/Vandenberghe, Convex Optimization,  Wright/Recht, Optimization for Data Analysis,</p>

	Sundaram, A First Course in Optimization Theory.
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## *Course Module*

<b>Course Constituent Title</b>	M2 - Data science applications for resource optimization, risk evaluation and sustainability
<b>Course Code</b>	27511B
<b>Scientific-Disciplinary Sector</b>	STAT-01/A
<b>Language</b>	English
<b>Lecturers</b>	Prof. Davide Ferrari, Davide.Ferrari2@unibz.it <a href="https://www.unibz.it/en/faculties/economics-management/academic-staff/person/39001">https://www.unibz.it/en/faculties/economics-management/academic-staff/person/39001</a> dr. Giulia Bertagnolli, Giulia.Bertagnolli@unibz.it <a href="https://www.unibz.it/en/faculties/economics-management/academic-staff/person/49312">https://www.unibz.it/en/faculties/economics-management/academic-staff/person/49312</a>
<b>Teaching Assistant</b>	
<b>Semester</b>	Second semester
<b>CP</b>	6
<b>Responsible Lecturer</b>	
<b>Teaching Hours</b>	<ul style="list-style-type: none"> <li>- 24 hours of in-person lectures</li> <li>- 12 hours of video lectures (counted as 24 hours to account for re-watching)</li> </ul>
<b>Lab Hours</b>	-
<b>Individual Study Hours</b>	-
<b>Planned Office Hours</b>	18
<b>Contents Summary</b>	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

	<p>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.</p>
<b>Course Topics</b>	<p>Spatio-Temporal Data Analysis: Trend-surface estimation, spatial and temporal correlation, forecasting methods</p> <p>Robust Statistics &amp; Outlier Detection: Data contamination and heavy tails, robust estimation and outlier analysis.</p> <p>Risk Modeling &amp; Dependence Structures: Extreme value methods, multivariate risk assessment</p> <p>Applications: Finance and risk evaluation, environmental planning, policy and resource optimization</p>
<b>Teaching Format</b>	<p>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 (<a href="https://edunext.eu">https://edunext.eu</a>), which promotes the integration of digital resources and active learning strategies within university teaching.</p>
<b>Required Readings</b>	<p>Lecture notes and selected readings from the following books:</p> <p>Wikle, Christopher K., Andrew Zammit-Mangion, and Noel Cressie. <i>Spatio-temporal statistics with R</i>. Chapman and Hall/CRC, 2019.</p> <p>Kolaczyk, Eric D., and Gábor Csárdi. <i>Statistical analysis of network data with R</i>. Vol. 65. New York: Springer, 2014.</p>
<b>Supplementary Readings</b>	