Syllabus

Descrizione corso

Titolo insegnamento	Programming and Visualisation for Data Science
Codice insegnamento	27531
Titolo aggiuntivo	
Settore Scientifico-Disciplinare	
Lingua	Inglese
Corso di Studio	Corso di laurea magistrale in Data Analytics for Economics and Management
Altri Corsi di Studio (mutuati)	This course is offered within the Master's programme in Computing for Data Science (LM-18) - course 73081
Docenti	prof. Antonio Liotta, Antonio.Liotta@unibz.it https://www.unibz.it/en/faculties/engineering/academic-staff/person/41903
Assistente	
Semestre	Primo semestre
Anno/i di corso	1
CFU	12
Ore didattica frontale	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)
Ore di laboratorio	M1: 12 hours M2: 12 hours
Ore di studio individuale	-
Ore di ricevimento previste	M1: 18

	M2: 18
Sintesi contenuti	M1: - Fundamentals of Python Programming - Programming paradigms and software abstractions in Python - Advanced Python language features - Professional Python development practices - AI-assisted programming with generative tools M2: - Data acquisition, exploration, integration, transformation, and preprocessing - Data quality evaluation, enhancement, and augmentation - Feature analysis, ranking, selection, and engineering - Models evaluation, validation, tuning and comparison - Advanced data visualization for high-dimensional data and models
Argomenti dell'insegnamento	Module 1 is designed to provide specific professional skills for advanced programming in Python. The students will learn how to develop a Python program, starting from designing it, and going through coding, testing and validation. They will master Python in its full object-oriented features, learning how to develop complex programs that are well structured, and make use of techniques for code re-use, pipelining, maintenance, and deployment. Module 2 is designed to acquire professional skills and knowledge useful when dealing with large-scale datasets. In particular, the students will master data collection, exploration, transformation, curation, analysis, and visualization, choosing the most appropriate technique for the data at hand. They will make insights from the data, supported by a rigorous data science pipeline, which starts with raw data, produces machine learning models, and ends with advanced visualizations. This module, addresses common pitfalls that can mislead the analysis and makes extensive use of specialized Python libraries, acquiring the best practices of reproducible, data-driven analysis and research.
Parole chiave	Python Programming; data science; data curation; data modeling; machine learning; data visualization.
Prerequisiti	Basic programming concepts. Linear algebra. Basic Statistics.
Insegnamenti propedeutici	

Modalità di insegnamento	The course adopts a blended, student-centered approach that emphasizes problem-based learning and active engagement. Selected lecture content is made available online in advance, enabling students to explore key concepts independently and at their own pace. This preparatory work allows in-person sessions to focus on applying knowledge through problem-solving, collaborative activities, and guided discussions—fostering critical thinking and deeper understanding. The teaching format combines frontal lectures, hands-on lab assignments, and project work, ensuring that students develop both theoretical knowledge and practical skills in python programming, and in data analysis, modelling, and visualization. The course is aligned with the principles of the EDUNEXT initiative (https://edunext.eu), promoted by Italian universities, which supports the integration of digital resources and active learning strategies in higher education.
Obbligo di frequenza	Not compulsory. Non attending students have to agree with the lecturer on the modalities of independent study at the beginning of the course.
Obiettivi formativi specifici e risultati di apprendimento attesi	Intended Learning Outcomes (ILO) M1: ILO 1 Knowledge and understanding: ILO 1.1 The student acquires programming knowledge, particularly aimed at data analysis and statistical methodologies for implementing models as well as analysing large-scale datasets. In particular, the computing skills are focused on machine learning methods, on understanding modern techniques for data management and storage, including data from heterogeneous sources in terms of type and structure, such as spatio-temporal data and high-dimensional data, also in cloud environments, and on implementing algorithms for massive data processing. ILO 2 Applying knowledge and understanding: ILO 2.1 Students will develop the ability to apply and implement techniques for analysing large-scale datasets and spatio-temporal data under conditions of uncertainty, through the design and development of

	algorithms. The goal is to ensure the utility, quality, and effectiveness of the analysis. ILO 2.2 Ability to use IT technologies, techniques and methodologies for the acquisition, management, integration, analysis and visualisation of large datasets, in order to ensure scalability in terms of dataset volume and acquisition speed. These skills relate in particular to large database and dataset management systems and related visualisation techniques, models and languages for expressing data semantics, learning techniques, decision-making models, information systems organisation, web search techniques and data flow management 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. 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 programming knowledge, particularly aimed at data analysis and statistical methodologies for implementing models as well as analysing large-scale datasets. In particular, the computing skills are focused on machine learning methods, on understanding modern techniques for data management and storage, including data from heterogeneous sources in terms of type and structure, such as spatio-temporal data and high-dimensional data, also in cloud environments, and on implementing algorithms for massive data processing. ILO 1.2 Students will acquire knowledge and skills in the analysis of textual data and network structures, with particular attention to issues related to data security and privacy. ILO 2 Applying knowledge and understanding: ILO 2.1 Students will develop the ability to apply and implement techniques for analysing large-scale datasets and spatio-temporal data under conditions of uncertainty, through the design and development of algorithms. The goal is to ensure the utility, quality, and effectiveness of the analysis. ILO 2.2 Ability to use IT technologies, techniques and methodologies for the acquisition, management, integration, analysis and visualisation of large datasets, in order to ensure scalability in terms of dataset volume and acquisition speed. These skills relate in particular to large database and dataset management systems and related visualisation techniques, models and languages for expressing data semantics, learning techniques, decision-making models, information systems organisation, web search techniques and data flow management 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.
Obiettivi formativi specifici e risultati di apprendimento attesi (ulteriori info.)	
Modalità di esame	The overall exam mark will be determined by the assessment of the two modules (M1+M2). The exam modalities are the same for both the attending and the non-attending students.

	All project works must have been submitted, at the very latest, 15 days ahead of the oral exam. In case of a positive mark, the projects will count for all 3 regular exam sessions. Module 1: Project work (70% of the final grade) (ILOs 1, 2, 5). Oral exam (30% of the final grade) (ILOs 3, 4). Module 2: Project work (70% of the final grade) (ILOs 1, 2, 5). Oral exam (30% of the final grade) (ILOs 3, 4).
Criteri di valutazione	70% project work, 30% oral exam. • Relevant for project work: clarity of presentation, ability to gain useful and novel insights from data, creativity, critical thinking, ability to adhere to reproducible research best practices • Ability to use Python to write, evaluate and deploy advanced, object-oriented computer programs • Ability to use Python to employ (understand, recall and use) data analytics methods in practical settings, from data collection and curation, to data analysis, modelling and visualization.
Bibliografia obbligatoria	*Data Visualization. A practical introduction.* Haley. Available online *A layered grammar of graphics*. Wickham. Available online *Python Data Science Handbook*, by Jake VanderPlas. O'Reilly Media (1st Edition, 2016). Subject Librarian: David Gebhardi, David.Gebhardi@unibz.it
Bibliografia facoltativa	*Fundamentals of Data Visualization*. Wilke. Available online *Visualization Analysis and Design*. Munzer. Amazon *Data Visualization: Charts, Maps, and Interactive Graphics.* Grant. Amazon

	Doing Data Science. Cathy O'Neil, Rachel Schutt. O'Reilly, 2013, https://www.oreilly.com/library/view/doing-data-science/9781449363871/ *Python for Data Analysis.* By Wes McKinney. O'Reilly, 2nd Edition, 2017, https://www.oreilly.com/library/view/python-for-data/9781491957653/
Altre informazioni	
Obiettivi di Sviluppo Sostenibile (SDGs)	Innovazione e infrastrutture, Istruzione di qualità

Modulo del corso

Titolo della parte costituente del corso	M1 - Programming in Python
Codice insegnamento	27531A
Settore Scientifico-Disciplinare	INFO-01/A
Lingua	Inglese
Docenti	dr. Sana Nadouri, Sana.Nadouri@unibz.it https://www.unibz.it/en/faculties/engineering/academic-staff/person/52863
Assistente	
Semestre	Primo semestre
CFU	6
Docente responsabile	
Ore didattica frontale	- 24 hours of in-person lectures - 12 hours of video lectures (counted as 24 hours to account for re-watching)
Ore di laboratorio	12
Ore di studio individuale	-
Ore di ricevimento previste	

Sintesi contenuti	- Fundamentals of Python Programming - Programming paradigms and software abstractions in Python - Advanced Python language features - Professional Python development practices - AI-assisted programming with generative tools
Argomenti dell'insegnamento	This module provides a comprehensive introduction to Python programming, starting with the setup of the development environment and core programming constructs. Students will explore Python's data structures and programming primitives, progressing to object-oriented programming and the development of structured, reusable code using functions, classes, and libraries. Emphasis is placed on best practices in software development, including code documentation, testing, version control, and distribution. The module concludes with advanced Python programming techniques, preparing students to build robust and maintainable applications.
Modalità di insegnamento	The course adopts a blended, student-centered approach that emphasizes problem-based learning and active engagement. Selected lecture content is made available online in advance, enabling students to explore key concepts independently and at their own pace. This preparatory work allows in-person sessions to focus on applying knowledge through problem-solving, collaborative activities, and guided discussions—fostering critical thinking and deeper understanding. The teaching format combines frontal lectures, hands-on lab assignments, and project work, ensuring that students develop both theoretical knowledge and practical programming skills. The course is aligned with the principles of the EDUNEXT initiative (https://edunext.eu), promoted by Italian universities, which supports the integration of digital resources and active learning strategies in higher education.
Bibliografia obbligatoria	*Python for Data Analysis.* By Wes McKinney. O'Reilly, 3nd Edition, 2022, https://www.oreilly.com/library/view/python-for-data/9781098104023/
Bibliografia facoltativa	Jupyter Notebook Documentation. https://jupyter-notebook.readthedocs.io/en/stable/

Modulo del corso

Titolo della parte costituente del corso	M2 - Data Analysis and Visualization
Codice insegnamento	27531B
Settore Scientifico-Disciplinare	INFO-01/A
Lingua	Inglese
Docenti	prof. Antonio Liotta, Antonio.Liotta@unibz.it https://www.unibz.it/en/faculties/engineering/academic-staff/person/41903
Assistente	dott. Caterina Giaimis
Semestre	Primo semestre
CFU	6
Docente responsabile	
Ore didattica frontale	- 24 hours of in-person lectures - 12 hours of video lectures (counted as 24 hours to account for re-watching)
Ore di laboratorio	12
Ore di studio individuale	-
Ore di ricevimento previste	
Sintesi contenuti	- Data acquisition, exploration, integration, transformation, and preprocessing - Data quality evaluation, enhancement, and augmentation - Feature analysis, ranking, selection, and engineering - Models evaluation, validation, tuning and comparison - Advanced data visualization for high-dimensional data and models
Argomenti dell'insegnamento	This module equips students with professional skills and knowledge essential for working with large-scale datasets. Through a hands-on and rigorous approach, students will learn to collect, explore, transform, curate, analyze, and visualize data—selecting the most appropriate techniques based on the nature and structure of the data. The course emphasizes the development of insights through a

	complete data science pipeline: starting from raw data, progressing through data preprocessing and machine learning modeling, and culminating in advanced visualizations. Students will gain practical experience using specialized Python libraries and will learn how to adopt best practices for reproducible, data-driven analysis and research. Common pitfalls in data analysis will be addressed, helping students to critically assess results and avoid misleading interpretations. By the end of the course, students will be able to design and implement robust analytical workflows that support decision-making and scientific inquiry.
Modalità di insegnamento	The course adopts a blended, student-centered approach that emphasizes problem-based learning and active engagement. Selected lecture content is made available online in advance, enabling students to explore key concepts independently and at their own pace. This preparatory work allows in-person sessions to focus on applying knowledge through problem-solving, collaborative activities, and guided discussions—fostering critical thinking and deeper understanding. The teaching format combines frontal lectures, hands-on lab assignments, and project work, ensuring that students develop both theoretical knowledge and practical data analysis, modelling, and visualization skills. The course is aligned with the principles of the EDUNEXT initiative (https://edunext.eu), promoted by Italian universities, which supports the integration of digital resources and active learning strategies in higher education.
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Bibliografia facoltativa	*Fundamentals of Data Visualization*. Wilke. https://www.oreilly.com/library/view/fundamentals-of-data/9781492031079/ *Visualization Analysis and Design*. Munzer. https://www.oreilly.com/library/view/visualization-analysis-and/9781466508910/ *Data Visualization: Charts, Maps, and Interactive Graphics.* Grant.

	Amazon *Doing Data Science*. Cathy O'Neil, Rachel Schutt. O'Reilly, 2013, https://www.oreilly.com/library/view/doing-data-science/9781449363871/