Syllabus

Course Description

Course Title	Programming and Visualisation for Data Science
Course Code	73081
Course Title Additional	
Scientific-Disciplinary Sector	
Language	English
Degree Course	Master in Computing for Data Science
Other Degree Courses (Loaned)	
Lecturers	Prof. Antonio Liotta, Antonio.Liotta@unibz.it https://www.unibz.it/en/faculties/engineering/academic-staff/person/41903 Dr. Sana Nadouri, Sana.Nadouri@unibz.it https://www.unibz.it/en/faculties/engineering/academic-staff/person/52863
Teaching Assistant	
Semester	First semester
Course Year/s	1
CP	12
Teaching Hours	80
Lab Hours	40
Individual Study Hours	180
Planned Office Hours	36
Contents Summary	M1- Programming in Python - 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 - Engineering-oriented Python development

	M2 – Data Analysis and Visualisation - 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 - Data science methods for image
Course Topics	Module 1: Programming in Python 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. Module 2: Data Analysis and Visualization The course is designed to acquire professional skills and knowledge useful when dealing with large-scale datasets. This module guides students through the complete data science pipeline, from raw data acquisition to advanced analytics and visualization. Students will gain hands-on experience in data ingestion, exploration, cleaning, and feature engineering, building a strong foundation for effective data-driven modelling. The course covers models evaluation, validation, tuning and comparison. Emphasis is placed on producing insightful and reproducible data analytics and visualizations using specialized Python libraries, enabling students to communicate data-driven findings with clarity and impact.
Keywords	Python Programming; data science; data curation; data modeling; machine learning; data visualization.
Recommended Prerequisites	Basic programming concepts. Linear algebra. Basic Statistics.

Propaedeutic Courses	
Teaching Format	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.
Mandatory Attendance	Not compulsory. Non attending students have to agree with the lecturer on the modalities of independent study at the beginning of the course.
Specific Educational Objectives and Learning Outcomes	The course belongs to the type "caratterizzanti – discipline informatiche". The course is designed to provide specific professional skills for advanced programming in Python and professional skills and knowledge useful when dealing with large-scale datasets. Knowledge and understanding: - D1.1 - Knowledge of the key concepts and technologies of data science disciplines - D1.2 - Understanding of the skills, tools and techniques required for an effective use of data science - D1.3 - Knowledge of principles, methods and techniques for processing data in order to make them usable for practical purposes, and understanding of the challenges in this field - D1.9 - Knowledge of the challenges in the field of man-machine interface and of the methods and techniques for overcoming these challenges - D1.12 - Basic knowledge of the main ethical and social

	implications of data science Applying knowledge and understanding: - D2.1 - Practical application and evaluation of tools and techniques in the field of data science - D2.4 - Ability to develop programmes and use tools for the analysis and management of data and related infrastructures - D2.8 - Practical application and evaluation of tools and techniques for data analysis - D2.9 - Design, application and evaluation of technologies and tools for human-machine interaction, data exploration and data visualization Making judgments - D3.2 - Ability to autonomously select the documentation (in the form of books, web, magazines, etc.) needed to keep up to date in a given sector. Communication skills - D4.1 - Ability to use English at an advanced level with particular reference to disciplinary terminology - D4.2 - Ability to present one's work in a clear and comprehensible way in front of an audience, including non-specialists - D4.3 - Ability to structure and draft scientific and technical documentation Learning skills - D5.3 – Ability to deal with problems in a systematic and creative way and to appropriate problem solving techniques.
Specific Educational Objectives and Learning Outcomes (additional info.)	
Assessment	The exam modalities are the same for both the attending and the non-attending students. Project work (70% of the final grade) and oral exam (30% of the final grade). 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.
Evaluation Criteria	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.
Required Readings	*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
Supplementary Readings	*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/

Further Information	Software used: Jupyter Notebook (for Python programming)
Sustainable Development Goals (SDGs)	Industry, innovation and infrastructure, Quality education

Course Module

Course Constituent Title	Programming in Python
Course Code	73081A
Scientific-Disciplinary Sector	INFO-01/A
Language	English
Lecturers	Dr. Sana Nadouri, Sana.Nadouri@unibz.it https://www.unibz.it/en/faculties/engineering/academic-staff/person/52863
Teaching Assistant	
Semester	First semester
CP	6
Responsible Lecturer	
Teaching Hours	40
Lab Hours	20
Individual Study Hours	90
Planned Office Hours	18
Contents Summary	- 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 - Engineering-oriented Python development
Course Topics	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.
Teaching Format	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.
Required Readings	*Python for Data Analysis.* By Wes McKinney. O'Reilly, 3nd Edition, 2022, https://www.oreilly.com/library/view/python-for-data/9781098104023/
Supplementary Readings	Jupyter Notebook Documentation. https://jupyter-notebook.readthedocs.io/en/stable/

Course Module

Course Constituent Title	Data Analysis and Visualization
Course Code	73081B
Scientific-Disciplinary Sector	IINF-05/A
Language	English
Lecturers	Prof. Antonio Liotta, Antonio.Liotta@unibz.it https://www.unibz.it/en/faculties/engineering/academic-staff/person/41903
Teaching Assistant	
Semester	First semester

CP	6
Responsible Lecturer	
Teaching Hours	40
Lab Hours	20
Individual Study Hours	90
Planned Office Hours	18
Contents Summary	- 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 - Data science methods for image
Course Topics	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.
Teaching Format	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.
Required Readings	*Data Visualization. A practical introduction.* Haley. Available online *A layered grammar of graphics*. Wickham. Available online
Supplementary Readings	*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/