Module Catalogue 2026/2027 – DSAI Module Exchange

Module 1

Institution: University of Zurich

Title: Systems for Data Science

Part of the following degree programme: Master of Science UZH in Informatics

ECTS: 6

Takes place in: Spring Term 2027

Lecturer: Sven Helmer

Language: English

Short Description: Data-driven decisions are changing the way organizations and science operate. Many methods which were infeasible a couple of decades ago, can now be leveraged due to increasingly available large amounts of data. Processing this kind of data, though, is not just difficult because of its sheer size, but also because it is generated ever more rapidly, exhibits a more complex structure, and is often noisy. In this course, we look at the backend part of data science, i.e., what kind of technology and systems do we need to process and store huge amounts of data efficiently and in a scalable way. On the one hand, we look at principles underlying distributed systems in general; on the other hand, we also investigate the functionality of concrete systems. The latter part is enhanced by practical (programming) exercises, in which we take a closer look at the architecture of these systems and the programming models they employ.

Learning Goals: Learn the general principles underlying distributed systems. Learn to process large amounts of data with massive parallel computations systems and understand their architecture and programming models. Learn about data processing and storage in these systems. Learn how to apply this knowledge in practical exercises using well-known systems (e.g. Apache Spark).

Maximum participants from Module Exchange: 10

Asynchronous or Synchronous: Asynchronous – students can follow the course content independently and flexibly, without needing to attend live sessions.

Assessment format: Written exam, on-site proctoring is required.

Examination date: to be announced

Grading System: Graded

Link: Module Systems for Data Science (L+E) 03SM22MI0030 - UZH Course Catalogue

Module 2

Institution: University of Zurich

Title: Interdisciplinary Introduction to Machine Learning – Theory

Part of the following degree programme: Master Level: Minor Digital Skills

ECTS: 3

Takes place in: Autumn Term 2026 and Spring Term 2027

Lecturer: Tilmann Altwicker, Markus Christen, Karsten Donnay, Manuel Günther, Sonja Hartnack, Ulrike Held, Giacomo Indiveri, Lena Ann Jäger, Michael Krauthammer, Titus Mangham-Neupert, Thomas Schlag, Claudio Tessone

Language: English

Short Description: This course on machine learning is designed to provide a comprehensive understanding from a multi-disciplinary perspective. Throughout the course, we will delve into the algorithms and techniques that constitute machine learning, while also considering its applications and limitations across various fields - Medicine, Law, Linguistics, Physical Sciences, and Robotics, to name a few. The aim is to equip students with the knowledge to critically assess the suitability of machine learning solutions for different types of challenges. By the end of this course, students should have a nuanced understanding of machine learning's capabilities and restrictions, informed by examples across multiple sectors.

Learning Goals: After passing the module, the students are able to: name fundamentals about functionality and limitations of both supervised and unsupervised machine learning algorithms; list different data types and problem types, such as classification and regression, and match them to the appropriate algorithms; discuss about the vulnerability of and adversarial attacks on machine learning algorithms; give an overview about the wide variety of applications of ML across many disciplines as well as discipline-specific challenges; reflect on machine learning, the promise of artificial intelligence, and big data from a legal, ethical, as well as philosophical perspective.

Maximum participants from Module Exchange: Unlimited

Asynchronous or Synchronous: Asynchronous – students can follow the course content independently and flexibly, without needing to attend live sessions.

Assessment format: Remote online exam (KPRIM, Single Choice, Drag'n'Drop, and open questions), no proctoring required.

Examination date: to be announced

Grading System: Pass/Fail

Link: Module Interdisciplinary Introduction to Machine Learning - Theory 10SMSTS-201 - UZH Course Catalogue

Module 3

Institution: University of Helsinki

Title: MOOC: AI in Society

Part of the following degree programme: This MOOC was co-developed by: University of Edinburgh, Helsingin yliopisto/Helsingfors universitet, Universidad Complutense de Madrid, and Université Paris 1 Panthéon-Sorbonne and is co-funded by the Erasmus+ Program of the European Union.

ECTS: can be booked either as 2 ECTS (covering chapters 1-4) or 3 ECTS (covering chapters 1-6) module

Takes place in: Autumn Term 2026 and Spring Term 2027

Lecturer: Online self-study environment

Language: English

Short Description: As Data Science and AI create many opportunities in all dimensions of our daily lives, they also pose new legal, ethical and political challenges. Our MOOC will respond to the increasing need for more public awareness and understanding of AI. The MOOC supports learners to engage critically with the basics of AI and its related ethical issues, as well as its impacts on different sectors of society - including justice and jurisprudence, health care, and democratic participation. The MOOC examines how society could address these issues, and how the societal impact and relevant values can be taken into account in design, implementation, and deployment of AI.

Learning Goals: This MOOC will give students 1. a basic understanding of various ethical and social aspects of AI, at the levels of social interaction and society as a whole 2. a necessary conceptual framework and cognitive tools to position AI applications in their social contexts and to assess their societal impact 3. an awareness and the ability to prevent potentially unwanted consequences and make deliberate choices in value-laden contexts while developing AI applications.

Maximum participants from Module Exchange: Unlimited

Asynchronous or Synchronous: Asynchronous – students can follow the course content independently and flexibly, without needing to attend live sessions.

Assessment format: Exercises (doing 90% of all exercises and getting 80% of the exercises right) and a written exam, on-site proctoring is required.

Examination date: to be announced

Grading System: Pass/Fail

Link: https://www.una-europa.eu/study/mooc-ai-society#content

Module 4

Institution: University of Helsinki

Title: MOOC: Computational Affective Modelling

Part of the following degree programme: Master's Program in Data Science

ECTS: 2+3

Takes place in: Autumn Term 2026 and Spring Term 2027

Lecturer: Aapo Hyvärinen

Language: English

Short Description: This course presents an introduction to modelling of affective phenomena. It has a particular focus on theories of human suffering, or mental pain. The basic premise is that we can use the modern theory of artificial intelligence (AI) to model and understand human suffering or mental pain. Both humans and sophisticated AI agents process information about the world in order to achieve goals and obtain rewards, which is why AI can be used as a model of the human brain and mind, and this includes affective phenomena. This course intends to make the theory accessible to a relatively general audience, requiring only some relevant scientific background (see prerequisites); it is based on the e-book available at https://www.cs.helsinki.fi/u/ahyvarin/painintl/ . Part I begins with the fundamental assumption that human suffering is mainly caused by frustration. Frustration means the failure of an agent (whether AI or human) to achieve a goal or a reward it wanted or expected. Frustration is inevitable because of the overwhelming complexity of the world, limited computational resources, and scarcity of good data. The concept of threat, related to risk and fear, provides a complementary approach to modelling suffering. Fundamental in such modelling is the idea of learning, or adaptation to the environment. While AI uses machine learning, humans and animals adapt by a combination of evolutionary mechanisms and ordinary learning. Another important concept here is the dual-process nature of human cognition: the division into logical-symbolic and neural-network information processing. Part II explores in more detail various aspects and limitations of intelligent agents and learning algorithms, and the implications of such limitations regarding suffering. In particular, such limitations imply that an agent acting in the real world must cope with uncontrollability, unpredictability, and uncertainty, which all lead to frustration. In the end, the computational theory is used to derive various interventions that should reduce suffering in humans. The amount of frustration is expressed by a simple equation which indicates how it can be reduced. The ensuing interventions are very similar to those proposed by Buddhist and Stoic philosophy, and include mindfulness meditation.

Learning Goals: After Part I of the course, the student - has become acquainted the basic concept of modelling affective phenomena, such as suffering, using the theory of autonomous agents and machine learning - understands the importance of frustration in modelling human suffering, and

how it can be modelled in an AI agent - understands how threat and risk can be modelled in a probabilistic AI framework - understands the idea of dual processing in a cognitive system and its implications for action selection and affective phenomena After Part II of the course, the student additionally - understands how limitations in information-processing capacity and the amount of data used in learning are related to affective phenomena - In particular, is able to discuss the implications of uncertainty and uncontrollability in agent design, and their relation to affective phenomena and emotions - has a general understanding of how interventions can be designed to reduce negative affect - has the expertise necessary to use these ideas and theories in areas such as HCI, computational neuroscience, or safe AI.

Maximum participants from Module Exchange: unlimited

Asynchronous or Synchronous: Asynchronous – students can follow the course content independently and flexibly, without needing to attend live sessions.

Assessment format: MOOC exercises and a remote, proctored exam on Moodle

Examination date: to be announced

Grading System: pass/fail

Link: https://studies.helsinki.fi/courses/course-unit/otm-d655b0f6-5c8a-49bd-a9b8-a0ba4daf36d3/DATA20060?cpId=hy-lv-77

Module 5

Institution: University of Helsinki

Title: Engineering of Machine Learning Systems

Part of the following degree programme: Master's Programme in Data Science

ECTS: 5 ECTS

Takes place in: Autumn Term 2026

Lecturer: Jukka Nurminen

Language: English

Short Description: Learn the state-of-the-art challenges, practices and tools for engineering of ML systems; Prerequisites: Basics of machine learning, basic programming skills; Topics covered Why study MLOps? MLOps pipelines, iterative workflow Data management (validation, feature stores, ...) (Re)Training Testing and validation Deploying Serving Monitoring Addressed Concerns Non-functional properties of ML systems (fault tolerance, robustness, accuracy, ...) Cost/resource efficiency Cloud vs. EdgeAI Big data in ML / Distributed computing platforms (Spark, ...) ?

Learning Goals: Compare the difference between developing ML systems with classical software. Outline ML workflow and its relationship to real-world use cases. Explaining the anatomy of MLOps pipeline and the role of its elements. Apply MLOps pipeline for an ML model-based system.

Maximum participants from Module Exchange: unlimited

Asynchronous or Synchronous: Synchronous – students must attend live sessions at scheduled times

Assessment format: Weekly exercises / Project ; Experiment with ML pipeline ; Learning diary: what is different in ML from classical

Examination date: no examination date

Grading System: graded

Link: https://studies.helsinki.fi/courses/course-unit/otm-995b4379-d234-4c64-bcf7-9981fc39ddfd/DATA11008?cpId=hy-lv-76

Module 6

Institution: University of Bologna

Title: Supervised Statistical Learning

Part of the following degree programme: Second cycle degree programme (LM) in Statistical Sciences

ECTS: 6

Takes place in: Spring Term 2027

Lecturer: Laura Anderlucci

Language: English

Short Description: Part 0: Introduction to Supervised Statistical Learning**,** Part 1: Resampling methods Cross-Validation, Part 2: Classification Naive Bayes k-Nearest Neighbours Logistic Regression Linear Discriminant Analysis, Part 3: Dimension Reduction and Regularisation, Part 4: Tree-based methods Regression and Classification trees Bagging; Random Forests; Boosting, Part 5: Visualizing classification results

Learning Goals: By the end of the course the student knows the fundamentals of the most important multivariate techniques to build supervised statistical models for predicting or estimating an output based on one or more inputs. The student is able to represent and organize knowledge about large-scale data collections, and to turn data into actionable knowledge.

Maximum participants from Module Exchange: 10

Asynchronous or Synchronous: Synchronous – students must attend live sessions at scheduled times via Teams

Assessment format: The learning assessment is composed by a **written/practical test.** The exam consists of 5-10 questions, both multiple choice and open, some of which to be solved in R. The final grade is out of thirty. During the written exam, students can only use the cheat sheet that is provided on virtuale.unibo.it, containing references to R packages and functions. Students cannot make use of the textbook, personal notes, artificial intelligence tools nor mobile phones (smart watch or similar electronic data storage or communication devices are not allowed either and must be switched off before taking the exam). **Exams can only be taken during official sessions. No exceptions**.

Examination date: TBA

Grading System: Graded

Link: https://www.unibo.it/it/studiare/insegnamenti-competenze-trasversali-moocs/insegnamenti/insegnamento/2025/454551

Module 7

Institution: University of Bologna

Title: Big Data and Analytics

Part of the following degree programme: Statistics, Economics and Business

ECTS: 10

Takes place in: Spring Term 2027

Lecturer: Matteo Farnè

Language: English

Short Description:

Introduction to Supervised Statistical Learning

Resampling methods:

- Cross-Validation
- Bootstrap

Classification:

- Naive Bayes
- k-Nearest Neighbours
- Logistic Regression
- Linear Discriminant Analysis

Dimension Reduction:

- Principal Component Analysis
- Principal Component Regression and Partial Least Squares
- Factor model: definition and estimation
- Clustering using R software

Regularisation:

- Lasso and Ridge Regression

Smoothing methods in R software

Tree-based methods

- Regression and Classification trees
- Bagging; Random Forests; Boosting

Machine learning methods

- Support Vector Machines
- Neural Networks

Learning Goals: Aim of the course is to learn the fundamentals of the most important multivariate techniques that help to make intelligent use of large data base by recognizing patterns for predicting or estimating an output based on one or more inputs. At the end of the course the student is able; - to represent and organize knowledge about big data collections; - to turn data into actionable knowledge; - to choose the best suited methodology for the problem at hand to critically interpret the results.

Maximum participants from Module Exchange: 10

Asynchronous or Synchronous: Synchronous – students must attend live sessions at scheduled times via Teams

Assessment format: The learning assessment will be by a written test lasting between 60 and 90 minutes. The test will be composed of theoretical and practical questions, aimed at assessing the student's knowledge of explained statistical methods and the student's ability to perform statistical analyses and to interpret the resulting outputs in R Studio. The final grade is out of thirty. During the written exam, students can only use the cheat sheet that is provided on virtuale.unibo.it, containing references to R packages and functions. Students cannot make use of the textbook, personal notes and mobile phones (smart watch or similar electronic data storage or communication devices are not allowed either). Students that, despite having passed the exam, do not feel represented by the obtained result can ask to have an additional (optional) oral exam that can change the grade by +/-3 points.

Examination date: to be announced

Grading System: graded

Link: https://www.unibo.it/en/study/course-units-transferable-skills-moocs/course-unit-catalogue/course-unit/2025/529406

Module 8

Institution: University of Bologna

Title: Modern Statistics and Big Data Analytics

Part of the following degree programme: Master's in Statistical Sciences

ECTS: 10 ECTS

Takes place in: Autumn Term 2026

Lecturer: Christian Martin Hennig

Language: English

Short Description: Cluster analysis: k-means, construction of distances, hierarchical clustering, partitioning around medoids, average silhouette width, mixture models, with algorithms, R-coding, theory, applications and in-depth discussion; advances techniques of cluster analysis; outlook on big data issues

Robust statistics: Influence function, breakdown point, robust estimation of univariate and multivariate location and scale and regression, with algorithms, R-coding, theory, applications and in-depth discussion

Learning Goals: By the end of the course, the student gains an understanding of theory and computing of modern statistical methods, with particular emphasis on methods for analysing large amounts of data (big data). More specifically, the student acquires knowledge on the most important methods of statistical learning and prediction and the skills required to solve real-world and decision-making problems.

Maximum participants from Module Exchange: 10

Asynchronous or Synchronous: Synchronous – students must attend live sessions at scheduled times via Teams

Assessment format: The assessment will be a 3 hours exam comprising of a theoretical exercise, a data analysis project, and an exercise that asks questions interpreting the given output of another data analysis. Aspects examined here are understanding of the theoretical background, the ability to apply methodology learnt in the course to a real dataset, and the ability to understand and draw practically relevant conclusions from the computer output of such methodology. Written material including course slides can be used in the exam. 5/30 bonus marks are assigned to regular homework activity (homework needs to be done but not necessarily correctly; students can work in groups if they choose to do so); they will count on top of the marks achieved in the written exam and

the literature question as long as these are below 30. A 30L is achieved by either having at least 32 marks including homework bonus, or by having all 30 marks in literature question and exam alone.

Examination date: to be announced

Grading System: graded

Link: https://www.unibo.it/it/studiare/insegnamenti-competenze-trasversali-moocs/insegnamenti/insegnamento/2025/444072

Module 9

Institution: University of Bologna

Title: Machine Learning and Data Mining

Part of the following degree programme: Second cycle degree programme (LM) in Computer Engineering

ECTS: 8 ECTS

Takes place in: Autumn Term 2026

Lecturer: Claudio Sartori

Language: English

Short Description:

Part 1 - Data Mining

- Introduction to the Data Mining Process
- Architectures of systems with data mining components
- Enterprise Data Warehouse
- Data Lake
- Case studies

Part 2 - Machine Learning

- What is Machine Learning: some history and motivating examples
- Theory of learning
- Supervised vs unsupervised learning
- Classification and regression
- Model Selection, validation and presentation of results
- Regression
- Classification with linear discrimination, decision trees, Bayesian inference, Support Vector Machines, k-nearest neighbors, logistic regression, random forests, adaboost

- Ensemble learning, boosting, bagging
- Association rules and the Apriori algorithm
- Clustering/segmentation with k-means, dbscan, Expectation Maximization, hierarchical methods, kernel methods
- Analysis of case studies
- CRISP-DM methodology

Pre-requisites

- Fundamentals of programming
- Fundamentals of calculus and linear algebra
- Fundamentals of statistics and probabilities
- Useful some general notion on Data Base Management Systems

Learning Goals: At the end of the course the student knows and understands: - the motivation and the components of the Data Mining process; - the general concepts, technologies and methodologies of Data Warehouse, OLAP and Data Lake, as enabling factors of the Data Mining process; - the principles and the most relevant use cases of a wide set of Machine Learning algorithms which are used to extract relevant and actionable information from large amounts of data. At the end of the course the student is able to: - design the main steps of a Data Mining process - choose the Machine Learning methods best suited for the process - evaluate the quality of the result in order to support strategic and operational decisions.

Maximum participants from Module Exchange: 10

Asynchronous or Synchronous: Synchronous – students must attend live sessions at scheduled times via Teams

Assessment format: The Verification of knowledge is tested through multiple choice questions. The minimum to pass is to answer correctly half + 1 of the questions. The weight of this part is 33%. The Verification of abilities will be tested in lab with the development of a program for the execution of a Machine Learning task on an assigned data set. The quality of the solution will be evaluated on the basis of the correctness of the approach, the correctness of the solution, the quality of the coding and of the documentation. The minimum to pass is to give a sensible approach and a reasonable coding. The weight of this part is 67% It is also possible, on request, to have an oral examination, with possible outcomes between -3="no answer" and +3="correct answer", to be added to the weighted sum of the above-mentioned scores. Additional details on Assessment are available in the

course page on https://virtuale.unibo.it [https://virtuale.unibo.it/] For the students of Machine Learning and Deep Learning (i.c.) the registration will be executed only after passing the Deep Learning module.

Examination date: to be announced

Grading System: graded

Link: https://www.unibo.it/en/study/course-units-transferable-skills-moocs/course-unit-catalogue/course-unit/2025/502283

Module 10

Institution: University of Bologna

Title: Matrix Tensor Techniques for Data Science

Part of the following degree programme: Master's Programme in Mathematics

ECTS: 6

Takes place in: Autumn Term 2026

Lecturer: Davide Palitta

Language: English

Short Description:

* Vector and matrix norms (including sparsity promoting)

* Mathematical foundations and algorithms for:

- Eigenvalues, SVD, pseudoinverse
- Linear regression and Least squares, also iterative solution

* Reduction and low rank representations:

- Principal Component Analysis (PCA)
- Sparse representation with l_0-norm: Orthogonal matching pursuit
- CUR factorization
- Nonnegative matrix factorization

* Applications in Data Science

- Matrix completion problems
- Dictionary learning

* Tensor computation

- Dealing with tensors and various representations: CPD, Tucker, TT
- HOSVD, Tensor OMP

* Elements of randomized numerical linear algebra:

- Randomized Range Finder and Randomized SVD
- Oblivious subspace embeddings

- The sketch-and-solve paradigm

Learning Goals: At the end of the course, students have theoretical and computational knowledge on matrix and tensor techniques for analysing large amounts of data. In particular, students are able to examine large samples of discrete data and extract interpretable information of relevance in image and data processing, in medical and scientific applications, and in social and security sciences.

Maximum participants from Module Exchange: 10

Asynchronous or Synchronous: Synchronous – students must attend live sessions at scheduled times via Teams

Assessment format: Final take home project with slides presentation and oral discussion on the course material. Students with learning disorders and\or temporary or permanent disabilities: please, contact the office responsible (https://site.unibo.it/studenti-con-disabilita-e-dsa/en/for-students) as soon as possible so that they can propose acceptable adjustments. The request for adaptation must be submitted in advance (15 days before the exam date) to the lecturer, who will assess the appropriateness of the adjustments, taking into account the teaching objectives.

Examination date: to be announced

Grading System: graded

Link: https://www.unibo.it/en/study/course-units-transferable-skills-moocs/course-unit-catalogue/course-unit/2025/517794

Module 11

Institution: University of Bologna

Title: Data Science for Lawyers

Part of the following degree programme: Master's in Legal Studies

ECTS: 6

Takes place in: Autumn Term 2026

Lecturer: Monica Palmirani

Language: English

Short Description: The course is included in the Jean Monnet Module programme LEDS4XAIL [https://site.unibo.it/leds4xail] . It wants to cope with the following goals: 1. to provide the knowledge of the technical and legal definitions related to the Artificial Intelligence, data analytics, big data, open data, open government data and connected policies; 2. to analyse the normative framework related to the AI Act and Data Governance (GAIA-X, EU regulation, GDPR, FOIA, PSI II, Licenses, Copyright Directive, DGA,DA, DSA); 3. to familiarize with some technical instruments for AI and data analytics as R, KNIME, Phyton for understanding the main principles; 4. to design an AI and data science project with legal data with an interdisciplinary methodology; 5. to analyse data science results under the quantitative and qualitative points of view; 6. to evaluate the explicability of the AI results (XAI and YAI); 7. to make an ethics evaluation of the AI models and Data Analytics methods in order to discover biases or other issues that could affect the human rights.

Learning Goals: At the end of the course, the student has the knowledge, competencies and skills to read and understand a quantitative and qualitative analysis of data manipulations with NLP and AI from activities related to the world of law (eg, judgments, justice statistics, legislation, administrative acts) in order to improve their legal profession. He/she is able to understand the data sources, to evaluate their completeness and consistency, as well as the quality in order to create an autonomous and argued opinion. He/she can analyze datasets in the light of data regulation (protection of personal data, licenses, competition, public law) and identify the legal issues to be addressed (anonymization, pseudo-anonymization, encryption).

Finally the data are manipulated using artificial intelligence techniques (e.g., Machine Learning, Generative AI, NLP), applied to the legal context that makes use of big data. In this way the student can understand how the datasets contribute to the final outcome of AI in order to provide a reasonable explanation of the conclusions. The student is encouraged to discover any cognitive biases introduced in the data and AI that could cause discrimination or in general regulatory violations and ethical criticalities.

Maximum participants from Module Exchange: 10

Asynchronous or Synchronous: Synchronous – students must attend live sessions at scheduled times via Teams

Assessment format: The exam requires you to design, implement, document (10 pages) a data-driven project using the competences acquired including the management of some software. The project includes: 1. legal analysis; 2. ethics analysis; 3. technical analysis of AI methods and Data analytics models; 4. visualization of the results; 5. argumentation of the results. The project could be carried out in groups of up to three people. The project must be presented orally with the possibility of discussing the theoretical part as well. Students with learning disorders and/or temporary or permanent disabilities: please contact the office responsible (https://site.unibo.it/studenti-con-disabilita-e-dsa/en/for-students) as soon as possible so that they can propose acceptable adjustments. The request for adaptation must be submitted in advance (15 days before the exam date) to the lecturer, who will assess the appropriateness of the adjustments, taking into account the teaching objectives.

Examination date: to be announced

Grading System: graded

Link: https://www.unibo.it/it/studiare/insegnamenti-competenze-trasversali-moocs/insegnamenti/insegnamento/2025/530585

Module 12

Institution: Complutense University of Madrid

Title: Big Data Management

Part of the following degree programme: Master's Degree in Internet of Things

ECTS: 6 ECTS

Takes place in: Autumn Term 2026

Lecturer: Pablo Cerro Cañizares

Language: Spanish

Short Description: Big Data Management is a 6-ECTS first-year course in the Master's Degree in Internet of Things at UCM. It introduces students to the foundations of Big Data, including NoSQL databases, distributed computing with tools such as Dask and Spark, cloud-based data architectures, data preprocessing and descriptive statistics, and core machine learning methods, including supervised, unsupervised, and hyperparameter optimization techniques.

Learning Goals: Introduction to Big Data. Storage: NoSQL databases Distributed computing (Dask, Spark) Data preprocessing and descriptive statistics Machine Learning models Supervised learning Hiperparameter optimization Unsupervised learning

Maximum participants from Module Exchange: 3

Asynchronous or Synchronous: Synchronous – students must attend live sessions at scheduled times

Assessment format: Laboratory practical work (80%). The practical component will be organized into several submissions, and attendance in class may be required for some of them. These may also include review quizzes on the material covered up to that point. * Other activities (20%): Public presentation of a project. For the resit examination period, a different practical assignment will be proposed, but the assessment scheme remains the same, including the public presentation (20% of the final grade).

Examination date: -

Grading System: graded

Link: https://web.fdi.ucm.es/UCMFiles/pdf/FICHAS_DOCENTES/2025/9181.pdf

Module 13

Institution: Complutense University of Madrid

Title: Applied Statistics and Data Mining (Estadística Aplicada y Minería de Datos)

Part of the following degree programme: Master's Degree in Mathematical Engineering

ECTS: 9 ECTS

Takes place in: Autumn Term 2026

Lecturer: Daniél Vélez Serrano, Alicia Irusta Tejedor, Carlos Rivero Rodríguez

Language: Spanish

Short Description: Applied Statistics and Data Mining is a 9-ECTS course in the Master's Degree in Mathematical Engineering at UUCM. It provides students with a solid foundation in statistical data analysis and predictive modelling, covering time series, data preprocessing, dimensionality reduction, clustering, classification, regression, decision trees, neural networks, and ensemble methods. The course combines theoretical instruction with hands-on computer labs using SAS, R, and Python, with a strong emphasis on the practical application and interpretation of supervised and unsupervised analytical methods.

Learning Goals: TOPIC 1. Programming in SAS TOPIC 2. Time Series Modelling TOPIC 3. Analytical modelling methodology: descriptive analysis, sampling techniques, data processing (missing-value imputation and outlier treatment), and validation metrics for results TOPIC 4. Unsupervised modelling: Principal Component Analysis, Correspondence Analysis, Cluster Analysis (Clustering) TOPIC 5. Supervised modelling: Discriminant Analysis, Advanced Regression Methods, Decision Trees, Neural Networks, and Model Ensemble Methods (bagging, random forest, boosting, stacking)

Maximum participants from Module Exchange: 3

Asynchronous or Synchronous: Synchronous – students must attend live sessions at scheduled times

Assessment format: -Attendance: 10% - The content corresponding to Topic 2 will be assessed through a practical assignment accounting for 30% of the overall course grade. - The content corresponding to Topic 4 will be assessed through a practical assignment accounting for 30% of the overall course grade. - The content corresponding to Topic 5 will be assessed through a practical assignment accounting for 30% of the overall course grade. If any of these three parts is not passed, that part must be retaken in the resit examination period, so the student may be required to complete one, two, or three new practical assignments.

Examination date: -

Grading System: graded

Link: https://matematicas.ucm.es/estudios/2025-26/master-ingenieriamatematica-plan-604330

Module 14

Institution: Complutense University of Madrid

Title: Neural Networks and Parallel Computing

Part of the following degree programme: Master's Degree in Mathematical Engineering

ECTS: 3 ECTS

Takes place in: Spring Term 2027

Lecturer: Benjamin Ivorra & Valeriy Makarov

Language: Spanish

Short Description: Students will be introduced to various parallel programming techniques that make it possible to solve certain numerical methods at a lower computational cost than their sequential counterparts. A brief introduction to artificial neural networks will also be provided. Different types of learning and methods for constructing neural networks will be discussed, together with several applications, for example in artificial intelligence. The principles of deep learning will also be addressed. Some concrete examples, inspired by problems with real-world applications, will be taught and implemented through computer lab sessions.

Learning Goals: A) Parallel Computing: Basic notions of computer architecture, Basic notions of parallel programming, Applications to the solution of various numerical methods (linear systems, optimization, etc.), Practical examples (computer lab sessions). B) Neural Networks: Basic concepts: perceptron, neural network Learning in neural networks: delta rule, Hebb's principle, gradient descent methods, Introduction to deep learning and its applications, Unsupervised learning algorithms: autoencoders

Maximum participants from Module Exchange: 3

Asynchronous or Synchronous: Synchronous – students must attend live sessions at scheduled times

Assessment format: Assessment will consist of several practical assignments, accounting for 50% of the final grade, and the submission of reports on the solution of the proposed problems, accounting for the remaining 50% of the course grade.

Examination date: -

Grading System: graded

Link: https://matematicas.ucm.es/estudios/2025-26/master-ingenieriamatematica-plan-604337

Module 15

Institution: Complutense University of Madrid

Title: Prediction techniques (Técnicas de predicción)

Part of the following degree programme: Master's Degree in Mathematical Engineering

ECTS: 3 ECTS

Takes place in: Spring Term 2027

Lecturer: Daniél Vélez Serrano

Language: Spanish

Short Description: The students will learn the foundations and main techniques for the univariate and multivariate analysis of time series, with the aim of forecasting their future behaviour. IMPORTANT PREREQUISITES: Only students who are also enrolled in the module "Applied Statistics and Data Mining" (Estadística Aplicada y Minería de Datos) will be admitted.

Learning Goals: Large-scale fitting of time series, Conditional heteroscedasticity models: ARCH and GARCH, Multivariate models: VARMA models, Error correction models, Cointegration

Maximum participants from Module Exchange: 3

Asynchronous or Synchronous: Synchronous – students must attend live sessions at scheduled times

Assessment format: Two practical assignments will be set, each accounting for 50% of the total course grade. If either part is not passed, that part must be retaken in the resit examination period, so the student may be required to complete one or two new practical assignments.

Examination date: -

Grading System: graded

Link: https://matematicas.ucm.es/estudios/2025-26/master-ingenieriamatematica-plan-604342