COURSE OF STUDY *Physics (LM-17)*

ACADEMIC YEAR *2024-2025*

ACADEMIC SUBJECT *Pattern Recognition*

General information	
Year of the course	2nd
Academic calendar (starting and ending date)	1st semester: September – December 2024
Credits (CFU/ECTS):	6
SSD	FIS/07
Language	English
Mode of attendance	Recommended, not compulsory

Professor/ Lecturer	
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Department and address	Dipartimento Interateneo di Fisica, Via Amendola 173, 70126 Bari (BA)
Virtual room	
Office Hours (and modalities: e.g., by appointment, on line, etc.)	Monday and Friday 10-12 am (on request)

Work schedule			
Hours			
Total	Lectures	Hands-on (laboratory, workshops, working groups, seminars, field trips)	Out-of-class study hours/ Self-study hours
150	40	15	95
CFU/ECTS			
6	5	1	

Learning Objectives	Acquire skills in processing and extracting information from highly complex spatio-temporal signals and images. Acquire skills in the design of predictive models.
Course prerequisites	The course requires: ● a deep knowledge of statistics, linear algebra and probability; ● notions of differential calculus.

Teaching strategies	
Expected learning outcomes in terms of	
Knowledge and understanding on:	o Understanding the scientific method, the nature, and the methods of research in Physics o Knowledge of advanced computer tools commonly used in basic and applied research o Knowledge of complex systems o Basic concepts on data analysis o Big data programming skills o Visualization and presentation of data analysis results o Ability to work in a team.

Applying knowledge and understanding on:	o Ability to use analogy to apply known solutions to new problems (problem solving) o Ability to design and implement experimental or theoretical procedures to solve problems in academic and industrial research or to improve existing results o Ability to use analytical and numerical mathematical computation tools o Ability to use electronic and computer technologies and their application to experimental data acquisition o Modelling databases of real systems o Ability to understand the underlying dynamics of complex systems
Soft skills	● **Making informed judgments and choices** o Ability to work with increasing levels of autonomy, including taking responsibility in project planning and managing facilities o Apply the notions learned in multi-disciplinary contexts o Apply mathematical concepts to real systems ● **Communicating knowledge and understanding** o Competence in communication in Italian and English in advanced fields of Physics o Use of rigorous and precise language o Use of logical arguments ● **Capacities to continue learning** o Acquisition of basic knowledge tools for continuous learning and knowledge updates o Mathematical theory of Machine Learning o Problem-solving strategies o Modelling real systems
Syllabus	
Content knowledge	• Preprocessing and filtering • Image segmentation • Feature Extraction • Classification • Clustering techniques • Elements of Machine Learning • Figures of merit
Texts and readings	● Christopher M. Bishop: Pattern Recognition and Machine Learning ● T. Hastie et al The Elements of Statistical Learning
Notes, additional materials	
Repository	

Assessment	
Assessment methods	Oral examination
Assessment criteria	● **Knowledge and understanding** Consistency of answers according to formulated questions ● **Applying knowledge and understanding** ● Setting up and carrying out numerical examples ● **Autonomy of judgment** ● Consistency with the subject of the program ● **Communicating knowledge and understanding** ● Clarity and precision of presentation ● **Communication skills** ● Ability to identify interconnection between the subjects of study ● **Capacities to continue learning** ● Cross-discipline applications
Final exam and grading criteria	Capability to select and apply descriptive and predictive data analytics methods. Skill to discover trends in analytical data stores using the data mining techniques

	of clustering, association, and decision trees. Adequate comprehension and global knowledge of concepts and arguments at the basis of the machine learning methods described throughout the course.
Further information	
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