UNIVERSITÀ DEGLI STUDI DI BARI ALDO MORO

DIPARTIMENTO INTERUNIVERSITARIO DI FISICA

General information	
Academic subject	Computational Physics
Degree course	Physics
Academic Year	First
European Credit Transfer and Accumulation System (ECTS)	6
Language	English
Academic calendar (starting and ending date)	First week of March – Last week of May
Attendance	Compulsory attendance

Professor/ Lecturer	
Name and Surname	Sebastiano Stramaglia
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Department and address	*Department of Physics, Via Orabona 4, Bari*
Virtual headquarters (Microsoft Teams code)	*j34o0tm*
Tutoring (time and day)	Thursday 11 am

Syllabus	
Learning Objectives	*To acquire abilities in the numerical solutions of differential equations; complex networks analysis; Monte Carlo methods and their applications to Statistical Mechanics models.*
Course prerequisites	*Background knowledge on classical mechanics and statistical physics*
Contents	An introduction to MATLAB Numerical solution of differential equations. Euler's method. Euler-Cauchy method. Verlet method. Applications: Lotka-Volterra model of prey-predator systems, SIR model for the spreading of infections, real pendulum, Foucalt's Pendulum, motion of a planet in the gravitational field of the Sun. Introduction to Complex Networks. Implementation of complex networks models: Erdos networks, Watts-Strogatz model, Barabasi-Albert model. Finding communities in complex networks, Spectral methods and optimization of modularity. Spreading models of informations, ideas and viruses on complex networks. Random walks in two and more dimensions. Self avoiding walks. Diffusion limited aggregation. Random sampling and Monte Carlo method. Monte Carlo Integration: rejection method, importance sampling, filtering techniques. Monte Carlo methods for the simulation of physics phenomena. Markov chain method. Metropolis algorithm. Statistical mechanics ensembles. The case of the two dimensional Ising model of ferromagnets: phase transition and critical exponents. Techniques to assess and extract the statistical features of a physics datasets and comparison with model predictions. Visualisation and graphical representation of datasets and their properties.
Books and bibliography	Rubin Landau, Manuel Paez, Cristian Bordeianu, Computational Physics. --: Wiley-VCH
Additional materials	

Work schedule			
Total	Lectures	Hands on (Laboratory, working groups, seminars,	Out-of-class study hours/

		field trips)	Self-study hours
Hours			
150	0	62	88
ECTS			
6			

Teaching strategy	
	Lectures in the multimedia room. Development of matlab routines beamed on the room screen.

Expected learning outcomes	
Knowledge and understanding on:	the main data analysis techniques and their application to solve concrete physics problems.
Applying knowledge and understanding on:	Capability to apply the main methods to extract information from complex physics datasets. The students will be able to gather, summarise and visualise the statistically relevant features of a dataset; furthermore, they will learn how to qualitatively and critically compare theoretical predictions with the experimental data. Capability to numerically solve differential equations arising in physics and complex systems science.
Soft skills	**Making informed judgments and choices** Knowledge and skills acquired in this course will allow a greater level of autonomy in the evaluation of methodologies to simulate physical systems and to analyze data from Complex Systems. **Transferable Communication skills.** Enable transition from theoretical physical models towards the numerical implementation and analysis of the corresponding simulations. **Lifelong learning skills**. Follow the current progress and further prospects within the area of simulation and analysis of complex systems. Discuss models and methods introduced in the course and assess the reliability of the description by numerical simulations.

Assessment and feedback	
Methods of assessment	Oral exam consisting in a discussion about the reports on the programming activities developed during the course. (100%)
Evaluation criteria	Capability to translate the physical problem in a computer program aiming at highlighting the physical behaviour of the system; capability to analyse data from complex systems. Adequate comprehension and global knowledge of concepts and arguments at the basis of the computational methods described throughout the course.
Criteria for assessment and attribution of the final mark	Oral exam consisting in a discussion about the reports on the programming activities developed during the course. (100%)
Additional information	