Title	Complex Networks: Big Data modelling and learning (SSD FIS/07)
Proponent	Nicola Amoroso
# CFU (1 CFU = 10 hours)	2 CFU
Schedule	10 lessons of two hours.
Brief Summary of the course	The increasing availability of high dimensional and heterogeneous data samples (big data) makes urgent the development of a scientific background including data science and machine learning techniques, with applications in many fields. This course introduces the fundamental concepts in complex networks and exploits this framework for learning purposes. We will cover the most popular network models: random graphs, small-world networks, scale-free networks; besides, we will explore how supervised and unsupervised learning algorithms including random forests, artificial neural networks, support vector machines and deep learning, can proficiently exploit the knowledge content provided by complex networks. After explaining the basic centrality measures for nodal and edge characterization, we will discuss the matrix representation of a graph and the necessary steps for automated learning: hypothesis space, overfitting, bias and variance, trade-offs between representational power and learnability, evaluation strategies and cross-validation. The course will be accompanied by hands-on problem solving with programming in R and some tutorial sessions.
Programme	- Introduction: graph theory. - Different graph models. - Nodal and edge characterization. - Local and global properties. - Community detection. - Learning: Basic definitions, bias, variance and cross-validation. - Supervised Models. - Deep Learning. - Unsupervised models: Clustering. - The use of computational facilities.
Recommended texts	- Latora, Vito, Vincenzo Nicosia, and Giovanni Russo. Complex networks: principles, methods and applications. Cambridge University Press, 2017. - Introduction to Machine Learning - Ethem Alpaydin - MIT Press 2010 - Deep Learning – Ian Goodfellow et al. – MIT Press 2016

Assessment methods	80% Case study 20% Presentation of the results