UNITELMA SAPIENZA
UNIVERSITÀ DEGLI STUDI DI ROMA

COURSE: Artificial economics: simulation and computational methods (SECS-S/06 – CFU: 6)
TEACHER: Rosella Castellano (rosella.castellano@unitelmasapienza.it) **GUEST LECTURER:** Dr. Roeland De Kok
TUTOR: Carlo Cavicchia (carlo.cavicchia@unitelmasapienza.it)

1. KNOWLEDGE AND SKILLS TO BE ACHIEVED DURING THE COURSE

Knowledge and understanding: to carry out calculations with matrices and vectors; to plot basic mathematical functions, to know how to look for the zeroes of a function; to know how to draw an histogram and to implement Monte Carlo simulations; to represent a network through a matrix, to compute the paths on the network; to compute the most common centrality measures; to create random networks; to identify clusters.

Applying knowledge and understanding: to apply random network to economics and social complex problems

Making judgements: to have a comprehensive and critical view of real world networks

Communication skills: to know how to give a proper interpretation of the results and to communicate and represent them to a target audience.

Learning skills: the student is supposed to have passed the basic university exam of calculus to participate in a profitable way to the course; at the end of the course the student is supposed to have acquired and to be able to manage the main tools and issues treated in the course.

2. PROGRAM/ CONTENTS

The goal of this course is to provide the students with a base set of methodological tools useful to face the study of social network. In this respect, the first three topics are devoted to review the mathematical background necessary for a proper understanding of the second part of the program. In particular, we will review some topics related to three different areas of mathematics: linear algebra, functions, statistics and probability.
The second part enters in the details of the complex network analysis, starting from the very beginning and going on step by step toward the most used methods characterizing complex network analysis.
In the following, a more detailed list of the topics is provided.

1) **Linear Algebra**: vector and matrices; operations with vectors and matrices; binary matrices; eigenvalues and eigenvectors (1 CFU)
2) **Functions**: power, exponential and logarithmic functions; axiomatic properties of a distance; iterative methods for determining zeroes of functions: Newton's method; least squares method (1 CFU)
3) **Statistics and probability**: histograms; estimation of the continuous probability starting from a histogram by regression / interpolation; introduction to Monte Carlo methods (1 CFU)
4) **Introduction to complex networks**: an introduction; historical traits and useful softwares; representation of network and clustering coefficients; the Erdös Bacon number, visit of a network; small world and connected components; minimum spanning tree and some centrality measures; centrality measures and structure of networks (1 CFU)
5) **Networks with specific topologies**: network topology; Erdös-Rényi and Wattts-Strogatz networks; replicating properties of real world networks, the Barabasi and Albert model; assortativity and beyond; diffusion of networks (1 CFU).
6) **Communities and advanced topics:** epidemic spreading, immunization and forecast; K-core and k-shells, community detections, advanced topics, case studies (1 CFU).

3. TEXT BOOKS

Teaching notes available on the moodle page .

4. EDUCATIONAL METHOD AND TOOLS

Video lessons;
Reading material;
Forum;
Summary questions and Auto evaluation tests.

5. SELF-ASSESMENT PROCEDURES

Summary questions and Auto evaluation tests.
Development and analysis of a case study.

6. EVALUATION METHODS (FINAL EXAM)

Oral discussion of a case study whose topic must be agreed with the teacher.
The case study must be presented in the form of a short dissertation.

7. AREAS OF APPLICATION OF ACQUIRED KNOWLEDGE

Social networks, innovation network, economics and finance.