

Academic Year: ( 2022 / 2023 )

Review date: 29-04-2022

Department assigned to the subject: Mathematics Department

Coordinating teacher: CUERNO REJADO, RODOLFO

Type: Electives ECTS Credits : 6.0

Year : 4 Semester :

**REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)**

Linear Algebra; Probability I and II; Programming I and II.

**OBJECTIVES**

- Acquisition of knowledge and skills that provide with a background of creativity in the development and application of ideas, often within a research context.
- Ability to apply acquired knowledge and to solve problems under novel or almost novel situations or within broader (multidisciplinary) contexts related with big data.
- Acquisition of skills for learning in an autonomous and continuous manner.
- Ability to apply the theoretical foundation of collect, storage, processing and presentation of information, especially for big data volumes.
- Ability to identify the most suitable data analysis technique in each problem, and to apply it for obtaining the most appropriate solution to each one.
- Ability to obtain practical and efficient solution for processing of big data volumes.
- Skill to synthesize data analysis conclusions, and to communicate it clearly and convincingly in a bilingual environment.
- Ability to generate new ideas and to anticipate new situations, within the context of data analysis and decision making.
- Skill to working collaboratively and to collaborate with others autonomously.
- Skill to design data processing systems, from the data gathering to statistical analysis and presentation of final results.
- Ability to apply the basic principles of network science and apply them to the study of different data to model and forecast their behavior using features extracted from network science.
- Ability to design effective visualizations of large data sets that can lead to the discover, interpretation and access to those datasets..
- Ability to identify the opportunity to apply network science and visualization techniques for solving real problems.
- Basic knowledge about network science techniques.
- Understanding of basic network science techniques.
- Making practical use of network science techniques in real problems.
- Basic knowledge of data visualization techniques.
- Ability to use visualization techniques to explain and solve real problems.

**DESCRIPTION OF CONTENTS: PROGRAMME****1 - Graphs**

- 1.1 - Graph theory, historical introduction, and examples
- 1.2 - Directed and weighted graphs; bipartite graphs; adjacency matrix
- 1.3 - Degree, mean degree, and degree distribution
- 1.4 - Topological concept on graphs: distance, minimal connecting path, diameter
- 1.5 - Centrality measures; cliques, motifs, and communities
- 1.6 - Types of networks: random, small-world, scale-free

**2 - Social networks**

- 2.1 - Definition and context
- 2.2 - Local and global properties of social networks
- 2.3 - Comparison with other networks
- 2.4 - Social mechanisms
- 2.5 - Applications of social networks

**3 - Graph/social network analysis**

- 3.1 - Creating a graph
- 3.2 - Graph analysis
- 3.3 - Graph simulation
- 3.4 - Statistical tests
- 3.5 - Practical examples
- 4. Practical examples of graph analysis
  - 4.1 Link prediction: application to friend recommendation
  - 4.2 Epidemic models in networks
  - 4.3 Build, analyze and visualize information networks
  - 4.4 Analysis and visualization of dynamic networks
- 5. Introduction to data visualization
  - 5.1 Data types and sources
  - 5.2 Main tools to visualize data
  - 5.3 Data reduction techniques
  - 5.4 Static and dynamic data visualization
  - 5.5 Graph data
  - 5.6 Practical examples

#### LEARNING ACTIVITIES AND METHODOLOGY

The course is imparted in specific rooms and computer rooms. It will include:

- Lectures for the presentation, development, and analysis of the contents of the course.
- Practical sessions for the resolution of individual problems and practical projects in computer rooms.
- Seminars for discussion with reduced groups of students or on an individual basis.

#### ASSESSMENT SYSTEM

Continuous evaluation: Participation during the classes and homework assignments to be done individually or in groups: 40%

Final exam: 60%

<b>% end-of-term-examination:</b>	60
<b>% of continuous assessment (assignments, laboratory, practicals...):</b>	40

#### BASIC BIBLIOGRAPHY

- A-L Barabasi Network science, Cambridge University Press, 2016
- E. Tufte The Visual Display of Quantitative Information, Graphic Press, 2001
- Rafe Donahue Fundamental Statistical Concepts in Presenting Data,  
[http://biostat.mc.vanderbilt.edu/wiki/pub/Main/RafeDonahue/fscipdpfcbg\\_currentversion.pdf](http://biostat.mc.vanderbilt.edu/wiki/pub/Main/RafeDonahue/fscipdpfcbg_currentversion.pdf), 2011

#### ADDITIONAL BIBLIOGRAPHY

- Alberto Cairo The Truthful Art: Data, Charts, and Maps for Communication, New Riders, 2016
- Douglas A. Luke A User's Guide to Network Analysis in R, Springer, 2015
- Maarten van Steen Graph Theory and Complex Networks: An Introduction, ISBN: 978-90-815406-1-2, 2010
- Nathan Yau Visualize This, John Wiley & Sons, 2011