Graphs and Social networks

Academic Year: (2024 / 2025) **Review date: 30-03-2024**

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 an dynamic data visualization
5.5 Graph data
5.6 Prtactical 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

% end-of-term-examination:	60
% of continuous assessment (assigments, laboratory, practicals…):	40

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

Final exam: 60%

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, 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