Network Analysis

Academic Year: (2024 / 2025) **Review date: 17-04-2024**

Department assigned to the subject: Statistics Department

Coordinating teacher: GALEANO SAN MIGUEL, PEDRO

Type: Electives ECTS Credits : 3.0

Year : 1 Semester : 2

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Mathematics for Data Science
Probability
Statistical Inference
Programming in R
Numerical Methods for Data Science
Multivariate Statistics

OBJECTIVES

The basic objectives of the subject are:

1. Understand the basics of networks, graphs, and families of graphs. Learn the concept of adjacency matrices and their significance.
2. Network Visualization:
Gain proficiency in designing and visualizing networks.
Explore techniques for decorating and handling large networks.
3. Descriptive Analysis of Networks:
Analyze network structures through vertex and edge characteristics.
Identify influential vertices, assess cohesion, detect communities, and understand assortativity.
Explore real-world applications of network analysis.
4. Models and Inference for Networks:
Familiarize with classical and generalized models for network representation.
Study small world models and their applications.
5. Prediction in Networks:
Learn methods for predicting network interactions using nearest neighbor approaches.
Explore alternative prediction methods in network contexts.

DESCRIPTION OF CONTENTS: PROGRAMME

1. Introduction and preliminaries.
   1.1 Introduction.
   1.2 Examples of networks.
   1.3 Graphs.
   1.4 Families of graphs.
   1.5 The adjacency matrix.
2. Network visualization.
   2.1 Introduction.
   2.2 Network design.
   2.3 Decorating networks.
   2.4 Large networks.
3. Descriptive analysis of networks.
   3.1 Introduction.
   3.2 Characteristics of vertices: centrality, influencers, ...
   3.3 Characteristics of the edges: centrality.
   3.4 Cohesion of networks.

3.5 Detection of communities in networks.
3.6 Assortativity.
3.7 Applications.
4. Models and inference for networks.
4.1 Introduction.
4.2 Classical models.
4.3 Generalized models.
4.4 Small world models.
4.5 Applications.
5. Prediction in networks.
5.1 Introduction.
5.2 Methods of nearest neighbors.
5.3 Alternatives.

LEARNING ACTIVITIES AND METHODOLOGY

Learning activities:

Theoretical classes
Practical classes
Tutorials
Team work
Individual work of the student
In-person evaluation tests

Methodology to be used:

Theoretical classes with support material available on the Web.
Problem solving classes. Computational practices in computer rooms. Oral exhibitions

Tutorial regime:

Individual tutorials throughout the course.

ASSESSMENT SYSTEM

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

Group assignments and presentations in class (60%)
Final test (40%)

Extraordinary evaluation similar to the ordinary evaluation.

BASIC BIBLIOGRAPHY

- Albert László Barabási Network Science, Cambridge University Press, 2016

- Erci D. Kolaczyk Statistical Analysis of Network Data, Springer, 2009