Course guide
230375 - GSP - Graph Signal Processing

Last modified: 24/05/2024

Unit in charge: Barcelona School of Telecommunications Engineering
Teaching unit: 739 - TSC - Department of Signal Theory and Communications.

Degree: MASTER'S DEGREE IN TELECOMMUNICATIONS ENGINEERING (Syllabus 2013). (Optional subject).
MASTER'S DEGREE IN ADVANCED TELECOMMUNICATION TECHNOLOGIES (Syllabus 2019). (Optional subject).

Academic year: 2024 **ECTS Credits:** 3.0 **Languages:** English

LECTURER

Coordinating lecturer: ALBA MARIA PAGES ZAMORA

Others: Segon quadrimestre:
ALBA MARIA PAGES ZAMORA - 31

PRIOR SKILLS

Basic knowledge of matrix analysis, Fourier transform, and signal filtering.
Basic Matlab programming skills.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CE1. Ability to apply information theory methods, adaptive modulation and channel coding, as well as advanced techniques of digital signal processing to communication and audiovisual systems.

Transversal:
CT4. EFFECTIVE USE OF INFORMATION RESOURCES: Managing the acquisition, structuring, analysis and display of data and information in the chosen area of specialisation and critically assessing the results obtained.

CT5. FOREIGN LANGUAGE: Achieving a level of spoken and written proficiency in a foreign language, preferably English, that meets the needs of the profession and the labour market.

TEACHING METHODOLOGY

- Theoretical lectures.
- Practical individual sessions in Matlab, and presentation of proposed problems.
- Practical sessions in groups and presentation of a report.

LEARNING OBJECTIVES OF THE SUBJECT

Graphs are useful for representing data obtained in numerous applications such as, for example, traffic evolution in a transport network, temperature values in different geographic locations, information dissemination in social networks or functional activities in the brain. The representation, analysis and compression of such data is a challenging task and requires the development of new tools that can identify and adequately exploit the structure of the data.
In this course, students will become familiar with the framework of "Graph Signal Processing", a discipline useful for processing data lying on a graph and that extends basic concepts of signal processing to graphs, such as frequency domain and filtering. Hand-out sessions will provide students with practical skills in the analysis of data in graphs.

STUDY LOAD

Type	Hours	Percentage
Hours small group	8,0	10.67
Self study	51,0	68.00
Hours large group	16,0	21.33

Total learning time: 75 h

CONTENTS

Introduction

Description:
Course organization. Motivation and applications of graph signals.

Full-or-part-time: 0h 30m
Theory classes: 0h 30m

Algebraic graph theory

Description:
Graph theory fundamentals. Laplacian matrix and spectral properties.

Related activities:
Application: Random Walks on Graphs and Spectral Clustering
Practical Session: Spectral Clustering

Full-or-part-time: 14h 30m
Theory classes: 5h 30m
Practical classes: 3h
Self study : 6h

Graph Signals

Description:
Definition of graph signals. Graph Fourier Transform. Convolution of graph signals.

Related activities:
Application: "Average Consensus"
Practical session: Frequency domain in graphs.

Full-or-part-time: 6h
Theory classes: 2h
Practical classes: 1h
Self study : 3h

Graph topology learning

Description:
Graphs based on similarity of node attributes. Graph learning based on signals

Full-or-part-time: 6h
Theory classes: 2h
Practical classes: 1h
Self study : 3h

Graph Convolutional Neural Networks

Description:
Multilayer Graph Convolutional Neural Networks with multiple features.

Full-or-part-time: 6h
Theory classes: 3h
Self study : 3h

Graph Systems and Filtering of Graph Signals

Description:
Graph linear systems filters. Graph filters in the frequency domain. Examples of graph filters.

Related activities:
Application: Denoising of graph signals and translation of signals across a graph.
Practical session: filtering of graph signals.

Full-or-part-time: 7h
Theory classes: 4h
Practical classes: 1h
Self study : 2h

GRADING SYSTEM

- Attendance is mandatory.
- Participation in class.
- Individual assignments (~45%), and group or individual reports (~55%).

EXAMINATION RULES.

There is no final exam.

BIBLIOGRAPHY

Basic:
- Ortega, A. Introduction to graph signal processing. New York: Cambridge University Press, 2022. ISBN 9781108428132.

Complementary:
- Kolaczyk, Eric D. Statistical analysis of network data methods and models [on line]. New York: Springer, 2009 [Consultation: 08/06/2022]. Available on: https://link-springer-com.recursos.biblioteca.upc.edu/book/10.1007/978-0-387-88146-1. ISBN 9780387881454.
- Godsil, Chris; Royle, Gordon. Algebraic graph theory. New York: Springer, 2001. ISBN 9780387952413.

RESOURCES

Computer material:
- Transparències de clase.. Lecture slides.
- Toolbox de grafs de Matlab i enunciats de sessions pràctiques.. Matlab graph toolbox and practical session guides.

Other resources: