Last update: 06-05-2019

230202 - CLP - Pattern Classification: Applications in Signal Processing

Coordinating unit: 230 - ETSETB - Barcelona School of Telecommunications Engineering

Teaching unit: 739 - TSC - Department of Signal Theory and Communications

Academic year: 2019

Degree: BACHELOR'S DEGREE IN TELECOMMUNICATIONS SCIENCE AND TECHNOLOGY (Syllabus 2010). (Teaching unit Optional)
BACHELOR'S DEGREE IN ELECTRONIC SYSTEMS ENGINEERING (Syllabus 2009). (Teaching unit Optional)
BACHELOR'S DEGREE IN TELECOMMUNICATIONS SYSTEMS ENGINEERING (Syllabus 2010). (Teaching unit Optional)
BACHELOR'S DEGREE IN NETWORK ENGINEERING (Syllabus 2010). (Teaching unit Optional)
BACHELOR'S DEGREE IN AUDIOVISUAL SYSTEMS ENGINEERING (Syllabus 2009). (Teaching unit Optional)
BACHELOR'S DEGREE IN TELECOMMUNICATIONS TECHNOLOGIES AND SERVICES ENGINEERING (Syllabus 2015). (Teaching unit Optional)

ECTS credits: 6 Teaching languages: Catalan, Spanish

Teaching staff

Coordinator: JOSEP VIDAL MANZANO

Others: VERONICA VILAPLANA
MARGARITA CABRERA BEAN
ANTONIO PASCUAL ISERTE

Opening hours

Timetable: To be agreed by email.

Prior skills

Stochastic processes. Signal processing.

Requirements

Teaching methodology

Learning objectives of the subject

The subject gives a review of the pattern classification and recognition from the mathematical point of view and at the same time, applies the methods to several areas of signal processing.
The structure of the general problem of pattern recognition (i.e, pre-processing, feature extraction and classification), can be applied to different areas, such as quality control, biomedical applications and diagnosis, communication systems, image processing, and speech recognition.
The subject, will give a general view of the bayesian desision theory, maximum likelihood estimation, non parametric

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classification techniques and non supervised learning, with application to different areas of signal processing, such as classification of biomedical signals, images, signal detection, signal modulation, etc.
For each of the selected applications, the work done in class, will deal with different classification criteria, in order to analyze the compromise between good performance and computation efficiency of each classifier.
The 6 credits of the subject are divided between theoretical classes, and at the same time, practical classes at the laboratory (MATLAB), where the student will develop the selected applications, with emphasis in the applications on medical diagnosis, image possessing, and communications. In each of the theoretical parts, the methods and algorithms will be developed so that they can be understood and programmed at the same time. Some advanced techniques will also be presented. In the last weeks of the course all the students will participate in a machine learning competition proposed by the teacher.

Study load

Total learning time: 150h	Hours large group:	26h	17.33%
	Hours small group:	26h	17.33%
	Self study:	98h	65.33%

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Content

1. Introduction

Learning time: 6h

Theory classes: 2h
Laboratory classes: 2h
Guided activities: 1h
Self study : 1h

Description:
1.1 Introduction to pattern classification
1.2 Feature extraction
1.3 Classes and models

2. Decision theory

Learning time: 10h

Theory classes: 4h
Laboratory classes: 4h
Guided activities: 1h
Self study : 1h

Description:
2.1 Minimization of the Bayesian risk
2.2 Gaussian model
2.3 Linear and quadratic discriminants
2.4 Máximum likelihood estimation

3. Feature selection

Learning time: 10h

Theory classes: 4h
Laboratory classes: 4h
Guided activities: 1h
Self study : 1h

Description:
3.1 Principal components analysis
3.2 Multiple discriminants analysis

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4. Non-parametric techniques for supervised learning

Learning time: 24h

Theory classes: 11h
Laboratory classes: 11h
Guided activities: 1h
Self study : 1h

Description:
4.1 Parzen windows and k-nearest neigbours
4.2 Support vector machines
4.3 Neural networks
4.4 Decision trees

5. Evaluation, combination and selection of classifiers

Learning time: 6h

Theory classes: 2h
Laboratory classes: 2h
Guided activities: 1h
Self study : 1h

Description:
5.1 Lack of superiority of any classifier
5.2 Complexity
5.3 Bias and variance
5.4 Resampling for classifier design
5.5 Combining classifiers
5.6 Comparing classifiers
5.7 Lauching a ML project

6. Unsupervised learning

Learning time: 8h

Theory classes: 3h
Laboratory classes: 3h
Guided activities: 1h
Self study : 1h

Description:
6.1 Parametric methods: EM i k-means
6.2 Non-parametric methods: clustering

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Planning of activities

Laboratories	Hours: 26h Laboratory classes: 26h

Description:
PRAC0: Exploratory data analysis
PRAC1: MAP for Gaussian data
PRAC2: Data basis and feature selection
PRAC3: K-Nearest
PRAC4: SVM
PRAC5: Neural networks
PRAC6: Tree classifiers
PRAC7: Competition

Support materials:
Matlab code and data bases will be available in Atenea.

Descriptions of the assignments due and their relation to the assessment:
Every second week, a report of the laboratory will have to be uploaded to Atenea.

Qualification system

Final exam: 45%
Laboratory: 25%
Competition: 15%
Deliverable exercises: 15%

Regulations for carrying out activities

The use of calculators, mobile phones or class notes is not allowed.

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Bibliography

Basic:

Duda, R.O.; Hart, P.E.; Stork, D.G. Pattern classification. 2nd ed. New York [etc.]: John Wiley & Sons, 2001. ISBN 0471056693.

Complementary:

Bishop, C.M. Pattern recognition and machine learning. New York: Springer, 2006. ISBN 0387310738.

Kuncheva, L.I. Combining pattern classifiers: methods and algorithms [on line]. 2nd ed. Hoboken (NJ): J. Wiley & Sons, 2014 [Consultation: 21/09/2018]. Available on: <https://onlinelibrary.wiley.com/doi/book/10.1002/9781118914564>. ISBN 9781118914564.

Stork, D.G.; Yom-Tov, E. Computer manual in MATLAB to accompany pattern classification. 2nd ed. Hoboken: Wiley, 2004. ISBN 0471429775.

Hastie, T.; Tibshirani, R.; Friedman, J.H. The elements of statistical learning: data mining, inference and prediction. 2nd ed. New york [etc.]: Springer, 2009. ISBN 9780387848570.

Others resources:

For the development of the laboratories, applications in Matlab will be provided through Atenea.