Course guide
240317 - 240NR024 - Data Analysis in Rehabilitation

Last modified: 16/05/2023

Unit in charge:	Barcelona School of Industrial Engineering
Teaching unit:	707 - ESAII - Department of Automatic Control.
Degree:	MASTER'S DEGREE IN NEUROENGINEERING AND REHABILITATION (Syllabus 2020). (Compulsory subject).

Academic year: 2023 **ECTS Credits:** 4.5 **Languages:** English

LECTURER

Coordinating lecturer: Joan Francesc Alonso López

Others:

PRIOR SKILLS

Basic programming, calculus, algebra, and statistics.
Knowledge on biomedical signals and images.

REQUIREMENTS

It is advisable to take or have taken the courses on Human-Machine Interfaces and Neuroimage.

TEACHING METHODOLOGY

- Participatory lectures and case studies
- Laboratory sessions
- Student activities guided by the teacher
- Teamwork
- Project-based learning

LEARNING OBJECTIVES OF THE SUBJECT

The main objective of the course is to provide a general view into the data analysis workflow, with special focus to neuroengineering and rehabilitation, using Python.

The specific learning objectives include:
- To set up the necessary tools to perform data analysis, understanding the advantages and limitations of the chosen tools, and possible alternatives.
- To learn and apply common machine learning algorithms.
- To understand how to extract meaningful features from biomedical data.
- To learn about the basic statistical framework necessary in rehabilitation.
- To learn feature selection techniques to improve the efficiency of the data analysis workflow

By the end of the course, students have to be able to develop a project on a particular example of neuroengineering and rehabilitation data analysis.

STUDY LOAD

Type	Hours	Percentage
Self study	72,0	64.00
Hours small group	20,0	17.78
Hours large group	20,5	18.22

Total learning time: 112.5 h

CONTENTS

Introduction to Data Analysis

Description:
- Data analysis workflow.
- Setting up a working environment.

Related activities:
- Laboratory Session 1. Python & NumPy
- Laboratory Session 2. Advanced Python
- Laboratory Session 3. Pandas, SciPy, Linear Regression
- Course project.

Full-or-part-time: 15h
Theory classes: 3h
Practical classes: 3h
Self study : 9h

Machine Learning

Description:
- Basic algorithms: linear regression, logistic regression, k-means clustering.
- Supervised algorithms (classification).
- Unsupervised algorithms (clustering).

Related activities:
- Laboratory Session 2. Advanced Python.
- Laboratory Session 3. Pandas, SciPy, linear Regression.
- Laboratory Session 4. Classification (sklearn).
- Laboratory Session 5. Clustering (sklearn).
- Course project.

Full-or-part-time: 34h
Theory classes: 6h
Practical classes: 12h
Self study : 16h

Feature engineering

Description:
- From the brain
- From the neuromuscular system
- From the cardiac system
- From the respiratory system
- Others

Related activities:
Course Project

Full-or-part-time: 6h
Theory classes: 1h
Self study : 5h

Statistics

Description:
- Identification of trends and outliers.
- Comparison of groups.
- Multivariate tests.

Specific objectives:
To understand the basic tests and their interpretation and usefulness in the context of data analysis.
Utilization of statistical measures for feature selection.

Related activities:
Laboratory session 7. Statistics (scipy, statsmodels)
Course Project.

Full-or-part-time: 9h
Theory classes: 1h 30m
Practical classes: 1h 30m
Self study : 6h

Feature selection and extraction

Description:
- Statistically-based selection
- PCA
- ICA
- Others

Related activities:
- Laboratory session 7. Statistics (scipy, statsmodels).
- Laboratory session 8. Feature selection and feature extraction.
- Course project.

Full-or-part-time: 12h
Theory classes: 1h 30m
Practical classes: 1h 30m
Self study : 9h

Integrative project

Description:
By the end of the course, students must be able to propose, plan, design, and program a data analysis workflow on a rehabilitation related application.

The integrative project will be developed during the final weeks, with lectures dedicated to research on specific topics, project planning and search of datasets, and finally the implementation and performance testing.

Full-or-part-time: 36h 30m
Theory classes: 0h 30m
Practical classes: 9h
Self study : 27h

GRADING SYSTEM

The following items will be considered for grading:
- Final exam (E).
- Laboratory sessions, including attendance and active involvement (L).
- Integrative project (P).

The final grade will be obtained by weighted sum of all items: $0.3*E + 0.3*L + 0.4*P$

This course has a reassessment text. This reassessment is equivalent to the final exam.

EXAMINATION RULES.

- The final exam will be administered individually.
- The laboratory sessions will be performed in groups (usually in pairs). Attendance, active involvement and reports will be taken into account for grading.
- The integrative project will also be performed in groups (3 or 4 people), and in addition to the report, it will be presented in class.
- Students may carry out the reassessment test according to the current regulations of the ETSEIB.

Failure to produce a grade in the integrative project will be considered as a "no show" for the course.

BIBLIOGRAPHY

Basic:
- Igual, Laura ; Santi Seguí. Introduction to data science : a Python approach to concepts, techniques and applications [on line]. Cham: Springer, 2017 [Consultation: 21/07/2022]. Available on: https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=6314089. ISBN 9783319500171.
- King, Andrew P; Eckersley, Robert. Statistics for biomedical engineers and scientists : how to visualize and analyze data [on line]. London: Academic Press, 2019 [Consultation: 24/03/2023]. Available on: https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?docID=5777787. ISBN 9780081029404.

Complementary:
- Bader, D. Python tricks : the book. 2021. ISBN 9781775093305.
- Müller, Andreas C.; Guido, Sarah. Introduction to machine learning with Python [on line]. Sebastopol, CA.: O'Reilly, 2016 [Consultation: 30/03/2023]. Available on: https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?docID=4698164. ISBN 9781449369903.
- Idris, Ivan. Python data analysis cookbook [on line]. Birmingham: Packt Publishing, 2016 [Consultation: 30/03/2023]. Available on: https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=4612

RESOURCES

Hyperlink:
- https://jakevdp.github.io/PythonDataScienceHandbook. Website containing the full text and code of the Python Data Science Handbook