Course guide
295622 - 295MB022 - Digital Biomarkers and Artificial Intelligence in Healthcare

Last modified: 28/01/2026

Unit in charge: Barcelona East School of Engineering
Teaching unit: 707 - ESAII - Department of Automatic Control.

Degree: MASTER'S DEGREE IN ADVANCED BIOMEDICAL TECHNOLOGIES (Syllabus 2025). (Compulsory subject).

Academic year: 2025 **ECTS Credits:** 6.0 **Languages:** Spanish

LECTURER

Coordinating lecturer: Lozano García, Manuel

Others: Torres Cebrian, Abel

PRIOR SKILLS

Prior knowledge of:
• Fundamentals of physiology and biology
• Biomedical signal processing and analysis
It is recommended to have passed the subject Biomedical Signal Analysis in the first semester.

LEARNING RESULTS

Knowledges:
K6. Describe advanced knowledge of analysis and interpretation of biomedical images in healthcare.
K2. Recognise advanced data analysis and modelling structures.
K7. Infer advanced knowledge of digital biomarkers and artificial intelligence techniques in health technologies.

Skills:
S10. Use common analysis tools in technological innovation to evaluate business opportunities and develop innovation proposals in the field of biomedical technologies.
S5. Propose digital biomarkers through advanced analysis of biomedical signals, artificial intelligence techniques and bioinformatics.
S6. Interpret biomedical data using data analysis, machine learning and deep learning techniques.
S7. Design advanced computer vision and robotics applications in healthcare.
S8. Design digital and mobile health applications (mHealth).

Competences:
C3. Identify and analyse problems that require making autonomous, informed and reasoned decisions in order to act with social responsibility following ethical values and principles.
C6. Integrate the values of sustainability and understand the complexity of systems, with the aim of undertaking or promoting actions that restore and maintain the health of ecosystems and improve justice, thereby generating visions of sustainable futures.
C4. Use information resources effectively, manage the acquisition, structure, analysis and visualisation of data and information in the area of specialisation and critically assess the results.
C5. Use scientific and technical information to respond to any demand for modification, innovation or improvement of devices, products and processes linked to biomedical engineering for new scientific or technological applications.

TEACHING METHODOLOGY

The course uses the following methodologies:
• Participative lectures
• Laboratory sessions
• Independent work
• Cooperative group work
• Debates
• Case studies and discussion of scientific articles
• Project-based learning

LEARNING OBJECTIVES OF THE SUBJECT

This course presents a set of fundamental and advanced concepts on digital biomarkers and artificial intelligence (AI) in healthcare. It will provide an overview of the technical and ethical aspects of AI projects in the health sector and will provide basic and advanced knowledge of programming and data processing for the extraction of digital biomarkers and the development of AI models and their application in the diagnosis and monitoring of different pathologies. The specific objectives of the course are the following:
• Acquire and apply advanced knowledge in digital biomarkers and AI techniques in health technologies.
• Identify and propose digital biomarkers through advanced biomedical signal analysis and AI techniques.

STUDY LOAD

Type	Hours	Percentage
Hours small group	28,0	18.67
Self study	94,0	62.67
Hours large group	28,0	18.67

Total learning time: 150 h

CONTENTS

Lesson 1: Introduction to digital biomarkers

Description:
- Definition of digital biomarker
- Conventional biomarkers VS digital biomarkers
- Types of digital biomarkers
- Biomedical data acquisition. Wired devices and wireless/wearable devices
- Examples of digital biomarkers in healthcare
- Ethical aspects of digital biomarkers
- Digital biomarker discovery pipeline

Related activities:
Case studies and discussion of scientific articles
Final exam

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

Lesson 2: Biomedical signal characterization: feature engineering

Description:
- General concepts: acquisition, noise and filtering of biomedical signals
- Time domain characterization of biomedical signals (definition and applications): RMS, ARV, kurtosis, skewness, zero-crossing, entropy, energy (Shannon, TKEO, ...)
- Frequency domain characterization of biomedical signals (definition and applications): spectral parameters
- Descomposition of biomedical signals and time-frequency characterization (definition and applications): DWT, SST, EMD, ICA, Hilbert spectrum

Related activities:
Collaborative project
Laboratory sessions (P1, P2 and P3)
Case studies and discussion of scientific articles
Final exam

Full-or-part-time: 53h
Theory classes: 15h
Laboratory classes: 6h
Self study : 32h

Lesson 3: Introduction to AI in healthcare

Description:
- Big data in healthcare and AI
- Types of AI models
- Applications of AI in healthcare
- Ethical and legal aspects of AI in healthcare
- AI in Python

Related activities:
- Laboratory sessions (P4)
- Case studies and discussion of scientific articles
- Final exam

Full-or-part-time: 11h
Theory classes: 3h
Self study : 8h

Lesson 4: Data preparation

Description:
- Data exploration and visualization: distribution, histograms, boxplots, scatter plots, etc.
- Data transformation, normalisation
- Feature selection: variance, correlation, information, PCA
- AI in Python

Related activities:
- Collaborative project
- Laboratory sessions (P4)
- Case studies and discussion of scientific articles
- Final exam

Full-or-part-time: 23h
Theory classes: 6h
Laboratory classes: 2h
Self study : 15h

Lesson 5: Machine Learning models

Description:
- Supervised models: logistic regression, decision trees, random forest, XGBoost, artificial neural networks
- Unsupervised models: k-means clustering
- AI in Python

Related activities:
- Collaborative project
- Laboratory sessions (P5)
- Case studies and discussion of scientific articles
- Final exam

Full-or-part-time: 27h
Theory classes: 6h
Laboratory classes: 2h
Self study : 19h

Lesson 6: Deep Learning models

Description:
- Convolutional neural networks for biomedical signals
- Recurrent neural networks for biomedical signals
- Hybrid models
- AI in Python

Related activities:
- Collaborative project
- Laboratory sessions (P6)
- Case studies and discussion of scientific articles
- Final exam

Full-or-part-time: 30h
Theory classes: 9h
Laboratory classes: 2h
Self study : 19h

GRADING SYSTEM

Collaborative project = 30%
Laboratory reports = 30%
Discussion of scientific articles = 15%
Final exam = 25%
This subject has no re-evaluation as it is based on a continuous assessment system in which each student must add up grades throughout the course.

BIBLIOGRAPHY

Basic:
- Talukdar, Jyotismita; Singh, Thipendra P.; Barman, Basanta. Artificial Intelligence in Healthcare Industry. ISBN 978-981-99-3159-0.
- Biomedical Signal Processing and Artificial Intelligence in Healthcare. ISBN 978-0-12-818946-7.
- Machine Learning for Biomedical Applications with Scikit-Learn and PyTorch. ISBN 978-0-12-822904-0.

RESOURCES

Audiovisual material:
- Nom recurs. Resource

Other resources:
Learning resources available at ATENEA (digital campus of the Universitat Politècnica de Catalunya)
Software: Matlab, Python (Google Colab)
Biomedical databases