Course guide
2703125 - ML - Machine Learning

Last modified: 30/01/2026

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

Degree: BACHELOR'S DEGREE IN BIOINFORMATICS (Syllabus 2024). (Compulsory subject).

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

LECTURER

Coordinating lecturer: ALEXANDRE PERERA LLUNA

Others:

PRIOR SKILLS

Basic Python

LEARNING RESULTS

Knowledges:
K2. Identify statistical and computational methods and mathematical models that can be used to solve problems in molecular biology, genomics, medical research and population genetics.
K3. Identify the mathematical foundations, computational theories, algorithmic schemes and principles of information organisation relevant to modelling biological systems and efficiently solving bioinformatics problems through the design of computational tools.
K4. Integrate the concepts offered by the most widely used programming languages in life sciences to model and optimise data structures and build efficient algorithms, relating them to each other and to their application cases.
K5. Identify the nature of the biological variables that need to be analysed, as well as appropriate mathematical models, algorithms and statistical tests to develop and evaluate statistical analyses and computational tools.

Skills:
S2. Computationally analyse DNA, RNA and protein sequences, including comparative genomic analysis, using computation, mathematics and statistics as the basic tools of bioinformatics.
S3. Solve problems in molecular biology, genomics, medical research and population genetics by applying statistical and computational methods and mathematical models.
S4. Develop specific problem-solving tools for the interpretation of biological and biomedical data, including complex visualisations.
S8. Make and defend reasoned decisions when solving problems in biology and, in appropriate fields, the health sciences, computer science and experimental sciences.

Competences:
C3. Communicate orally and in writing with others in English about learning outcomes, thought processes and decision making.
C6. Identify and overcome gaps in one’s knowledge by thinking critically and choosing the best approach to extending one’s knowledge.

TEACHING METHODOLOGY

Lectures will be mainly of expository type. There will be alsolife sessions and practical sessions using python.

LEARNING OBJECTIVES OF THE SUBJECT

1.Apply deep learning models to biological and biomedical data, selecting and adapting architectures such as convolutional, recurrent, and transformer networks to solve specific problems in bioinformatics and bioengineering.
Preprocess, represent, and analyze heterogeneous biomedical data (medical images, biological sequences, physiological signals), using modern computational tools and good scientific programming practices.
Interpret and evaluate the performance of deep learning models in biomedical contexts, using appropriate metrics and understanding the limitations and ethical risks of using artificial intelligence in biomedicine.
2.Preprocess, represent, and analyze heterogeneous biomedical data (medical images, biological sequences, physiological signals), using modern computational tools and good scientific programming practices.
3.Interpret and evaluate the performance of deep learning models in biomedical contexts, using appropriate metrics and understanding the limitations and ethical risks of using artificial intelligence in biomedicine.

STUDY LOAD

Type	Hours	Percentage
Self study	90,0	60.00
Hours large group	30,0	20.00
Hours small group	30,0	20.00

Total learning time: 150 h

CONTENTS

Introduction to Deep Learning in Bioinformatics & Bioengineering

Description:
Introduction to Deep Learning in Bioinformatics & Bioengineering, Biological Data Types and software tools for effective learning workflows.

Multilayer Perceptrons: Foundations of Deep Learning

Description:
An introduction to the fundamental building blocks of deep learning through multilayer perceptrons (MLPs), covering network architecture, activation functions, forward and backward propagation, and their role in modeling complex nonlinear relationships in biological data.

Biomedical Image Analysis with CNNs

Description:
This module explores convolutional neural networks (CNNs) for analyzing biomedical images, focusing on feature extraction, classification, and segmentation tasks in applications such as pathology, radiology, and microscopy.

Biological Time-Series and Sequence Modeling with RNNs

Description:
An in-depth look at recurrent neural networks (RNNs) and their variants for modeling sequential and temporal biological data, including time series, physiological signals, and nucleotide or protein sequences.

Transformers and Attention Mechanisms for Biological Sequences

Description:
Introduction to the attention mechanisms and transformer architectures, emphasizing their effectiveness in capturing long-range dependencies in biological sequences for tasks such as structure prediction, and functional annotation

Encoder-Decoder Architectures

Description:
Design and application of encoder-decoder models for transforming, annotating, and generating biological sequences and biomedical data, with emphasis on RNN and transformer variants, attention integration, and real-world sequence modeling tasks.

Language Models and NLP in Bioinformatics and Biomedicine

Description:
This module explores how language models are applied to biomedical texts and biological sequences, enabling tasks such as named entity recognition, document classification, and functional annotation through pretrained models like BioBERT, DNABERT, and protein sequence transformers.

ACTIVITIES

Theoretical expository lectures

Specific objectives:
1, 2

Full-or-part-time: 70h
Theory classes: 25h
Self study: 45h

Laboratories

Specific objectives:
2, 3

Full-or-part-time: 75h
Practical classes: 30h
Self study: 45h

Mid Term

Full-or-part-time: 2h
Guided activities: 2h

Theory exam

Full-or-part-time: 3h
Guided activities: 3h

GRADING SYSTEM

The course assessment is as follows:
- 30% corresponds to practical assignments (to be done by pairs),
- 70% consists of a 2 partial theoretical exams taken at mid term (35%) and final term (35%).

Recuperation Information
can be retake.
Only the students that after the evaluation have a grade equal or greater than 3 can perform the re-evaluation exam. In the reassessment exam (R) only the theoretical part is reassessed and the reassessment grade in this case will be 70%R plus 30% of the practical work carried out during the course

BIBLIOGRAPHY

Basic:
- Bharath Ramsundar, Peter Eastman, Pat Walters, Vijay Pande. Deep Learning for the Life Sciences. O'Reilly Media, Inc., ISBN 9781492039839.
- Tiago Antão. Bioinformatics with Python Cookbook. ISBN 978-1789344691.