Universitat Autònoma de Barcelona

2023/2024

Deep Learning and Experimental Design

Code: 45026
ECTS Credits: 20

Degree	Type	Year	Semester
3500042 Erasmus Mundus Master in Human Disease Models Morphological Phenotyping	OB	0	2

Contact

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Teaching groups languages

You can check it through this link. To consult the language you will need to enter the CODE of the subject. Please note that this information is provisional until 30 November 2023.

Teachers

Jesus Ruberte Paris

External teachers

Anastasia Tsingotjidou - Contact Person (astsing2014@gmail.com)

Anastasios Delopoulos

Prerequisites

There are no prerequisites.

Objectives and Contextualisation

- Understand the fundamental principles and terminology of machine learning including deep learning.

- To know how to use machine learning architectures in real problems including detection and to recognise patterns on images and 1D signals, diagnosis, decisions.

- To know how to evaluate the performance of machine learning methods using the appropriate metrics (recall, precision, F1 score, AUC, etc.)

- To know how to run machine learning based experiments including good practices in data collection, training and evaluating performance of machine learning methods

- To know to use established machine tools

- Gain hands on experience by applying machine learning to data related to mouse anatomy and pathology

- Understand the ethical issues on mouse laboratory experimentation to follow the 3R principles.

- Understand the ARRIVE guidelines to increase reproducibility on mouse research.

- Integrate imaging and machine learning methodologies with pathology

Learning Outcomes

- CM04 (Competence) Evaluate the performance of deep learning methods.
- CM05 (Competence) Create a valid experimental project design using mice.
- KM11 (Knowledge) Understand the fundamental principles of deep learning.
- KM12 (Knowledge) Recognise the main established tools of deep learning.
- KM13 (Knowledge) Understand the ethical aspects (3Rs) of animal experimentation.
- KM14 (Knowledge) Identify the quantitative and ARRIVE aspects related to the reproducibility of animal experimentation.
- SM06 (Skill) Use terminology from the fields of deep and machine learning correctly.
- SM07 (Skill) Use deep learning architectures for real problems, including 1D signal pattern recognition, diagnosis and decisions.
- SM08 (Skill) Use statistical tools for qualitative analysis in experiments with mice.

Content

- Introduction to deep and machine learning

- Classifiers and metrics for evaluation

- Supervised and unsupervised algorithms

- Convolutional neural and recurrent networks

- Methodologies for 1D and 2D signals: sliding windows, super-pixels, streaming data and whole pictures transformation

- Methodologies for conducting deep learning experiments

- Experimental design with mouse: quantitative comparison, ARRIVE and 3Rs

- Optional language course (Greek)

Methodology

The methodology used in the teaching and learning process of this module is based on the student working on the information that is made available to them through lectures and practical classes.

• Classroom lectures: The student acquires the scientific knowledge of the discipline. The student must complete this knowledge with the personal and autonomous study of the topics explained.

• Laboratory sessions: Practical sessions approach the theoretical models to reality and reinforce, complete and allow to apply the knowledge acquired in lectures. In the practical classes the student will train in bioinformatic analysis and R, as well as in the realization of specific projects.

• Case Projects: Practical case studies assigned to each student and supervised by the teachers.

The materials used in the subject will be available on the Moodle platform.

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Classroom lectures	175	7	CM04, KM11, KM12, KM13, KM14, SM06, SM07, SM08, CM04
Practical session	32	1.28	CM04, CM05, KM13, KM14, SM06, SM07, SM08, CM04
Type: Supervised			
Case Projects	66	2.64	CM04, CM05, KM11, KM12, KM13, KM14, SM06, SM07, SM08, CM04
Type: Autonomous			
Autonomous learning	217	8.68	CM04, CM05, KM11, KM12, KM13, KM14, SM06, SM07, SM08, CM04

Assessment

The evaluation of the "Deep learning and experimental design" module will be carried out continuously, throughout the entire module, to encourage continued effort during the learning process and verifying that the specific skills are reached.

The evaluation of each of the 5 submodules is described below:

Submodule 3.1 - Experimental design and data analysis of animal experiments

1. Practical project: 100%

Submodule 3.2 - Introduction to Systems Biology. Imaging omics in individual cells

1. Theoretical test exams (2 in total, one for each section of the submodule): 40%
2. Practical assessment exercises (2 in total, one for each section of the submodule): 20%
3. Practical project (2 in total, one for each section of the submodule): 40%

Submodule 3.3 - Artificial intelligence and medical diagnosis. Decision Support Systems

1. Practical project: 100%

Submodule 3.4 - Machine learning in data analysis in biomedicine

1. Practical project: 60%
2. Final exam (theory and problem solving): 40%

Submodule 3.5 - Practical experience in Deep learning

1. Several practical projects: 100%

The additive weight of submodules 3.1 and 3.2 is 5 ECTS, while the total weight of submodules 3.3, 3.4 and 3.5 together is 15 ECTS.

The module will be passed with a final grade of 5/10 or higher, after averaging the different parts.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Case Projects	87,5	6	0.24	CM04, CM05, KM11, KM12, KM13, KM14, SM06, SM07, SM08
Theoretical exams	12,5	4	0.16	CM04, CM05, KM11, KM12, KM13, KM14, SM06, SM07, SM08

Bibliography

Bishop, Christopher M, Nasrabadi NM, Pattern recognition and machine learning. Vol. 4. No. 4. 2006, Springer: New York.

Dey N, et al., eds. Machine learning in bio-signal analysis and diagnostic imaging. 2018, Academic Press.

Ghouila A, Tsagiopoulou M, Mpangase PT, Hazelhurst S, Psomopoulos FE. ELIXIR / CODATA-RDA Research Data Science Advanced Workshop on Bioinformatics (Version v1.0.0). 2019, Zenodo.

Goodfellow I, Bengio Y, Courville A, Deep learning. 2016, MIT press. (Available Online: https://www.deeplearningbook.org/)

Greener JG, et al. A guide to machine learning for biologists. 2022, Nature Reviews Molecular Cell Biology 23.1: 40-55.

Krishnan S, Kesavan R, Surendiran B, Mahalakshmi GS, eds. Handbook of artificial intelligence in biomedical engineering. 2021, Apple Academic Press Inc.

Russell SJ and Norvig P. Artificial Intelligence: A Modern Approach. 2010, Prentice Hall (Third Edition).

Software

InVivoStat, SPSS, Galaxy, R and RStudio, Python and Google Collab