# Course guide
# 270734 - DL - Deep Learning

**Last modified:** 02/02/2024

**Unit in charge:** Barcelona School of Informatics
**Teaching unit:** 968 - BSC - Barcelona Supercomputing Center-Centro Nacional de Supercomputación.

**Degree:** MASTER'S DEGREE IN ARTIFICIAL INTELLIGENCE (Syllabus 2017). (Optional subject).

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

## LECTURER

**Coordinating lecturer:** DARIO GARCÍA GASULLA

**Others:** Primer quadrimestre:
MARC CASAS GUIX - 10
DARIO GARCÍA GASULLA - 10

Segon quadrimestre:
MARC CASAS GUIX - 10
DARIO GARCÍA GASULLA - 10

## PRIOR SKILLS

Basic concepts of neural networks (SGD, back-propagation, loss functions) and machine learning (classification, regression, evaluation methodologies) are required.
Students must be able to program autonomously (Python), to work on a remote server through a terminal (ssh, bash), and to interact with third-party libraries.

## DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

**Specific:**
CEP3. Capacity for applying Artificial Intelligence techniques in technological and industrial environments to improve quality and productivity.
CEP4. Capability to design, write and report about computer science projects in the specific area of ??Artificial Intelligence.

**Transversal:**
CT6. REASONING: Capability to evaluate and analyze on a reasoned and critical way about situations, projects, proposals, reports and scientific-technical surveys. Capability to argue the reasons that explain or justify such situations, proposals, etc..
CT7. ANALISIS Y SINTESIS: Capability to analyze and solve complex technical problems.

## TEACHING METHODOLOGY

This subject has a theoretical component and a practice.
The theoretical component consists of face-to-face classes where the teacher will review concepts of Deep Learning, present applications, and other recent trends in the field. At the end of the course, students will have to read and analyse articles from Deep Learning to demonstrate the knowledge learned.
The practical component is composed by individual practices, where students will have to experiment with the various techniques of Deep Learning. Based on simple experiments, and using popular Deep Learning libraries (e.g., Keras, TensorFlow, Theano, Caffe), the students will test the effects of the various available techniques.

## LEARNING OBJECTIVES OF THE SUBJECT

1.Understand the various techniques that can be integrated into a deep learning system, and know how to experiment with them coherently in a realistic production environment through the use of third-party libraries.
2.Be able to understand scientific articles from the area of deep learning, to extract the most relevant conclusions, and to derive possible applications or limitations.

## STUDY LOAD

| Type | Hours | Percentage |
|---|---|---|
| Hours large group | 40,5 | 100.00 |

**Total learning time:** 40.5 h

## CONTENTS

### Convolutional Neural Networks

**Description:**
We will review the main aspects of CNNs. How they work, why, and how can they be improved.

### Recurrent Neural Networks

**Description:**
We will review the main aspects of RNNs. How they work, why, and how can they be improved.

### Transfer Learning

**Description:**
We will review several ways in which neural network embeddings can be reused, the pros and cons.

### HPC&DL

**Description:**
We will review basic concepts of High Performance Computing in the context of Deep Learning.

### Transformer Networks

**Description:**
Introduction to Transformer Networks

## ACTIVITIES

### Practical experimentation

**Description:**
Experimentation using deep learning libraries, and reporting of the relevant conclusions.

**Specific objectives:**
1

**Related competencies :**
CEP3. Capacity for applying Artificial Intelligence techniques in technological and industrial environments to improve quality and productivity.
CT7. ANALISIS Y SINTESIS: Capability to analyze and solve complex technical problems.

**Full-or-part-time:** 17h 36m
Guided activities: 2h 36m
Self study: 15h

### Theoretical comprehension

**Description:**
Read a relevant article in the field of deep learning, describe and present the main contributions, as well as possible future work lines or limitations of the same.

**Specific objectives:**
2

**Related competencies :**
CEP4. Capability to design, write and report about computer science projects in the specific area of ??Artificial Intelligence.
CT6. REASONING: Capability to evaluate and analyze on a reasoned and critical way about situations, projects, proposals, reports and scientific-technical surveys. Capability to argue the reasons that explain or justify such situations, proposals, etc..

**Full-or-part-time:** 11h
Guided activities: 2h
Self study: 9h

### Review of Multilayer Perceptron and Convolutiona Neural Networks

**Full-or-part-time:** 9h
Theory classes: 3h
Laboratory classes: 3h
Self study: 3h

### Lab on Multilayer Perceptron and Convolutional Neural Networks

**Full-or-part-time:** 12h
Laboratory classes: 3h
Self study: 9h

**Review of Recurrent Neural Networks**

**Full-or-part-time:** 9h
Theory classes: 3h
Laboratory classes: 3h
Self study: 3h

**Lab on Recurrent Neural Networks**

**Full-or-part-time:** 12h
Laboratory classes: 3h
Self study: 9h

**Review of Neural Embedding Spaces**

**Full-or-part-time:** 9h
Theory classes: 3h
Laboratory classes: 3h
Self study: 3h

**Lab on Neural Embedding Spaces**

**Full-or-part-time:** 12h
Laboratory classes: 3h
Self study: 9h

**Review of HPC for Deep Learning**

**Full-or-part-time:** 9h
Theory classes: 3h
Laboratory classes: 3h
Self study: 3h

**Lab on HPC for Deep Learning**

**Full-or-part-time:** 12h
Laboratory classes: 3h
Self study: 9h

## GRADING SYSTEM

This subject will be evaluated taking into account the theoretical (25%) and practical (75%) aspects.
For the theoretical part, students must read an article from Deep Learning (proposed or validated by the teacher) and do a presentation detailing the main contributions to the class. They will also have to do a critical analysis of the article, detailing aspects that could be done differently, future work that could be derived from the paper, or limitations of the same methodology.
For the practical part, the students will have to do a summary of the experiments realized in the practices, detailing the results obtained in each experiment, and interpreting these results.

## BIBLIOGRAPHY

**Basic:**
- Goodfellow, I.; Bengio, Y.; Courville, A. Deep learning. The MIT Press, 2016. ISBN 9780262035613.