

Academic Year: (2021 / 2022)

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Department assigned to the subject: Computer Science and Engineering Department

Coordinating teacher: ISASI VIÑUELA, PEDRO

Type: ECTS Credits : 6.0

Year : 4 Semester :

Branch of knowledge: Engineering and Architecture

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Programming. First year, first semester
 Linear Algebra. First year, first semester
 Statistics. Second year, second semester

OBJECTIVES

The aim of this course is that the student knows and develops computational learning techniques in the context of Artificial Neural Networks in addition designing and implementing applications and systems that use them, including those dedicated to automatic extraction of information and knowledge from data.

In more detail, the competences acquired by students are:

- Knowledge:
 - To know the mathematical / biological foundations of artificial neural neurons.
 - Acquiring the concept of neural network and learning process.
 - To know the different architectures of neural networks.
 - To know the different learning paradigms of neural networks and their theoretical foundation.
 - To know the differences among different types of neural networks from an applied perspective.
 - To understand the operation of artificial neural networks, adapting each technique to the specific characteristics of problem.
 - To know the different areas of applicability of artificial neural networks.
- Application:
 - To apply knowledge of neural networks in solving real problems, with emphasis on the accuracy and complexity of models.
 - To identify correctly the different phases for solving a problem using neural networks.
 - To develop an application that solves approximation, prediction or classification problems using neural networks.
 - Ability to design a set of experiments that lead to solving the problem.
 - To document correctly solving a problem using neural networks.
- Analysis, synthesis and evaluation:
 - Ability to analyze and interpret results.
 - To recognize and classify the different problems that can be solved by artificial of neural networks.
 - To combine and extrapolate the knowledge acquired for the design of a neural network, deciding the architecture and their parameters.
 - Ability to assess the effectiveness of neural networks for solving a specific problem.
 - To consider the relationship between computational cost and improvement of different solutions, choosing reasonable solutions to the characteristics of a given problem.

DESCRIPTION OF CONTENTS: PROGRAMME

1. Introduction
 - 1.1. Basics of Neural Networks
 - 1.2. History of Neural Networks
 - 1.3. First computational models
2. Perceptron
 - 2.1. Architecture and parameters
 - 2.2. Learning algorithm
 - 2.3. Learning procedure
3. Non supervised neural models
 - 3.1. Basics of non supervised learning
 - 3.2. Clustering
 - 3.3. Self organizing maps
 - 3.4. Different non supervised models
4. Recurrent Neural Networks
 - 4.1. Basics of Recurrent Neural Networks
 - 4.2. Learning in recurrent networks
 - 4.3. Recurrent models
5. Convolutional Neural Networks
 - 5.1. Autoencoders
 - 5.2. Image processing task
 - 5.3. Fundamentals of Convolutional networks
 - 5.4. Architecture in convolutional networks
 - 5.5. Advance Neural Networks models
6. Neural networks in practice
 - 6.1. Treatment and pre-processing of learning data
 - 6.2. Generation and validation of neural network models
 - 6.3. Hyperparameter tuning
 - 6.4. Model comparison

LEARNING ACTIVITIES AND METHODOLOGY

Theory: Lectures will be focused on teaching all concepts related to neural networks, so that students acquire knowledge on artificial neural networks necessary for professional development and they will be carried out in synchronous on-line mode.

Practical sessions (small groups): The practical classes will be developed so that, in a supervised way, students learn to solve real problems with artificial neural networks. The practices will be carried out in groups of 2 students, enhancing teamwork (Soft-skill: teamwork).

The weekly planification shows the exact distribution for each activity.

ASSESSMENT SYSTEM

% end-of-term-examination/test:	40
% of continuous assessment (assignments, laboratory, practicals...):	60

Assessment will be done through continuous assessment and final examination.

Continuous assessment: It will allow students to continue their learning process and get 60% of the final grade. To be provided through the assessment of two practices and a partial test about practical contents. The detailed grading are as follows:

Practice 1: 2 points (PO: b, d, e, g)

Practice 2: 2 points (PO: b, d, e, g)

Partial Test: 2 points (PO: a, b, e, k)

There will be a final exam (40%) that will be used to make a global assessment of all the competences knowledge, understanding, practical use, and skills. The exam consists of a series of theoretical and practical issues and / or exercise (PO: a, b, e, k).

Assessment tests could include questions about the practices carried out.

The final grade is calculated by adding the scores for the continuous assessment and final examination. If the student has not conducted ongoing assessment, s/he may conduct an examination worth 60% of the final grade.

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BASIC BIBLIOGRAPHY

- Ian Goodfellow, Yoshua Bengio & Aaron Courville Deep Learning , MIT Press, 2016.
<http://www.deeplearningbook.org>
- Simon O. Haykin Neural Networks and Learning Machines, Prentice Hall, 3rd edition, 2008

ADDITIONAL BIBLIOGRAPHY

- Charu C. Aggarwal Neural Networks and Deep Learning: A Textbook, Springer, 2018. <http://link.springer.com/978-3-319-94463-0>
- Mohamad H. Hassoun: Fundamentals of Artificial Neural Networks , MIT Press, 2003
- T.M. Mitchell Machine Learning, McGraw Hill, 1997