COURSE DATA

Data Subject	
Code	36428
Name	Connectionist models
Cycle	Grade
ECTS Credits	6.0
Academic year	2023 - 2024

Study (s)

Degree	Center	Acad. year	Period
1400 - Degree in Computer Engineering	School of Engineering	4	Second term
1406 - Degree in Data Science	School of Engineering	3	Second term

Subject-matter

Degree	Subject-matter	Character
1400 - Degree in Computer Engineering	16 - Optional subject	Optional
1406 - Degree in Data Science	9 - Machine Learning and Data Mining	Obligatory

Coordination

Name	Department
SORIA OLIVAS, EMILIO	242 - Electronic Engineering

SUMMARY

This course plans to review the classical connectionist models ("*narrow neural models*") together with more advanced structures such as convolutional networks. It is proposed to study these systems starting from the most individual element (neuron) to the complex structures composed by these units. On the other hand, fuzzy logic, concepts, operations on fuzzy sets and their most extended applications will be introduced. Finally, the two elements seen in the course, neural models and fuzzy systems, will be joined to give rise to the neuro-fuzzy systems.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

There are no specified enrollment restrictions with other subjects of the curriculum.

Other requirements

This subject is part of the third year of the degree so he has a minimum knowledge of algebra and mathematical analysis necessary for this subject. Knowledge of Python and R is required, which is taught in previous courses. It is convenient that the student has passed the subjects of algebra, mathematical analysis, data processing and programming fundamentals.

OUTCOMES

1400 - Degree in Computer Engineering

- IC3 - Ability to analyse, evaluate, select and configure hardware platforms for the development and implementation of computer applications and services.

1406 - Degree in Data Science

- (CG02) Ability to solve problems with initiative and creativity and to communicate and transmit knowledge, abilities and skills, which should include the ethical and professional responsibility of the activity of a data scientist.
- (CG03) Capability to elaborate models, calculations, reports, to plan tasks and other works analogous to the specific field of data science.
- (CT03) Ability to defend your own work with rigor and arguments and to expose it in an adequate and accurate way with the use of the necessary means.
- (CT05) Ability to evaluate the advantages and disadvantages of different methodological and / or technological alternatives in different fields of application.
- (CE03) Ability to solve classification, modelling, segmentation and prediction problems from a set of data.
- (CE07) Ability to model dependency between a response variable and several explanatory variables, in complex data sets, using machine learning techniques, interpreting the results obtained.
- (CE13) To know how to design, apply and evaluate data science algorithms for the resolution of complex problems.
- (CB3) Students must have the ability to gather and interpret relevant data (usually in their field of study) to make judgements that take relevant social, scientific or ethical issues into consideration.
- (CB4) Students must be able to communicate information, ideas, problems and solutions to both expert and lay audiences.

LEARNING OUTCOMES

Basic and general competencies will be associated with the following learning outcomes:

Knowledge of the concept of neuron (Competences CB3, CG2, CG3, CT3, CE3)

Learn the main neural architectures (Competences CB3, CB4, CG2, CG3, CT3, CT5, CE3, CE7, CE13)

Know what a convolutional network is (Competences CB3, CB4, CG2, CG3, CT3, CT5, CE3, CE7, CE13)

Learn the difference between classic and fuzzy logic. (Competences CB3, CB4, CG2, CG3, CT3, CT5, CE13) Knowing how to implement neurological systems. (Competences CB3, CB4, CG2, CG3, CT3, CT5, CE3, CE7, CE13).

DESCRIPTION OF CONTENTS

1. Neuron, Perceptron and Adaptive Systems

1.1. Connector models. History.
1.2. Neuron. Elements.
1.3. Perceptron. Learning algorithm.
1.4. ADALINE. Adaptive filters.
1.5. Hebb's rule. Learning algorithm.
1.6. Applications of mononeuronal systems.

2. Multilayer neural models.

2.1 Limitations of a neuron Extension.
2.2 Multilayer systems. Architecture. Backpropagation (BP) algorithm.
2.3 Variants of the BP algorithm.
2.4 Problems in multilayer neuronal systems.
2.5 Applications of multilayer neuronal systems.

3. Convolutional Networks

3.1 Architecture. Description.
3.2 Learning algorithms.
3.3 Most famous architectures.
3.4 CNN applications.

4. Fuzzy logic

4.1 Classic and fuzzy logic.
4.2 Fuzzy Sets. Operations.
4.3 Fuzzy rules.
4.4 Deffuzzifiers.
4.5 Sugeno and Mandani Systems.

5. Neuro-fuzzy systems.

5.1 Neuro-fuzzy neuron models.
5.2 Neuro-fuzzy models. Architectures.
5.3 Neuro-fuzzy models. Learning algorithms.
5.4 Applications and use cases.

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	36,00	100
Laboratory practices	20,00	100
Classroom practices	4,00	100
Attendance at events and external activities	2,00	0
Development of group work	6,00	0
Development of individual work	5,00	0
Study and independent work	35,00	0
Readings supplementary material	4,00	0
Preparation of evaluation activities	20,00	0
Preparing lectures	4,00	0
Preparation of practical classes and problem	4,00	0
Resolution of case studies	7,00	0
Resolution of online questionnaires	3,00	0
TOTAL	**150,00**	

TEACHING METHODOLOGY

The classes will combine theoretical and practical content:

MD1 - Theoretical activities. Expository development of the subject with the participation of the student in the resolution of specific questions. Conducting individual evaluation questionnaires. In the theoretical activities of presential character the subjects of the course will be developed providing a global and integrating vision, analyzing with greater detail the key aspects and of greater complexity, fomenting, at any moment, the participation of the students (CB3, CB4, CT3, CT5).

MD2 - Practical activities. Learning through problem solving, exercises and case studies through which skills are acquired on different aspects of the subject. (CB3, CB4, CG2, CG3, CT3, CT5, EC3, EC7, EC13) The theoretical activities are complemented by practical activities with the aim of applying the basic concepts and extending them with the knowledge and experience acquired during the performance of the proposed work.

MD4 -Laboratory and/or computer room work. Learning by doing activities developed individually or in small groups and carried out in laboratories and/or computer classrooms. (CB3, CB4, CG2, CG3, CT3, CT5, CE3, CE7, CE13).

EVALUATION

There will be a final exam with a weight of 60 % in the final mark. In order to pass the course, it is necessary to obtain a minimum score of 5 points (out of 10) in this exam. Students who do not reach this minimum grade in the final exam will have a "failing" grade and their final grade will not exceed 5 points. Students who do not pass the subject in the first call will have a new final exam on the day of the second call under the same conditions. (SE1, competences evaluated: CB3, CB4, CG2, CT3, CE3, CE7, CE13)

30 % of the qualification will be for the computer laboratory classes, which will be assessed by carrying out a series of practical tasks using the material in the laboratory. The students who do not pass the subject in the first call will have the possibility of using the score obtained in the first call in this part, but only if it is greater than or equal to 5 points, or take a final computer laboratory test under conditions similar to those of the computer laboratory classes on the same day as the second call. For organisational reasons, teachers may require prior registration for this make-up test, which will be announced sufficiently in advance (SE2/SE3, competences assessed: CB3, CB4, CG2, CG3, CT3, CT5, CE3, CE7, CE13)

The 10% of the grade will be obtained by continuous evaluation of the student through the use of on-line questionnaires that will be carried out both in the theory class and in the laboratory part. This part of the grade will not be recoverable in the second call. Students who do not pass the course in the first call will use in the second call the grade obtained in this part in the first call (SE2/SE3, competences evaluated: CB3, CB4, CG2, CG3, CT3, CT5, CE3, CE7, CE13)

In any case, the evaluation system will be governed by the Regulations of Evaluation and Qualification of the University of Valencia for bachelor’s and master’s degrees

(https://webges.uv.es/uvTaeWeb/MuestraInformacionEdictoPublicoFrontAction.do?accion=inicio&idEdictoSeleccionado=5639)

REFERENCES

Basic

- Neural Networks and Deep Learning A Textbook . Aggarwal, Charu C. Springer 2018.
- Deep Neuro-Fuzzy Systems with Python With Case Studies and Applications from the Industry. Himanshu Singh, Yunis Ahmad Lone. Apress 2020
- Artificial Neural Networks A Practical Course. da Silva, Ivan Nunes. Springer 2017.
- Advanced Applied Deep Learning: Convolutional Neural Networks and Object Detection. Umberto Michelucci. Apress 2019.
- Fuzzy Logic with Engineering Applications. Timothy J. Ross. Wiley 2016.

Additional

- Applied Deep Learning A Case-Based Approach to Understanding Deep Neural Networks. Michelucci, Umberto, Apress 2018
- Computational intelligence : synergies of fuzzy logic, neural networks, and evolutionary computing. Siddique, Nazmul. Wiley 2013.