

## COURSE DESCRIPTION

### COURSE DETAILS

Title (of the course): **INTRODUCCIÓN A LOS MODELOS COMPUTACIONALES**

Code: 101428

Degree/Master: **GRADO DE INGENIERÍA INFORMÁTICA**

Year: 4

Name of the module to which it belongs: OBLIGATORIO ESPECIALIDAD COMPUTACIÓN

Field: INTRODUCCIÓN A LOS MODELOS COMPUTACIONALES

Character: OBLIGATORIA

Duration: FIRST TERM

ECTS Credits: 6.0

Classroom hours: 60

Face-to-face classroom percentage: 40.0%

Study hours: 90

Online platform: <http://moodle.uco.es>

### LECTURER INFORMATION

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### PREREQUISITES AND RECOMMENDATIONS

#### Prerequisites established in the study plan

None

#### Recommendations

Solid knowledge of programming, mathematics and statistics. To have passed the courses "Introduction to Machine Learning" and "Metaheuristics" of the third year of the Grade in Computer Engineering, Computer Science mention.

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### INTENDED LEARNING OUTCOMES

CB4	To make students able to share information, ideas, problems and solutions with an audience of specialists and non-specialists
CTEC4	Ability to know the fundamentals, paradigms and techniques of intelligent systems and analyze, design and build systems, services and computer applications that use these techniques in any field of application.
CTEC5	Ability to acquire, obtain, formalize and represent human knowledge in a computable way to solve problems through a computer system in any field of application, particularly those related to aspects of computing, perception and performance in intelligent environments.
CTEC7	Ability to learn and develop computational learning techniques and design and implement applications and systems that use them, including those for the automatic extraction of information.

### OBJECTIVES

To develop and implement classification and regression techniques using non-linear models based on:

- Supervised Error Backpropagation and Hybrid learning.
- Using different neural network models: Multilayer perceptron (MLP), product units, radial basis functions and hybrid models.
- Using Hopfield networks.
- Using Support vector machines.
- Deep learning algorithms.

### CONTENT

#### 1. Theory contents

Block 1. Sigmoidal neural networks (multilayer perceptron, MLP), Radial Basis Functions (RBFs), product units and hybrids models. Error backpropagation and hybrid algorithms for neural network training.

Block 2. Hopfield networks.

Block 3. Support vector machines.

Block 4. Introduction to deep learning.

Block 5. fairness, accountability, transparency and ethics (FATE) in machine learning.

#### 2. Practical contents

- Assignment 1: Programming an MLP neural network for Regression.
- Assignment 2: Programming an MLP neural network for Classification.
- Assignment 3: Programming an RBF neural network for Classification/Regression.
- Assignment 4: Use of support vector machines support for classification problems.

### SUSTAINABLE DEVELOPMENT GOALS RELATED TO THE CONTENT

Gender equality

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### METHODOLOGY

#### General clarifications on the methodology (optional)

##### Assessment activities

In addition to the official exam of the course, some of the face-to-face laboratory sessions will be devoted to the defence of the different practice reports.

##### Case study

Some sessions of the large group as well as medium group will focus on the study of real-world cases to provide a wider understanding of the deployment and impact of machine learning based systems.

##### Lab practice

During the practical classes, the professor will propose a series of lab assignments whose main objective is the implementation of computational models (neural networks and support vector machines) using different programming languages.

##### Lectures

These sessions will present the concepts of each topic, while developing examples to help the student understand and clarify these concepts. During the theoretical classes the teacher will propose and carry out some practical exercises, which will complement the theory approached.

##### Tutorials

A forum will be placed in Moodle for asking and solving questions of the course in a collective way. In addition, during the development of the course, individualized tutorials will be available for the students within the schedule established by the teacher. Moreover, 2 hours of collective tutorials have been scheduled to be held throughout the course in the large group. In these sessions, doubts about theory will be solved in view of the final exam.

#### Methodological adaptations for part-time students and students with disabilities and special educational needs

For part-time students or those with specific needs, their condition and availability in the course will be taken into account, both in the development of the course and in its evaluation. The adaptation of the part-time student to the course will be carried out by mutual agreement with the teachers responsible at the beginning of the term, and each student should contact the teacher to indicate his/her situation. In exceptional and duly justified cases, the assessment criteria may be modified and adapted to these students, provided that equal rights and opportunities are guaranteed among all classmates.

#### Face-to-face activities

Activity	Large group	Medium group	Total
<i>Assessment activities</i>	2	4	6
<i>Case study</i>	6	2	8
<i>Lab practice</i>	-	18	18
<i>Lectures</i>	26	-	26
<i>Tutorials</i>	2	-	2

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Activity	Large group	Medium group	Total
<b>Total hours:</b>	<b>36</b>	<b>24</b>	<b>60</b>

### Off-site activities

Activity	Total
Activities	10
Information search	10
Reference search	10
Self-study	60
<b>Total hours</b>	<b>90</b>

## WORK MATERIALS FOR STUDENTS

Coursebook - <http://moodle.uco.es>

Exercises and activities - <http://moodle.uco.es>

### Clarifications

All the material will be uploaded to the Moodle platform.

## EVALUATION

Intended learning	Exams	Oral Presentation	Placement reports
CB4		X	
CTEC4			X
CTEC5	X		X
CTEC7	X		X
<b>Total (100%)</b>	<b>50%</b>	<b>20%</b>	<b>30%</b>
<b>Minimum grade</b>	<b>5</b>	<b>5</b>	<b>5</b>

(\*)Minimum mark (out of 10) needed for the assessment tool to be weighted in the course final mark. In any case, final mark must be 5,0 or higher to pass the course.

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### Method of assessment of attendance:

With regard to the lab classes, the student must attend at least 80% of the total number of lab sessions in order to pass the practical part in the January call (except in duly justified cases). Otherwise, they will not pass the practical part. This criterion does not apply to the February call or the September call.

### General clarifications on instruments for evaluation:

The evaluation of the course is divided in two parts, a practical part and a theoretical part (**Theory 50% + Practice 50%**). In order to pass the course, it is necessary to obtain at least **5 out of 10 points** in the practical part and 5 out of 10 points in the theory part. If a student passes only the theory part or only the practice part, in both cases with **5 out of 10 points**, the corresponding mark will be kept during the corresponding academic course.

The theory part ("**Exams**", **50% of the final mark**) will be evaluated with a final theoretical examination which will consist of:

- **Short answer tests (20%).**
- **Long Answer Test (30%).**

The practical part (**50% of the grade**) will be evaluated by means of "**Placement reports**" (**30% of the total grade**) made during the course, which will include the code of the assignments. In addition, the evaluation of these practices will include a defense or validation of each one of them ("**Oral presentation**", **20% of the total grade**), to be carried out during the practical sessions. This defence corresponds to the instrument **Interview** of the Verifica document. It is necessary to pass **individually** all the practices to pass the practical part.

If a student only attends some of the evaluation mechanisms of the course, he/she will appear in the official evaluation reports with a maximum grade of "Suspenso 3" ("Fail 3").

Repeating students who have already passed the practical or theoretical part in other academic courses (providing documentation or justification from the previous teacher) will not have to do it again, the grade assigned in the corresponding part being the one obtained at the time.

All these indications are valid for the first and second ordinary calls.

For the first ordinary call, both the theory and the practical part can be passed by **continuous evaluation**:

- For the theory part (**50% of the final mark**), in the middle of the term, students will be able to take a partial evaluation test of the content taught so far, with the same structure as the final test (i.e. short answer and problem solving questions). At the end of the term, students will be able to take another assessment test with the remaining content. The assessment tests are eliminatory. If the students do not take the mid-term tests or one or both of them are not passed during the term, they will have a second chance, and they will be able to make up the parts not passed on the date of the official final January exam set by the school.
- For the practical part, students must submit reports on each practice during the course. In the middle of the four-month period, interviews will be held for the reports already submitted and, at the end of the period, for the remaining ones.

The **extraordinary call for the completion of studies** is for students who meet the requirements of the established in Article 29.2 of the Academic Regulations. They will be examined according to the guide from the previous year and the criteria specified therein.

The "Matrícula de Honor" award may be given to students who have earned a grade of 9.0 or higher. Its number cannot exceed 5% of the students officially listed, unless the number of students is less than 20, in which case only one "Matrícula de Honor" may be awarded. Those that can be granted will be determined by the teachers

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according to the results obtained by the students in the evaluations and their participation and involvement in the course. In the event that several students are eligible for this qualification and it cannot be awarded to all of them, a small test will be held to be determined by the teachers.

### Clarifications on the methodology for part-time students and students with disabilities and special educational needs:

For part-time students, their status and availability in the course will be taken into account. The adaptation of the part-time student to the course will be carried out by mutual agreement at the beginning of the four-month period between the teacher responsible for the course and the students involved. It is necessary that, at the beginning of the course, these students inform the teacher. As far as possible, the methodology of the course will be adapted to students with special educational needs. It is necessary that, at the beginning of the course, these students inform the teacher. In any case, for both part-time students and students with special educational needs, the same evaluation criteria will be applied as those applied to other students.

### Clarifications on the evaluation of the extraordinary call and extra-ordinary call for completion studies:

Both calls will be evaluated following the general clarifications described above. The only difference is that the interviews will take place on the same day as the theoretical tests.

### Qualifying criteria for obtaining honors:

*Consult General clarifications on instruments for evaluation*

## BIBLIOGRAPHY

### 1. Basic Bibliography

- C.M. Bishop, Pattern recognition and machine learning, Springer, 2006.
- Hastie, T. and R. Tibshirani, and J.H. Friedman. The elements of statistical learning: data mining, inference, and prediction. Springer. 2009.
- Géron, A. Hands-on machine learning with Scikit-Learn, Keras, and TensorFlow. O'Reilly Media, Inc., 2022.
- Hertz, J., A. Krogh, R.G. Palmer and H. Horner. Introduction to the theory of neural computation. Taylor & Francis, segunda edición, 1991.
- Haykin, Simon S. Neural networks and learning machines. Pearson Education, 2009.
- Meyers, S. Effective modern C++: 42 specific ways to improve your use of C++ 11 and C++ 14. O'Reilly Media, Inc. 2014.
- Witten, Ian H., and Eibe Frank. Data Mining: Practical machine learning tools and techniques. Morgan Kaufmann, 2005.
- Goodfellow, Ian, Yoshua Bengio, and Aaron Courville. Deep learning. MIT press, 2016.
- Berzal, Fernando. Redes Neuronales & Deep Learning. Universidad de Granada. 2018.
- Barocas, Solon, Hardt, Moritz, and Narayanan, Arvind. Fairness and Machine Learning. <https://fairmlbook.org>, 2019.
- IEEE Recommended Practice for Assessing the Impact of Autonomous and Intelligent Systems on Human Well-Being. IEEE Std 7010-2020, 1--96. <https://doi.org/10.1109/IEEESTD.2020.9084219>, 2020.
- ISO/IEC TR 24027:2021(en), Information technology—Artificial intelligence (AI)--Bias in AI systems and AI aided decision making. (n.d.). <https://www.iso.org/obp/ui/#iso:std:iso-iec:tr:24027:ed-1:v1:en>, 2022.

### 2. Further reading

- Alpaydin, E. 2010 Introduction to Machine Learning, 2Ed. The MIT Press.
- R. Duda, P.E. Hart, D.G. Stork. Pattern Classification. Wiley. 2001.



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- J. Hernández-Orallo, M.J. Ramírez, C. Ferri. Introducción ala Mineríade Datos. Pearson Educación. 2004.
- L. Kuncheva. Combining Pattern Classifiers. Wiley. 2004.
- S. Sharma. Applied Multivariate Techniques. Wiley. 1996.
- A. Webb. Statistical Pattern Recognition. Wiley. 2002.
- Tom M. Mitchell. Machine Learning. McGraw-Hill, 1997.
- Saso Dzeroski and Nada Lavrac: Relational Data Mining. Springer Verlag
- Jiawei Han and Micheline Kamber. Data Mining: Concepts and Techniques. Morgan Kaufmann Publishers, 2000
- Mitchell, Margaret, Wu, Simone, Zaldivar, Andrew, Barnes, Parker, Vasserman, Lucy, Hutchinson, Ben, Spitzer, Elena, Raji, Inioluwa Deborah, & Gebru, Timnit. Model Cards for Model Reporting. Proceedings of the Conference on Fairness, Accountability, and Transparency, 220-229, 2019. <https://doi.org/10.1145/3287560.3287596>

## COORDINATION CRITERIA

Joint activities: lectures, seminars, visits ...

Tasks deadlines

### Clarifications

The possible completion or delivery of work will be coordinated with other courses, so as not to interfere with the normal development of them.

## SCHEDULE

Period	Assessment activities	Case study	Lab practice	Lectures	Tutorials
1# Week	0,0	0,0	0,0	3,0	0,0
2# Week	0,0	0,0	2,0	3,0	0,0
3# Week	0,0	2,0	0,0	0,0	0,0
4# Week	0,0	0,0	2,0	3,0	0,0
5# Week	0,0	0,0	2,0	3,0	0,0
6# Week	0,0	0,0	2,0	3,0	0,0
7# Week	2,0	3,0	0,0	0,0	0,0
8# Week	2,0	0,0	0,0	0,0	0,0
9# Week	0,0	0,0	2,0	3,0	0,0
10# Week	0,0	0,0	2,0	3,0	0,0
11# Week	0,0	3,0	2,0	0,0	0,0
12# Week	0,0	0,0	2,0	3,0	0,0
13# Week	0,0	0,0	2,0	0,0	2,0
14# Week	2,0	0,0	0,0	2,0	0,0
<b>Total hours:</b>	<b>6,0</b>	<b>8,0</b>	<b>18,0</b>	<b>26,0</b>	<b>2,0</b>



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The methodological strategies and the evaluation system contemplated in this Course Description will be adapted according to the needs presented by students with disabilities and special educational needs in the cases that are required.