



## Teaching Guide

Teaching Guide				
Identifying Data				2024/25
Subject (*)	Introduction to Machine Learning		Code	730497240
Study programme	Mestrado Universitario en Enxeñaría Industrial (plan 2018)			
Descriptors				
Cycle	Period	Year	Type	Credits
Official Master's Degree	2nd four-month period	Second	Optional	4.5
Language	SpanishGalician			
Teaching method	Face-to-face			
Prerequisites				
Department	Ciencias da Computación e Tecnoloxías da InformaciónComputación			
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Lecturers	Bellas Bouza, Francisco Javier		E-mail	francisco.bellas@udc.es
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General description	This course provides an introduction to the computational automatic learning techniques most commonly used in the field of industrial engineering. It will provide an overview of the field of machine learning to understand what types of problems are solved and with what techniques, with the aim of providing the student with a general knowledge on the scope of application of them.			

## Study programme competences / results

Code	Study programme competences / results
A8	ETI8 - Ability to design and project automated production systems and advanced process control.
B1	CB6 - Possess and understand knowledge that provides a basis or opportunity to be original in the development and / or application of ideas, often in a research context.
B2	CB7 - That students know how to apply the knowledge acquired and their ability to solve problems in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their area of ??study.
B3	CB8 - That students are able to integrate knowledge and face the complexity of making judgments based on information that, being incomplete or limited, includes reflections on the social and ethical responsibilities linked to the application of their knowledge and judgments.
B4	CB9 - That the students know how to communicate their conclusions -and the knowledge and ultimate reasons that sustain them- to specialized and non-specialized audiences in a clear and unambiguous way.
B5	CB10 - That students have the learning skills that allow them to continue studying in a way that will be largely self-directed or autonomous.
B6	G1 - Have adequate knowledge of the scientific and technological aspects in Industrial Engineering.
B13	G8 - Apply the knowledge acquired and solve problems in new or unfamiliar environments within broader and multidisciplinary contexts.
B14	G9 - Be able to integrate knowledge and face the complexity of making judgments based on information that, being incomplete or limited, includes reflections on social and ethical responsibilities linked to the application of their knowledge and judgments.
B15	G10 - Knowing how to communicate the conclusions -and the knowledge and ultimate reasons that sustain them- to specialized and non-specialized publics in a clear and unambiguous way.
B16	G11 - Possess the learning skills that allow to continue studying in a self-directed or autonomous way.
C1	ABET (a) - An ability to apply knowledge of mathematics, science, and engineering.
C3	ABET (c) - An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
C6	ABET (f) - An understanding of professional and ethical responsibility.
C7	ABET (g) - An ability to communicate effectively.
C8	ABET (h) - The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.
C9	ABET (i) - A recognition of the need for, and an ability to engage in life-long learning.
C11	ABET (k) - An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.



Learning outcomes			
Learning outcomes	Study programme competences / results		
Coñecer as principais técnicas de clasificación supervisada e non supervisada, e o seu uso práctico	AJ8	BJ1 BJ2 BJ6 BJ13	CJ1 CJ3
Know the non-resolved problems in autonomous robotics	AJ8	BJ1 BJ4 BJ6 BJ13 BJ14	CJ1 CJ3 CJ11
Know the problems of sensing and actuation in systems that operate in the real world and real time	AJ8	BJ1 BJ4 BJ6 BJ13 BJ14	CJ1 CJ3 CJ11
Know the problems of knowledge representation in autonomous robotics		BJ1 BJ4 BJ5 BJ6 BJ14 BJ16	CJ1 CJ6 CJ7 CJ8
Know the problems to tackle when an autonomous robotic control system is developed		BJ1 BJ2 BJ3 BJ13 BJ14 BJ15	CJ3 CJ6 CJ7 CJ8 CJ9 CJ11

Contents	
Topic	Sub-topic
Introduction	Preliminary concepts. Types of problems: classification, regression, clustering, anomaly detection, etc. Forms of learning: supervised, unsupervised, reinforcement, etc.
Classification and clustering methods	Introduction Supervised classification algorithms Unsupervised classification algorithms (clustering)
Data processing methods	Data Preparation Dimensionality reduction
Regression methods for modeling and prediction	Introduction Main techniques Artificial Neural Networks
Experimental methodology and result analysis	Methods for estimating error Results analysis Model comparison

Planning
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Methodologies / tests	Competencies / Results	Teaching hours (in-person & virtual)	Student's personal work hours	Total hours
Supervised projects	B2 B3 B4 B13 C1 C3	0	37	37
Oral presentation	B1 B5 B15 B14 B6 C7 C9 C11	3	9	12
ICT practicals	A8 B13 B14 B16 B6 C11	10.5	21	31.5
Document analysis	B3 B5 B14 B6 C11	2	8	10
Guest lecture / keynote speech	B1 B6 C6 C8	16	2	18
Personalized attention		4	0	4
(*)The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.				

Methodologies	
Methodologies	Description
Supervised projects	Programming exercises in which some of the techniques seen in the theory classes will be implemented on real engineering problems, using the programming language selected by the teachers. These exercises will be carried out by the students autonomously and their progress will be tutored by the teachers.
Oral presentation	Theoretical work or works about a specific topic from the contents that will be orally presented and discussed with other students
ICT practicals	In person computer sessions in which teachers explain the use and programming of automatic learning techniques as seen in theory, so that students acquire sufficient skills to use them autonomously.
Document analysis	Methodological technique that involves the use of audiovisual and/or bibliographic documents relevant to the subject matter with activities specifically designed for their analysis. In this case, it will be used in a context of "flipped classroom" in which the theoretical concepts will be reviewed by the students independently prior to the lecture session, in which an activity will be carried out to assess their understanding.
Guest lecture / keynote speech	Oral exposition by the teachers of the theory of the subject.

Personalized attention	
Methodologies	Description
Oral presentation ICT practicals Supervised projects Document analysis	<p>During the ICT practical classes, the student will be allowed to ask the teacher any questions that arise about the programming of the learning methods.</p> <p>Supervised projects: It is recommendable the use of a personal assistance in these activities to resolve conceptual doubts or procedures than can appear during the resolution of the practical problems. Also, the personal assistance will be focused on in the explanation, by the student, of the proposed solution.</p> <p>Oral presentation: the students' progress in their theoretical work must be supervised by the teachers, both in terms of contents and format.</p> <p>Document analysis: students will be able to consult lecturers on reference materials prior to the lectures.</p> <p>Students enrolled part-time will have an online personalised communication channel in all the methodologies.</p>

Assessment			
Methodologies	Competencies / Results	Description	Qualification



Oral presentation	B1 B5 B15 B14 B6 C7 C9 C11	The oral presentation, the participation in the discussion and the written inform will be considered in the final qualification. It is mandatory to pass this methodology independently in order to pass the whole subject.	30
Supervised projects	B2 B3 B4 B13 C1 C3	Different programming projects will be proposed along the course that must be carried out in an autonomous way by the student and that will be presented and explained to the teachers afterwards. It is mandatory to pass this methodology independently in order to pass the whole subject.	60
Document analysis	B3 B5 B14 B6 C11	Part of the lectures will be used to evaluate the understanding of the documentary sources, which will be provided by the teachers prior to the class for consultation and understanding. These evaluations will be carried out by means of group work, small reports, questionnaires, or other methodologies that allow an objective assessment of the degree of analysis carried out.	10

## Assessment comments

### First opportunity:

To pass the course on the first opportunity, a minimum score of 50 must be achieved by adding up all the previous methodologies, being necessary to obtain a minimum of 30 in the Supervised Work and 20 in the sum of the Oral Presentation and the Analysis of documentary sources.

### Second opportunity:

If the student does not pass the subject on the first opportunity, he/she must repeat the activities that are necessary from the method(s) that were not passed in the second call. For example, if a student passed the Oral Presentation + Analysis of documentary sources part, but failed the Supervised Work, he/she must repeat the practical work necessary to pass the course, normally those that were not individually passed.

In the second opportunity, the minimum grade criteria established in the first call are maintained.

### Early opportunity

For this opportunity, the same criteria are maintained as for the first, with the student having to specify delivery deadlines with the subject teachers.

### Students with part-time registration or academic exemption

They may accumulate 15% of the grade corresponding to the Analysis of documentary sources in the oral presentation in the both opportunities. This modification must be requested from the professors of the subject at the beginning of the semester. Likewise, if they cannot make the oral presentation with the rest of the students, they must arrange an alternative date with the professors in all sessions.

All regulatory aspects related to ?academic exemption?, ?dedication to study?, ?permanence? and ?academic fraud? will be governed in accordance with the current academic regulations of the UDC (<https://www.udc.es/es/normativa/academica/>)

## Sources of information

<b>Basic</b>	<ul style="list-style-type: none"> <li>- Marsland, Stephen (2014). Machine Learning: An Algorithmic Perspective. Chapman and Hall/CRC Press</li> <li>- Gonzalo Pajares Martínez, Jose Manuel de la Cruz García (2010). Aprendizaje automático : un enfoque práctico. Ra-Ma</li> <li>- Ethem Alpaydin (2014). Introduction to Machine Learning. MIT Press</li> <li>- Christopher M. Bishop (2010). Pattern Recognition and Machine Learning. Springer</li> <li>- A Whirlwind Tour of Python by Jake VanderPlas (O'Reilly):HTML bookExercises source code</li> <li>- A Whirlwind Tour of Python by Jake VanderPlas (O'Reilly):HTML bookExercises source code</li> </ul>
<b>Complementary</b>	<ul style="list-style-type: none"> <li>- Andreas C. Müller, Sarah Guido (2016). Introduction to Machine Learning with Python: A Guide for Data Scientists. O'Reilly Media</li> <li>- Sebastian Raschka, Vahid Mirjalili (2019). Python machine learning : aprendizaje automático y aprendizaje profundo con Python, scikit-learn y TensorFlow. Marcombo</li> <li>- Aurelien Geron (2017). Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems. O'Reilly Media</li> <li>- Kevin P. Murphy (2010). Machine Learning, a probabilistic perspective. MIT Press</li> </ul>



## Recommendations

### Subjects that it is recommended to have taken before

### Subjects that are recommended to be taken simultaneously

Machine Vision for Industrial Applications/730497239

Industrial Process Design and Optimization Project/730497236

Machine Design and Construction/730497226

Kinematics and Dynamics of Industrial Robots/730497228

### Subjects that continue the syllabus

### Other comments

1.- The delivery of the documentary works that are carried out in this subject: 1.1. It will be requested in virtual format and/or computer support. 1.2. It will be done through Moodle, in digital format without the need to print them? 1.3. If done on paper:- No plastic will be used.- Double-sided printing will be done.- Recycled paper will be used.- Printing drafts will be avoided. 2.- Sustainable use of resources must be made and negative impacts on the natural environment must be prevented. 3.- The importance of ethical principles related to the values of sustainability in personal and professional behavior must be taken into account. 4.- According to the different regulations applicable to university teaching, the gender perspective must be incorporated in this matter (non-sexist language will be used, bibliography by authors of both sexes will be used, the intervention of male and female students in class will be encouraged...). 5.- Work will be done to identify and modify sexist prejudices and attitudes, and the environment will be influenced to modify them and promote values of respect and equality. 6. Situations of discrimination based on gender must be detected and actions and measures will be proposed to correct them. 7. The full integration of students who, for physical, sensory, psychological or sociocultural reasons, experience difficulties in having suitable, equal and beneficial access to university life will be facilitated.

(\*)The teaching guide is the document in which the URV publishes the information about all its courses. It is a public document and cannot be modified. Only in exceptional cases can it be revised by the competent agent or duly revised so that it is in line with current legislation.