Teaching Guide				
Identifying Data				2023/24
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			
Coordinador	Bellas Bouza, Francisco Javier	E-mail	francisco.bellas@udc.es	
Lecturers	Bellas Bouza, Francisco Javier Mallo Casdelo, Alma María	E-mail	francisco.bellas@udc.es alma.mallo@udc.es	
Web				
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
Experimental methodology and result analysis	Methods for estimating error Results analysis Model comparison
Regression methods for modeling and prediction	Introduction Main techniques Artificial Neural Networks

Planning

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	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. 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. Oral presentation: the students' progress in their theoretical work must be supervised by the teachers, both in terms of contents and format. Document analysis: students will be able to consult lecturers on reference materials prior to the lectures. Students enrolled part-time will have an online personalised communication channel in all the methodologies.

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.	25
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.	15

Assessment comments
In order to obtain a pass in this subject, a minimum mark of 50 must be obtained in all the above methodologies, with a minimum of 30 in the Tutored Work and 25 in the sum of the Oral Presentation and the Document Analysis. If the student does not pass the subject at the first sitting, he/she will have to repeat the necessary activities of the methodology(ies) that were not passed at the second sitting. As an example, if a student passed the Oral Presentation + Document Analysis part, but failed the tutored assignments, he/she will have to repeat the practical assignments necessary to achieve a pass, normally those that were not passed individually. Assessment of the extraordinary call: students who opt for this call will have to do the tutored work and oral presentation methodologies, but not the Document Analysis. The value of this methodology is added to that of Oral Presentation, becoming worth 40%. It is necessary to contact the professors at the beginning of the term (January) in order to have a sufficient deadline for delivery. Part-time students will be able to accumulate 15% of the grade corresponding to the Document Analysis in the oral presentation in all the sessions. This modification must be requested to the lecturers of the subject at the beginning of the term. Likewise, in the event of not being able to give the oral presentation with the rest of the students, an alternative date must be agreed with the lecturers at all the sessions. In the case of plagiarism in internships or teaching assignments, article 11, section 4 b) of the UDC Student Disciplinary Regulations will be taken into account: b) Failure grade in the exam session in which the offence is committed and with respect to the subject in which it is committed: the student will be graded with a "fail" (numerical grade 0) in the corresponding exam session of the academic year, whether the offence is committed on the first or second occasion. To this end, the student's grade will be modified at the first opportunity, if necessary.

Sources of information	
Basic	- Marsland, Stephen (2014). Machine Learning: An Algorithmic Perspective. Chapman and Hall/CRC Press - Gonzalo Pajares Martínez, Jose Manuel de la Cruz García (2010). Aprendizaje automático : un enfoque práctico. Ra-Ma - Ethem Alpaydin (2014). Introduction to Machine Learning. MIT Press - Christopher M. Bishop (2010). Pattern Recognition and Machine Learning. Springer A Whirlwind Tour of Python by Jake VanderPlas (O?Reilly):Libro en HTMLCódigo fuente de los ejercicios
Complementary	- Andreas C. Müller, Sarah Guido (2016). Introduction to Machine Learning with Python: A Guide for Data Scientists. O'Reilly Media - Sebastian Raschka, Vahid Mirjalili (2019). Python machine learning : aprendizaje automático y aprendizaje profundo con Python, scikit-learn y TensorFlow. Marcombo - Aurelien Geron (2017). Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems. O'Reilly Media - Kevin P. Murphy (2010). Machine Learning, a probabilistic perspective. MIT Press

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
-According to the different regulations applicable to university teaching, the gender perspective must be incorporated into this subject.-Work will be done to identify and modify sexist prejudices and attitudes and influence the environment to modify them and promote values of respect and equality.-Situations of gender discrimination should be detected and actions and measures should be proposed to correct them.In order to help achieve a sustainable environment and fulfil the objective of the Green Campus Action Plan, the delivery of the documentary work carried out in this area:- Virtual format or digital support will be requested.- They'll be done on the Virtual Campus without printing them.In case they?re done in paper:- Don't use plastics.- Use double-sided printing.- Use recycled paper.- Avoid printing drafts.