UNIVERSIDADE DA CORUÑA

Teaching Guide				
Identifying Data				2022/23
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	
Code	Study programme competences
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		
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	Ordinary class hours	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
Objective test	B1 B14 B6	1	0	1
Guest lecture / keynote speech	B1 B6 C6 C8	17	10	27
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.
Objective test	A multiple-choice or test-type questionnaire that is completed online at the end of the master theory sessions, with the aim of assessing the degree of participation, attention and understanding of the concepts explained by the teacher. Tools like Moodle, Microsoft Forms or Kahoot could be used.
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	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. Students enrolled part-time will have an online personalised communication channel in all the methodologies.

Assessment			
Methodologies	Competencies	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
Objective test	B1 B14 B6	Understanding the concepts explained by the teacher in the master sessions implies that students participate in the classes in an active way, raising questions and making the most of personal interaction. This understanding is valued in the final grade of the course through the online questionnaires that are made in the final minutes of each master session.	10

Assessment comments
The evaluation of this subject is based on the pass of the two main methodologies, Supervised Projects and Oral Presentation, in an independent way. The first is focused on the practical demonstration of the knowledge and skills acquired to solve engineering problems through automatic learning techniques, and the second on the realization and exposition of a work on a specific topic within the theoretical topics. Thus, in case the student does not pass the subject in the ordinary call, he/she will have to repeat the necessary activities of the method(s) that were not passed in the extraordinary call. As an example, if a student passed the Oral Presentation but failed in the supervised projects, he/she will have to repeat the projects necessary to reach the passing grade, normally that/those that individually were not passed Early assessment (December): students who choose this call have to carry out Supervised Projects and Oral Presentation methodologies but not the Objective test. The value of this methodology will be added to the Supervised Projects value, which will value 70%. At the beginning of the academic period (September), the students must let the professors know they'll attend the early assessment to get enough time to accomplish the work Students with part-time enrollment, in the case of not being able to carry out an oral presentation with the rest of the students, nor in person neither online, an alternative date must be arranged with the teachers. This modification must be requested to the subject teachers at the beginning of the course.

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
The documents to be deliver in this subject:- 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.

(*)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.