Teaching Guide				
Identifying Data				2024/25
Subject (*)	Machine Learning II		Code	614544014
Study programme	Máster Universitario en Intelixencia Artificial			
Descriptors				
Cycle	Period	Year	Type	Credits
Official Master's Degree	2nd four-month period	First	Optional	3
Language	English			
Teaching method	Hybrid			
Prerequisites				
Department	Ciencias da Computación e Tecnoloxías da Información			
Coordinador	Fernández Blanco, Enrique	E-mail	enrique.fernandez@udc.es	
Lecturers	Fernández Blanco, Enrique	E-mail	enrique.fernandez@udc.es	
Web				
General description	The subject introduces students to machine learning techniques applicable in environments that present restrictions in the distribution of the data used in the generation of the models: treatment of flows, incorporation of new experiences, the evolution of concepts over time or the preservation of the privacy of the information. Their consideration requires specific training in the application of incremental learning techniques, detection of obsolescence and confidentiality in the handling of datasets. 1. To acquire knowledge of how the main incremental learning techniques work. 2. To apply incremental learning techniques for the analysis of real-time data in stationary and non-stationary environments. 3. To know the working principle of the main privacy-preserving learning paradigms.			

Study programme competences / results	
Code	Study programme competences / results
A11	CE10 - Ability to implement, validate and apply a stochastic model starting from the observed data on a real system, and to perform a critical analysis of the obtained results, selecting those ones most suitable for problem solving
A12	CE11 - Understanding and command of the main techniques and tools for data analysis, both from the statistical and the machine learning viewpoints, including those devised for large volumes of data, and ability to select those ones most suitable for problem solving
A13	CE12 - Ability to outline, formulate and solve all the stages of a data project, including the understanding and command of basic concepts and techniques for information search and filtering in big collections of data
A16	CE15 - Knowledge of computer tools in the field of machine learning and ability to select those ones most suitable for problem solving
B2	CG02 - Successfully addressing each and every stage of an AI project
B3	CG03 - Searching and selecting that useful information required to solve complex problems, with a confident handling of bibliographical sources in the field
B4	CG04 - Suitably elaborating written essays or motivated arguments, including some point of originality, writing plans, work projects, scientific papers and formulating reasonable hypotheses in the field
B5	CG05 - Working in teams, especially of multidisciplinary nature, and being skilled in the management of time, people and decision making
B6	CB01 - Acquiring and understanding knowledge that provides a basis or opportunity to be original in the development and/or application of ideas, frequently in a research context
B7	CB02 - The students will be able to apply the acquired knowledge and to use their capacity of solving problems in new or poorly explored environments inside wider (or multidisciplinary) contexts related to their field of study
B8	CB03 - The students will be able to integrate different pieces of knowledge, to face the complexity of formulating opinions (from information that may be incomplete or limited) and to include considerations about social and ethical responsibilities linked to the application of their knowledge and opinions
B9	CB04 - The students will be able to communicate their conclusions, their premises and their ultimate justifications, both to specialised and non-specialised audiences, using a clear style language, free from ambiguities

C3	CT03 - Use of the basic tools of Information and Communications Technology (ICT) required for the student's professional practice and learning along her life
C4	CT04 - Acquiring a personal development for practicing a citizenship under observation of the democratic culture, the human rights and the gender perspective
C7	CT07 - Developing the ability to work in interdisciplinary or cross-disciplinary teams to provide proposal that contribute to a sustainable environmental, economic, political and social development
C8	CT08 - Appreciating the importance of research, innovation and technological development in the socioeconomic and cultural progress of society
C9	CT09 - Being able to manage time and resources: outlining plans, prioritising activities, identifying criticisms, fixing deadlines and sticking to them

Learning outcomes			
Learning outcomes	Study programme competences / results		
To acquire knowledge of how the main incremental learning techniques work.	AC10 AC11 AC12 AC15	BC2 BC3 BC4 BC5 BC6 BC7 BC8 BC9	CC3 CC4 CC7 CC8 CC9
To apply incremental learning techniques for the analysis of real-time data in stationary and non-stationary environments	AC10 AC11 AC12 AC15	BC2 BC3 BC4 BC5 BC6 BC7 BC8 BC9	CC3 CC4 CC7 CC8 CC9
To know the working principle of the main privacy-preserving learning paradigms	AC10 AC11 AC12 AC15	BC2 BC3 BC4 BC5 BC6 BC7 BC8 BC9	CC3 CC4 CC7 CC8 CC9

Contents	
Topic	Sub-topic
1. Theory	1. Machine Learning Online 2. Concept Drift 3. Federated Learning
2. Practice	1. Machine Learning Online and Concept Drift 2. Federated Learning

Planning

Methodologies / tests	Competencies / Results	Teaching hours (in-person & virtual)	Student?s personal work hours	Total hours
Guest lecture / keynote speech	A11 A12 A13 A16 B3 B6 B7 B8 B9 C3 C4 C8	10	10	20
Seminar	A11 A12 A13 A16 B2 B4 B5 C7 C9	4	20	24
ICT practicals	A11 A12 A13 A16 B3 B6 B7 B8 C3 C4 C8	7	21	28
Mixed objective/subjective test	A11 A12 A13 A16 B4 B6 B7	1	0	1
Personalized attention		2	0	2
(*)The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.				

Methodologies	
Methodologies	Description
Guest lecture / keynote speech	The contents of the course will be taught indistinctly between lectures and interactive classes. The completion of all the proposed activities is necessary, as well as the attendance to all the classes (lectures and interactive) to pass the course. Expository classes (theory): will consist of the explanation of the different sections of the course syllabus, with the help of electronic media (presentations, videos, etc.)
Seminar	Case studies: students may be presented with real or fictional work scenarios that present certain problems. Students will have to apply the theoretical and practical knowledge of the subject to find a solution to the question or questions posed. As a general rule, case studies will be carried out in groups. The different working groups will present and share their solutions.
ICT practicals	Interactive classes (practical): different practical problems related to the content of the subject will be posed for the student to solve individually or in groups. Project-based learning: students may be given practical projects whose scope requires them to dedicate a significant part of their time to the subject. Autonomous work: the scope and objectives of the projects, use cases and/or practical problems may require autonomous work on the part of the students, albeit under the supervision of the teaching staff.
Mixed objective/subjective test	A mixed test which can contain quiz questions, short=answer questions or development questions. It is going to evaluate the teorethical part of the subject and it can contain questions about the content of the seminars or practical exercises

Personalized attention	
Methodologies	Description
Guest lecture / keynote speech ICT practicals Seminar	Office hours: Office hours will be used to solve students' doubts related to the contents of the subject. These office hours can be both face-to-face and virtual (via email, virtual campus or Microsoft Teams platform). Virtual Classroom: This subject will have a virtual classroom where students will be provided with all the necessary material in digital format. Different communication tools will also be provided to support both teaching and office hours, including videoconferencing, chat, e-mail, forums...

Assessment			
Methodologies	Competencies / Results	Description	**Qualification**

Mixed objective/subjective test	A11 A12 A13 A16 B4 B6 B7	Subjective test which can be a mixture model with quiz questions and some short-answer or development questions.	50
ICT practicals	A11 A12 A13 A16 B3 B6 B7 B8 C3 C4 C8	This mark includes the evaluation exercises made during the practical lessons and the developed project.	30
Seminar	A11 A12 A13 A16 B2 B4 B5 C7 C9	This is going to include the grading og the practical exercises and the proyects developed in the seminars.	20

Assessment comments
In order to pass the course, the student will have to carry out all the proposed activities and pass the corresponding exams.First opportunity:To pass the subject, the student must deliver and pass the proposed activities (50% of the final grade) and pass the final exam (50% of the grade).Mid-term exams:No mid-term exams will be held.Second opportunity:The grade obtained in the laboratory practices during the course is maintained, as well as its weight in the final grade. Students who have notreached the cut-off mark in the activities proposed during the previous call, may submit, prior to the second chance final exam, similar activities,which will be proposed by the teachers. Once both parts have been passed separately, the exam will account for the 50% of the final mark and thelaboratory practices for the remaining 50%.Exemption from attendance:In case of dispensation of attendance, students will be examined under the same conditions as students in the first round. Repeating students:In case of repeating students, they will be examined under the same conditions as students in the first round.No-show qualification:The student will receive the qualification of "no-show" when he/she does not take the final exam.Evaluation of competences: In general, the development of the practical activities, projects and use cases, as well as the preparation of the theoretical topics will allow students to work on the basic, general and transversal competences of the subject. Specifically, through the projects and use cases, the competences CT7, CT9, CG5, CG4, CG2 will be assessed. The development of the practices, as well as the final test, will allow the evaluation of the specific competences: CE10, CE11, CE12, CE15.Equality: According to the various applicable regulations for university teaching, the gender perspective should be incorporated into this subject (using non-sexist language, using bibliographic references from authors of both genders, encouraging the participation of male and female students in class). Efforts will be made to identify and modify prejudices and sexist attitudes, and the environment will be influenced to change them and promote values of respect and equality. Situations of gender-based discrimination should be identified, and actions and measures should be proposed to correct them. All aspects related to "academic exemption," "study dedication," "continuity," and "academic fraud" will be governed in accordance with the current academic regulations of the University

Sources of information	
Basic	- Bahri, M., Bifet, A., Gama, J., Gomes, H. M., & Maniu, S (2021). Data stream analysis: Foundations, major tasks and tools. Wiley nterdisciplinary Reviews: Data Mining and Knowledge Discovery,11(3) - Bifet, A., Gavalda, R., Holmes, G., & Pfahringer, B (2018). Machine learning for data streams: with practical examples in MOA. MIT Press - Gama, J., ?liobaitė, I., Bifet, A., Pechenizkiy, M., & Bouchachia, A. (2014). A survey on concept drift adaptation.. CM computing surveys(CSUR),46(4), 1-37 - Gomes, H. M., Read, J., Bifet, A., Barddal, J. P., & Gama, J. (2019). Machine learning for streaming data: state of the art, challenges, and opportunities.. ACM SIGKDD Explorations Newsletter,21(2), 6-22 - Hoi, S. C., Sahoo, D., Lu, J., & Zhao, P. (2021). Online learning: A comprehensive survey. Neurocomputing,459, 249-289. - Li, T., Sahu, A. K., Talwalkar, A., & Smith, V. (2020). Federated learning: Challenges, methods, and future directions.. IEEE signal processing magazine, 37(3), 50-60 - Lu, J., Liu, A., Dong, F., Gu, F., Gama, J., & Zhang, G. (2018). Learning under concept drift: A review.. IEEE Transactions on Knowledge and DataEngineering,31(12), 2346-2363 - Orabona, F. (2019). A modern introduction to online learning.. arXivpreprint arXiv:1912.13213 - Yang, Q., Liu, Y., Chen, T., & Tong, Y. (2019). Federated machine learning: Concept and applications.. ACM Transactions on Intelligent Systems and Technology (TIST), 10(2), 1-19

Complementary	- AbdulRahman, S., Tout, H., Ould-Slimane, H., Mourad, A., Talhi, C., & Guizani, M. (2020). A survey on federated learning: The journey fromcentralized to distributed on-site learning and beyond.. IEEE Internet of Things Journal, 8(7), 5476-5497 - Bifet, A., Gavalda, R. (2007). Learning from time-changing data with adaptive windowing. Proceedings of the 2007 SIAM international conference ondata mining, pp. 443-448. Society for Indust - Bifet, A., & Gavalda, R. (2009). Adaptive learning from evolving data streams.. InAdvances in Intelligent Data Analysis VIII - (). ttps://federated.withgoogle.com/. - Gama, J., & Castillo, G. (2006). Learning with local drift detection.. Advanced Data Mining and Applications: Second International Conference,ADMA 2006, Xi?an, China, Augu - Gama, J., Medas, P., Castillo, G., & Rodrigues, P. (2004). Learning with drift detection. InBrazilian symposium on artificialintelligence(pp. 286-295). Springer, Berlin, Heidelberg. - Ghesmoune, M., Lebbah, M., & Azzag, H (2016). State-of-the-art on clustering data streams.. Big Data Analytics, 1, 1-27 - Gomes, H. M., Montiel, J., Mastelini, S. M., Pfahringer, B., & Bifet, A. (2020). On ensemble techniques for data stream regression. In 2020International Joint Conference on Neural Networks (IJCNN) (pp. 1-8) - McMahan, B., Moore, E., Ramage, D., Hampson, S., & y Arcas, B. A. (2017). Communication-efficient learning of deep networks from decentralized data. In Artificial intelligence and statistics (pp. 1273-1282). - Rahman, K. J., Ahmed, F., Akhter, N., Hasan, M., Amin, R., Aziz, K. E., ... & Islam, A. N. (2021). hallenges, applications and design aspects of federated learning: A survey.. IEEE Access,9, 124682-124700.

Recommendations
Subjects that it is recommended to have taken before
Machine Learning I /614544012
Subjects that are recommended to be taken simultaneously
Subjects that continue the syllabus
Other comments
The students should be familiar with mid-level programming concepts, linear algebra, calculus and stadistics. The knowledge of basic concurrence and parallel architecture is also helpfulEquality:According to the various applicable regulations for university teaching, the gender perspective should be incorporated into this subject (using non-sexist language, using bibliographic references from authors of both genders, encouraging the participation of male and female students in class).Efforts will be made to identify and modify prejudices and sexist attitudes, and the environment will be influenced to change them and promote values of respect and equality.Situations of gender-based discrimination should be identified, and actions and measures should be proposed to correct them.