UNIVERSIDADE DA CORUÑA

Teaching Guide				
Identifying Data				**2022/23**
Subject (*)	Deep Learning		**Code**	614544013
Study programme	Máster Universitario en Intelixencia Artificial			
Descriptors				
Cycle	**Period**	**Year**	**Type**	**Credits**
Official Master's Degree	2nd four-month period	First	Optional	6
Language	English			
Teaching method	Face-to-face			
Prerequisites				
Department	Ciencias da Computación e Tecnoloxías da Información			
Coordinador	Mosqueira Rey, Eduardo		**E-mail**	eduardo.mosqueira@udc.es
Lecturers	Mosqueira Rey, Eduardo		**E-mail**	eduardo.mosqueira@udc.es
Web				
General description	The course introduces methods that mimic human perception and learning through abstractions based on multilevel assimilation. Focusing on the concept of artificial neural networks, the student will be trained not only in the use of different generation strategies, but also in those that are best adapted to each particular application case. Regularization and stability techniques will also be described in order to maximize the performance of the generated models.			

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 understand the functioning of Artificial Neuron Networks.	AC10 AC11		CC8 CC9
Be able to design Deep Learning architectures	AC10 AC11 AC12 AC15	BC2 BC3 BC4 BC5 BC6 BC7 BC8 BC9	CC4 CC7 CC8 CC9
Be able to obtain models capable of pattern classification and image recognition.	AC10 AC11 AC15	BC2 BC3 BC4 BC6 BC7 BC8 BC9	CC3 CC4 CC8 CC9
Be able to visualize and analyze the learning information of a Deep Learning architecture.	AC10 AC11	BC4 BC9	CC8 CC9

Contents	
Topic	Sub-topic
1. Introduction to deep learning	Shallow learning
	Deep learning
2. Regularization and optimization in deep learning	Regularization via data
	Regularization via model
	Regularization via objective function
	Optimization
3. Convolutional neural networks (CNNs)	Convolutions
	Pooling
	CNN architectures
4. Recurrent neural networks (RNNs)	Simple recurrent networks
	LSTM networks
	GRU networks
5. Autoencoders	How autoencoding works
	Anomaly detection autoencoders
	Denoising autoencoders
6. Generative Adversial Networks (GANs)	Generative modeling with variational autoencoders
	GAN networks
	Deep convolutional GANs

7. Transfer learning	How transfer learning works
	Transfer learning approaches
8. Other deep learning techniques	Multi-task learning
	Transformers

Planning				
Methodologies / tests	Competencies / Results	Teaching hours (in-person & virtual)	Student?s personal work hours	Total hours
Guest lecture / keynote speech	A11 A12 A13 B2 B3 B6 B8 B9 C4 C8	21	21	42
Laboratory practice	A11 A12 A13 A16 B2 B3 B4 B5 B6 B7 B8 B9 C3 C7 C9	21	84	105
Objective test	A11 A12 B7 B9	3	0	3
Personalized attention		0		0
(*)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	Lectures explain the theoretical concepts using different digital resources.
Laboratory practice	Laboratory activities are based on the knowledge that students are acquiring in lectures.
Objective test	A test shall be administered to assess the theoretical and practical knowledge acquired by students

Personalized attention	
Methodologies	Description
Laboratory practice	Personalized attention to students includes not only tutorials (either virtual or in-person) to discuss questions, but also the following actions: - Monitor the work of laboratory practices proposed by the teacher. - Evaluate of the results obtained in practice and seminars. - Conduct personalized meetings to answer questions about the contents of the subject.

Assessment			
Methodologies	Competencies / Results	Description	Qualification
Laboratory practice	A11 A12 A13 A16 B2 B3 B4 B5 B6 B7 B8 B9 C3 C7 C9	Practice exercises based on the knowledge acquired in the theoretical classes.	50
Objective test	A11 A12 B7 B9	Test conducted at the end of the semester with theoretical and practical content.	50

Assessment comments

Specific evaluation percentages for each part of the course.

The evaluation of the course will be carried out in two parts: continuous evaluation (practices) and final exam. In order to pass the course it is essential to obtain a minimum grade of 4 in both parts separately. The final grade of the subject will be the arithmetic mean of the continuous evaluation and the final exam, except in those situations in which the minimum grade has not been reached in any of the two parts, in which case the final grade cannot be higher than 4.How the non-attending students are evaluated.

The submission of any of the activities or tests of continuous evaluation by a student will indicate the student has chosen to attend the course. Therefore, from that moment on, even if he/she does not take the final exam, he/she will have used up an opportunity.How the second exam opportunity is evaluated.

In the second opportunity (July) the grades of the continuous evaluation and/or the final exam obtained during the four-month period will be kept, as long as the grade in that part is 4 or more points. If the student attends the second opportunity in the continuous evaluation part or the final exam, the grade obtained in the first opportunity for that part will be annulled, and the corresponding grade for that part will be that of the second opportunity. For the continuous evaluation, a deadline will be established for the submission of the practices. The final grade of the course in the second opportunity will be calculated with the same criteria as in the first opportunity.

Sources of information	
Basic	- François Chollet (2021). Deep Learning with Python, 2nd Ed.. Manning
	- Aurélien Géron (2019). Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, 2nd Ed.. O'Reilly
	- Mohamed Elgendy (2020). Deep Learning for Vision Systems. Manning
	- Jakub Langr, Vladimir Bok (2019). GANs in Action. Manning
	- Ian Goodfellow, Yoshua Bengio, Aaron Courville (2016). Deep Learning. MIT Press
Complementary	- Andrew Ferlitsch (2021). Deep Learning Patterns and Practices. Manning
	- Andrew W. Trask (2019). Grokking Deep Learning . Manning

Recommendations	
Subjects that it is recommended to have taken before	
Machine Learning I /614544012	
Subjects that are recommended to be taken simultaneously	
Machine Learning II /614544014	
Subjects that continue the syllabus	
Other comments	