Teaching Guide				
Identifying Data				2023/24
Subject (*)	Evolutionary Computation		Code	614544015
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	Face-to-face			
Prerequisites				
Department	Ciencias da Computación e Tecnoloxías da Información			
Coordinador	Santos Reyes, Jose	E-mail	jose.santos@udc.es	
Lecturers	Rabuñal Dopico, Juan Ramon Santos Reyes, Jose	E-mail	juan.rabunal@udc.es jose.santos@udc.es	
Web				
General description	The course introduces the student to the modeling of systems capable of adapting to their environments and learning from their experience, imitating the evolutionary processes of nature. In this context, the student will be instructed not only in the use of different techniques for the search of solutions inspired by the prevalence or subsistence strategies of a population, but also in the application of meta-heuristics for their optimization.			

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		
Know the basic concepts of evolutionary computation, classical evolutionary algorithms and bio-inspired algorithms.	AC10 AC11 AC12 AC15	BC2 BC3 BC4 BC5 BC6 BC7 BC8 BC9	CC3 CC4 CC7 CC8 CC9
Have the ability to design bio-inspired and complex system models of real systems.	AC10 AC11 AC12 AC15	BC2 BC3 BC4 BC5 BC6 BC7 BC8 BC9	CC3 CC4 CC7 CC8 CC9
Know and apply techniques based on evolutionary systems, advanced artificial neural networks and other bio-inspired models.	AC10 AC11 AC12 AC15	BC2 BC3 BC4 BC5 BC6 BC7 BC8 BC9	CC3 CC4 CC7 CC8 CC9
Identify the appropriate data-driven solution search techniques according to the type of problem. Understand the different possibilities of combination or hybridization between global evolutionary search methods and other local search metaheuristics.	AC10 AC11 AC12 AC15	BC2 BC3 BC4 BC5 BC6 BC7 BC8 BC9	CC3 CC4 CC7 CC8 CC9
Know different bio-inspired adaptive models and handle the most current tools and work environments in the field of bio-inspired algorithms.	AC10 AC11 AC12 AC15	BC2 BC3 BC4 BC5 BC6 BC7 BC8 BC9	CC3 CC4 CC7 CC8 CC9

Contents	
Topic	**Sub-topic**
Introduction to optimization algorithms	General scheme of evolutionary algorithms. Basic concepts: search domain, constraints, penalties. No Free Lunch theorem. Basic concepts of multi-objective optimization.
Paradigms and meta-heuristics of nature-inspired algorithms	Bio-inspired metaheuristics. Swarm intelligence.
Specific algorithms of evolutionary computation	Genetic algorithms. Evolutionary strategies. Genetic programming. Examples of swarm intelligence: Particle Swarm Optimization, Arficial Bee Algorithm, Bacterial Colony Optimization, Ant algorithms. Examples of other bio-inspired evolutionary algorithms.
Advances in automatic adaptation of evolutionary algorithms	Automatic adaptation of the defining parameters of an EA. Use of hyper-heuristics.

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 B2 B3 B4 B5 B6 B7 B8 B9 C3 C4 C7 C8 C9	10.5	10.5	21
Objective test	A11 A12 A13 A16 B2 B3 B4 B5 B6 B7 B8 B9 C3 C4 C7 C8 C9	3	0	3
Laboratory practice	A11 A12 A13 A16 B2 B3 B4 B5 B6 B7 B8 B9 C3 C4 C7 C8 C9	10.5	31.5	42
Mixed objective/subjective test	A11 A12 A13 A16 B2 B3 B4 B5 B6 B7 B8 B9 C3 C4 C7 C8 C9	2	2	4
Personalized attention		5	0	5
(*)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	Oral presentation of the theory topics by the professors of the course.
Objective test	Test/exam of the concepts explained in theory classes.
Laboratory practice	Laboratory sessions in which the necessary concepts will be explained in order to carry out programming practices related to optimization problems with evolutionary algorithms. The professors will indicate which optimization problems will be considered, as well as the programming platform/language to be used in the use or implementation of different evolutionary/bio-inspired algorithms. The professors will indicate whether this work will be carried out by the students autonomously or in groups, and their progress will be supervised by the teachers.
Mixed objective/subjective test	Continuous monitoring of the practices carried out, by means of class attendance and continuous and final correction of the same. The possibility of a brief oral presentation of the work done in this part is included.

Personalized attention

Methodologies	Description
Laboratory practice Mixed objective/subjective test	In the laboratory practices, the student will be able to ask the teacher all the doubts that may arise about the realization of the practical problems formulated, as well as about the aspects that will be evaluated in the resolution of the problems.

Assessment			
Methodologies	Competencies / Results	Description	**Qualification**
Guest lecture / keynote speech	A11 A12 A13 A16 B2 B3 B4 B5 B6 B7 B8 B9 C3 C4 C7 C8 C9	The theoretical part of the course will be continuously monitored through class attendance and possible test-type questionnaires at the end of the lectures.	5
Laboratory practice	A11 A12 A13 A16 B2 B3 B4 B5 B6 B7 B8 B9 C3 C4 C7 C8 C9	Evaluation of the different practices carried out by the students.	50
Objective test	A11 A12 A13 A16 B2 B3 B4 B5 B6 B7 B8 B9 C3 C4 C7 C8 C9	Final exam of the theoretical part.	40
Mixed objective/subjective test	A11 A12 A13 A16 B2 B3 B4 B5 B6 B7 B8 B9 C3 C4 C7 C8 C9	There will be a continuous monitoring of the practices carried out, by means of class attendance and continuous and final correction of the same. The possibility of a brief oral presentation of the work done in this part is included.	5

Assessment comments
In the case of plagiarism in practices or assignments, article 11, section 4 b) of the UDC Student Discipline Regulation will be taken into account: b) Qualification of fail in the call in which the offense is committed and with respect to the subject in which it was committed: the student will be graded with "fail" (numerical grade 0) in the corresponding call of the academic year, whether the plagiarism is committed at the first or the second opportunity. For this, the qualification will be modified in the first opportunity report, if necessary.

Sources of information	
Basic	- Dan Simon (2013). Evolutionary Optimization Algorithms. Wiley - A. E. Eiben (2010). Introduction to Evolutionary Computing (Natural Computing Series). Springer
Complementary	

Recommendations
Subjects that it is recommended to have taken before
Subjects that are recommended to be taken simultaneously
Subjects that continue the syllabus
Other comments

(*)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.