Teaching Guide				
Identifying Data				2022/23
Subject (*)	High performance computing in bioinformatics		Code	614522011
Study programme	Mestrado Universitario en Bioinformática para Ciencias da Saúde			
Descriptors				
Cycle	Period	Year	Type	Credits
Official Master's Degree	2nd four-month period	First	Obligatory	6
Language	SpanishGalicianEnglish			
Teaching method	Hybrid			
Prerequisites				
Department	Enxeñaría de Computadores			
Coordinador	González Domínguez, Jorge	E-mail	jorge.gonzalezd@udc.es	
Lecturers	González Domínguez, Jorge Rey Expósito, Roberto	E-mail	jorge.gonzalezd@udc.es roberto.rey.exposito@udc.es	
Web	campusvirtual.udc.es/moodle			
General description	Analisis of different parallel architectures that can be exploited in bioinformatics. Introduction to different parallel programming models. Usage of parallel systems to accelerate the execution of bioinformatics tools.			

Study programme competences	
Code	Study programme competences
A2	CE2 ? To define, evaluate and select the architecture and the most suitable software for solving a problem in the field of bioinformatics
A3	CE3 ? To analyze, design, develop, implement, verify and document efficient software solutions based on an adequate knowledge of the theories, models and techniques in the field of Bioinformatics
B2	CB7 - Students should know how to apply the acquired knowledge and ability to problem solving in new environments or little known within broad (or multidisciplinary) contexts related to their field of study
B5	CB10 - Students should possess learning skills that allow them to continue studying in a way that will largely be self-directed or autonomous.
B7	CG2 - Maintain and extend well-founded theoretical approaches to enable the introduction and exploitation of new and advanced technologies
C1	CT1 - Express oneself correctly, both orally writing, in the official languages of the autonomous community
C3	CT3 - Use the basic tools of the information technology and communications (ICT) necessary for the exercise of their profession and lifelong learning

Learning outcomes			
Learning outcomes	Study programme competences		
To understand the main differences in the organization of parallel architectures	AJ2	BJ7	
To understand the main programming models for high performance computing	AJ3	BJ2 BJ5	
To apply the new knowledge to the efficient execution of parallel bioinformatics tools	AJ2	BJ5	CJ1 CJ3

Contents	
Topic	Sub-topic
1) Introduction to parallel programming	1.1) Basic concepts of parallel computing 1.2) Parallel computer architectures 1.3) Parallel programming paradigms 1.4) Performance evaluation of parallel algorithms

2) Parallel programming on shared memory architectures	2.1) Shared memory architectures 2.2) Shared memory programming model 2.3) Programming languages for shared memory architectures
3) Parallel programming on distributed memory architectures	3.1) Distributed memory architectures 3.2) Message-passing programming model 3.3) Programming languages for distributed memory architectures
4) Parallel programming on emerging architectures	4.1) GPUs 4.2) Programming languages for GPUs 4.3) Big Data Frameworks
5) Executing parallel bioinformatics tools	5.1) Analysis of parallel bioinformatics tools 5.2) Execution on shared memory systems 5.3) Execution on distributed memory systems 5.4) Execution on GPUs 5.5) Usage of execution queues on supercomputers centers

Planning				
Methodologies / tests	Competencies	Ordinary class hours	Student?s personal work hours	Total hours
Guest lecture / keynote speech	A2 A3 B2 B5 B7	14	28	42
Laboratory practice	A2 B2 B5 C3	21	52.5	73.5
Supervised projects	A2 C1 C3	3	18	21
Oral presentation	A2 C1 C3	2	6	8
Objective test	A2 A3 B2 B5 B7	2	0	2
Personalized attention		3.5	0	3.5
(*)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 lectures with slides and questions from the students. The goal of these presentations is to provide information and to help in the adquisition of knowledge. There will be oral lectures related to the contents 1, 2, 3 and 4. I will be the besis for the rest of activities.
Laboratory practice	Activity to increase the knowledge of the concepts explained in the oral lectures, by performing practical sessions in computers. The students will understand the practical concepts of high performance computing. Particularly, these sessions will focus on content 5, and it will be necessary for the supervised project and the oral test.
Supervised projects	The student will develop a work where he must use a parallel bioinformatic tool. This project will be used to evaluate whether the student learnt the concepts explained during the laboratory prcatices and he is able to use the new knowledge on different scenarios.
Oral presentation	Activity where students must expose to the teacher and the colleagues the results of their projects. There will enough time so that the other students can ask questions about the work (they must be active).
Objective test	Activity to evaluate the knowledge acquired by the students during the oral lectures. It consists of a written test with several questions.

Personalized attention	
Methodologies	Description

Objective test Oral presentation Laboratory practice Supervised projects	In the laboratory practical sessions the students will be allowed to ask questions. The teacher will use any necessary activity to solve the questions and doubts. Moreover, it is recommended that students attend to tutorships in the teacher office, where they will be allowed to ask questions related to the theorical and practical concepts that will be evaluated. Partial-time students must use the tutorships and the personalized attention to follow the lectures and laboratory practices when they are not able to attend the original date.

Assessment			
Methodologies	**Competencies**	**Description**	**Qualification**
Objective test	A2 A3 B2 B5 B7	Written test about the contents presented in the lectures and the laboratory practices.	30
Oral presentation	A2 C1 C3	Presentation of the results of the supervised project in front of the teacher and the other students. It is necessary (but not sufficient) to perform this oral presentation and actively attend to the colleagues presentations in order to pass the subject.	10
Laboratory practice	A2 B2 B5 C3	The mark will be obtained by correctly completing a practical exercise as well as attending to the laboratory sessions.	20
Supervised projects	A2 C1 C3	The mark of these supervised project depends on both the quality of the results and the quality of the final report. It is necessary (but not sufficient) to write the final report and obtain at least 25% of its qualification (equivalent to 10% of the global qualification) in order to pass the subject.	40

Assessment comments
In order to pass the subject it is necessary to fulfill the following conditions: - To obtain global qualification equal or higher than 50%. - To obtain qualification equal or higher than 2.5/10 in the supervised project. - To complete the oral presentation. If the student obtains global qualification equal or higher than 50% but any of the previous conditions is not fulfilled, the final qualification will be Fail (4.5/10). In the second chance the student will be allowed to retake 80% of the total qualification: supervised project, oral presentation and objective test. Only the qualification of the laboratory practices can not be retaken. The qualification of the laboratory practices obtained in the first chance will be kept for the second chance. Qualification for partial-time students will be assigned using the same rules as for ordinary students. Partial-time students must attend to the oral presentations of their colleagues too. Attendance to lectures and laboratory practices are not compulsory for any student.

Sources of information	
Basic	- Thomas Rauber [et al.] (2013). Parallel Programming for Multicore and Cluster Systems. Springer - Peter S. Pacheco (2011). An introduction to parallel programming. Morgan Kaufmann - Bertil Schmidt [et al.] (2018). Parallel Programming. Concepts and Practice. Morgan Kaufmann
Complementary	- Francisco Almeyda [et al.] (2008). Introducción a la programación paralela. Paraninfo Cengage Learning - Bertil Schmidt (2010). Bioinformatics: High Performance Parallel Computer Architectures. CRC Press

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
It is advisable to have certain knowledge about programming and computer architecture

(*)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.