VNIVERSITAT DE VALÈNCIA

Course Guide
36438 Parallel programming

COURSE DATA

Data Subject	
Code	36438
Name	Parallel programming
Cycle	Grade
ECTS Credits	6.0
Academic year	2020 - 2021

Study (s)

Degree	Center	Acad. year	Period
1406 - Degree in Data Science	School of Engineering	2	Second term
1407 - Degree in Multimedia Engineering	School of Engineering	4	Second term

Subject-matter

Degree	Subject-matter	Character
1406 - Degree in Data Science	12 - Computer Science	Obligatory
1407 - Degree in Multimedia Engineering	19 - Optatividad	Optional

Coordination

Name	Department
ZARAGOZA ALVAREZ, IRENE	240 - Computer Science

SUMMARY

This course introduces students to parallel, concurrent and distributed programming.

The course begins by introducing the characterization or profiling of a program, which enables us to locate the more expensive elements of the program. This information will provide us with ideas for making possible improvements to the program.

Students will then learn various models of parallel programming and basic ideas on the different architectures that support it.

We will use these models to obtain basic knowledge of the design of concurrent algorithms and to measure their efficiency.

In the practical component of the course, various problems will be set and the efficiency of the sequential approach will be compared to that of the concurrent approach.

The theory classes will be taught in Spanish. The language for the practical and laboratory classes will be stated in the course guidelines available on the website for this degree.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

There are no specified enrollment restrictions with other subjects of the curriculum.

Other requirements

Students are recommended to have passed 36411 Programming Fundamentals and 36413 Algorithms and Data Structures of the first year of the bachelors degree in Data Science. They are also recommended to have completed 36435 Data Storage Infrastructure of the first semester of the second year.
The prior knowledge and skills required for this course are:
- Analysis of algorithms (best and worst cases),
- Programming in Python, and
- Programming with basic data structures (sequence, binary trees, graphs).

COMPETENCES (RD 1393/2007) // LEARNING OUTCOMES (RD 822/2021)

1406 - Degree in Data Science

- Students must have the ability to gather and interpret relevant data (usually in their field of study) to make judgements that take relevant social, scientific or ethical issues into consideration.
- Students must have developed the learning skills needed to undertake further study with a high degree of autonomy.
- (CG05) Analysis and synthesis capability in the preparation of reports and in the defence of ideas.
- (CG07) Ability to autonomously make decisions and to properly and originally elaborate reasoned arguments, in order to obtain reasonable and contrastable hypotheses.
- (CT02) To be able to complete technical, scientific, social and human training in general, and to organise self-learning with a high degree of autonomy.
- (CT05) Ability to evaluate the advantages and disadvantages of different methodological and / or technological alternatives in different fields of application.
- (CE02) To methodologically know and apply the programming techniques and the algorithms necessary for the efficient processing of information and the computer resolution of problems that use large volumes of data.

- (CE08) Ability to understand, select and use the infrastructure and the techniques used to handle mass data, according to criteria of efficiency, scalability, security, error tolerance and adaptation to the production environment.

1407 - Degree in Multimedia Engineering

- G2 - Have the learning skills needed to undertake further studies or to gain further training with a certain degree of autonomy. (RD1393/2007)
- MM2 - Be able to understand and manage the different technologies involved in multimedia systems, both from the point of view of hardware and electronics and of software.

LEARNING OUTCOMES (RD 1393/2007) // NO CONTENT (RD 822/2021)

Identify and describe the architectures of parallel and distributed computers. (CT02)

Evaluate the performance and scalability of a parallel processing system, establishing and applying the metrics for comparison. (CG05, CG07, CT05, CE08)

Know and apply the paradigms of parallel and distributed programming, related programming models and standards for the development of high performance systems. Design and develop concurrent algorithms that exploit the parallelism capabilities of parallel and distributed computing infrastructures. Design and develop programs that efficiently use multiprocessors and parallel architectures for data processing. (CB3, CB5, CE02)

DESCRIPTION OF CONTENTS

1. Introduction

Basic concepts.
Need and justification.

2. Types of parallelism and architectures.

Parallel & distributed architectures, multiprocessors and multicomputers.
Processes and threads.

3. Profiling

Analysis of program performance: Objectives and tools.

4. Performance Metrics for Parallel & Distributed Systems

Definition, use and applications.

5. Parallel & distributed programming models

Types of parallelism
Message passing, Tasks, Data parallelism, Shared memory and others

6. Analysis of problems and design of parallel programs

Embarrassingly parallel problems.
Identification of the load and bottlenecks.
Strategies for decomposition of the problem.
Communication needs
Selection of the paradigm to be used.

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	34,00	100
Laboratory practices	20,00	100
Classroom practices	6,00	100
Development of group work	10,00	0
Development of individual work	20,00	0
Study and independent work	15,00	0
Preparation of evaluation activities	10,00	0
Preparing lectures	15,00	0
Preparation of practical classes and problem	20,00	0
TOTAL	**150,00**	

TEACHING METHODOLOGY

The topics taught in the theory classes will provide a global and integrating vision, analyze the key and most complex aspects of the course in detail, and encourage student participation at all times (CB1). These activities are complemented by practical activities in which the basic concepts will be applied and expanded with the knowledge and experience students acquire when completing their assignments (CB2). These activities include finding solutions to problems and questions discussed in the classroom, discussion sessions, problem solving and other exercises previously worked on by the students, laboratory practice, and individual evaluation questionnaires to be completed in the classroom in the presence of academic staff (CG01, CG06, CE02, CE11).

As well as classroom activities, students will carry out individual tasks outside the classroom. These will include work on monographs, bibliographic searches, questions and problems, as well as studying for classes and exams (CT01, CT02). Most of this work will be done individually and is intended to promote autonomous learning. Some tasks, however, will require work to be done in small groups of 4-6 students to promote their ability to work as members of a team (CT03) .

The University of Valencia's e-learning platform (*Aula Virtual*) will be used to communicate with the students. The students will also be able to access the learning materials used in class and the problems and exercises they need to solve via this platform.

EVALUATION

Evaluation for this course will comprise the following components:

- Continuous assessment based on the student's participation and his/her degree of involvement in the teaching-learning process, attendance at the planned activities and solutions to the questions and problems set. Occasionally, students may be required to deliver oral presentations (individually and/or in groups) to assess their ability to produce documents and transmit knowledge (N_Continuous).
  The activities conducted in the classroom cannot be re-taken (SE3).
- An individual objective exam consisting of several tests throughout the semester and a final exam that will comprise theoretical and practical questions and problems (N Exams) (SE1).

  N_Exams = 50% Controls + 50% Final Exam
  The value for all tests will be the same.
  The tests cannot be re-taken.
- Evaluation of practical activities based on the student's fulfilment of the objectives of the laboratory sessions, solutions to problems and preparation of papers/reports (N Practices). Attendance at the laboratory sessions is compulsory to pass the subject at the first examination sitting (SE2).

The final grade for this course will be calculated as follows:

- Final Score = 20% N Continuous + 50% N Exams + 30% N Practices

Students will need to obtain at least 4 out of 10 on each component in order to pass.

At the second examination sitting, students can improve their score for the practical work by taking a specific practice exam and improving their final exam grade (test scores will be reduced by 20% in N_Examenes). The weights for each section and the conditions for passing the subject will be the same as at the first examination sitting.

In all cases the evaluation system will be governed by the University of Valencia's regulations on grading and assessment for bachelor's degrees and master's degrees, which is available at :

https://webges.uv.es/uvTaeWeb/MuestraInformacionEdictoPublicoFrontAction.do?accion=inicio&idEdictoSeleccionado=5639

REFERENCES

Basic

- [Zaccone , Giancarlo (2019)] Python Parallel Programming Cookbook Second Edition (Packt Publishing) https://uves.summon.serialssolutions.com/#!/search?bookMark=ePnHCXMw42JgAfZbU5kZuAzNLUBrF82NjTigE
- [Palach, Jan (2014)] Parallel Programming with Python (Packt Publishing) https://ebookcentral.proquest.com/lib/univalencia/detail.action?docID=1644017

Additional

- [Vallejo Fernández, David. González Morcillo, Carlos. Albusac Jiménez, Javier A. (2016)] Programación Concurrente y Tiempo Real. 3ª edición (David Vallejo). http://www.libropctr.com/docs/LibroPCTR_2017_Intro.pdf
- [Trobec, Roman. Slivnik, Botjan. Buli, Patricio. Robi, Borut (2018)] Introduction to Parallel Computing (Springer) https://link.springer.com/book/10.1007/978-3-319-98833-7
- [Lanaro, Gabriele (2017)] Python High Performance Programming. Second edition (Packt Publishing) https://ebookcentral.proquest.com/lib/univalencia/detail.action?docID=1572936

ADDENDUM COVID-19

This addendum will only be activated if the health situation requires so and with the prior agreement of the Governing Council

The teaching methodology of the course will follow the Teaching Model approved by the Data Science Academic Committee (https://go.uv.es/cienciadatos/ModelDocentGCD2Q). In the event that the facilities are closed for health reasons that affect all or part of the course sessions, these will be replaced by non-presential sessions following the established timetable. If the closure affects a presential assessment test for the subject, it will be replaced by a test of a similar nature that will be carried out in virtual mode through the computer tools supported by the University of Valencia. The percentages of each assessment test will remain unchanged, as established by this guide.