

270208 - AP2 - Algorithmics and Programming II

Coordinating unit:	270 - FIB - Barcelona School of Informatics
Teaching unit:	723 - CS - Department of Computer Science
Academic year:	2019
Degree:	BACHELOR'S DEGREE IN DATA SCIENCE AND ENGINEERING (Syllabus 2017). (Teaching unit Compulsory)
ECTS credits:	7,5
Teaching languages:	Catalan, English

Prior skills

Those acquired at the course AP1-GCED.

Degree competences to which the subject contributes

Basic:

CB5. That the students have developed those learning skills necessary to undertake later studies with a high degree of autonomy

Specific:

CE2. To be able to program solutions to engineering problems: Design efficient algorithmic solutions to a given computational problem, implement them in the form of a robust, structured and maintainable program, and check the validity of the solution.

Generical:

CG1. To design computer systems that integrate data of provenances and very diverse forms, create with them mathematical models, reason on these models and act accordingly, learning from experience.

CG2. Choose and apply the most appropriate methods and techniques to a problem defined by data that represents a challenge for its volume, speed, variety or heterogeneity, including computer, mathematical, statistical and signal processing methods.

CG5. To be able to draw on fundamental knowledge and sound work methodologies acquired during the studies to adapt to the new technological scenarios of the future.

Transversal:

CT5. Solvent use of information resources. Manage the acquisition, structuring, analysis and visualization of data and information in the field of specialty and critically evaluate the results of such management.

CT6. Autonomous Learning. Detect deficiencies in one's own knowledge and overcome them through critical reflection and the choice of the best action to extend this knowledge.

CT7. Third language. Know a third language, preferably English, with an adequate oral and written level and in line with the needs of graduates.

Teaching methodology

The syllabus is presented in a very practical way, through the presentation of many examples.

The theory classes introduce all the necessary concepts and techniques, which are put into practice in the classes of problems and laboratory through a collection of problems and exercises in an automatic judge.

Every week, there are two hours of theory classes, one hour of problems and two hours of laboratory.

The course uses C++ and Python as programming languages.

Learning objectives of the subject

1. Being able to design, analyze, implement algorithms that solve problems using algorithmic and programming



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techniques.

Study load

Total learning time: 187h 30m	Hours large group:	45h	24.00%
	Hours small group:	30h	16.00%
	Guided activities:	0h	0.00%
	Self study:	112h 30m	60.00%

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Content

Abstract Data Types.

Degree competences to which the content contributes:

Description:

Specification and implementation. Abstraction, functional and data decomposition, information hiding and encapsulation. Object-oriented languages: classes and objects, private and public methods, constructors and destructors. Genericity. Examples: point, rectangle, rational numbers.

Algorithm analysis.

Degree competences to which the content contributes:

Description:

Cost in time and space. Worst, best and average case. Asymptotic notation. Analysis of the cost of iterative and recursive algorithms. Examples: insertion and selection sort, maximum subsequence sum, convex hull.

Divide and conquer.

Degree competences to which the content contributes:

Description:

Principles: partition into subproblems, recombination of solutions. Master theorem. Examples: binary search, merge sort, quick sort, quick select, finding the two closest points in a plane. Fast Fourier Transform (FFT).

Memory management.

Degree competences to which the content contributes:

Description:

Representation of data in memory. Pointers and references. Dynamic memory management (vector class). Memory layout of a program (code, stack, heap).

Basic containers.

Degree competences to which the content contributes:

Description:

Operations, usage and implementations of stacks, queues, priority queues and lists.

Graphs.

Degree competences to which the content contributes:



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Description:

Representations: adjacency matrices, adjacency lists and implicit representations. Depth-first search (DFS). Breadth-first search (BFS). Topological sort. Algorithms for shortest paths (Dijkstra, Bellman-Ford). Algorithms for minimum spanning trees (Prim and Kruskal). Algorithms for the maximum flow problem (Ford-Fulkerson).

Sets and dictionaries.

Degree competences to which the content contributes:

Description:

Trees and their representation. Binary trees and traversals (pre-order, post-order, in-order and level-order). Binary search trees and balanced trees: operations and implementation. Hashing.

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Planning of activities

Development of content 1	Hours: 16h Theory classes: 5h Practical classes: 0h Laboratory classes: 3h Guided activities: 0h Self study: 8h
Specific objectives: 1	
Partial examination (with computer)	Hours: 2h Guided activities: 2h Self study: 0h
Specific objectives: 1	
Final examination (on paper)	Hours: 2h Guided activities: 2h Self study: 0h
Final examination (with computer)	Hours: 2h Guided activities: 2h Self study: 0h
Project delivery	Hours: 9h Guided activities: 0h Self study: 9h
Development of content 2	Hours: 20h Theory classes: 4h Practical classes: 0h Laboratory classes: 4h Guided activities: 0h Self study: 12h
Specific objectives: 1	

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<p>Development of content 3</p>	<p>Hours: 35h Theory classes: 9h Practical classes: 0h Laboratory classes: 6h Guided activities: 0h Self study: 20h</p>
<p>Specific objectives: 1</p>	
<p>Development of content 4</p>	<p>Hours: 11h Theory classes: 3h Practical classes: 0h Laboratory classes: 2h Guided activities: 0h Self study: 6h</p>
<p>Specific objectives: 1</p>	
<p>Development of content 5</p>	<p>Hours: 27h 30m Theory classes: 7h Practical classes: 0h Laboratory classes: 5h Guided activities: 1h Self study: 14h 30m</p>
<p>Specific objectives: 1</p>	
<p>Development of content 6</p>	<p>Hours: 35h Theory classes: 9h Practical classes: 0h Laboratory classes: 5h Guided activities: 1h Self study: 20h</p>
<p>Specific objectives: 1</p>	

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Development of content 7	Hours: 28h Theory classes: 7h Practical classes: 0h Laboratory classes: 5h Guided activities: 1h Self study: 15h
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Qualification system

The grade of the course is calculated based on a grade obtained from two laboratory projects (NL), a partial exam on computer (NP), and a final exam consisting of two tests: one on paper (NF1) and the other on computer (NF2).

The final grade is the maximum of:

$$* 0.15 \text{ NL} + 0.25 \text{ NP} + 0.3 \text{ NF1} + 0.3 \text{ NF2}$$

$$* 0.15 \text{ NL} + 0.425 \text{ NF1} + 0.425 \text{ NF2}$$

Re-evaluation:

Only those students that have attended the exams and who have not passed the course are eligible for the re-evaluation exam. The exam consists of two tests similar to the final exam: one on paper (R1) and the other on computer (R2). If you do not attend any of the tests, the corresponding mark of the final exam will be maintained (NF1 or NF2).

In case of re-evaluation, the final grade of the course is calculated as the maximum of:

$$* 0.5 \text{ R1} + 0.5 \text{ R2}$$

$$* 0.15 \text{ NL} + 0.425 \text{ R1} + 0.425 \text{ R2}$$

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Bibliography

Basic:

Weiss, M.A.; Chandavarkar, B.R. Data structures and algorithm analysis in C++. 4th ed., int. ed. Boston: Pearson, 2014. ISBN 0273769383.

Dasgupta, S.; Papadimitriou, C.H.; Vazirani, U.V. Algorithms. Boston: Mc Graw Hill Higher Education, 2008. ISBN 9780073523408.

Cormen, T.H. Introduction to algorithms [on line]. 3rd ed. Cambridge: MIT Press, 2009 [Consultation: 22/07/2019]. Available on: <<https://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?docID=3339142>>. ISBN 9780262033848.

Brassard, G.; Bratley, P. Fundamentos de algoritmia. Madrid: Prentice Hall, 1997. ISBN 848966000X.

Complementary:

Manber, U. Introduction to algorithms: a creative approach. Repr. with corr. Reading, Mass.: Addison-Wesley, 1989. ISBN 0201120372.

Sedgewick, R. Algorithms in C++. 3rd ed. Boston: Addison-Wesley, 1998-2002. ISBN 0201350882.

Others resources:

Hyperlink

<https://jutge.org>

<http://www.cs.upc.edu/~jordicf/Teaching/AP2>