Course guides  
270208 - AP2 - Algorithmics and Programming II

Unit in charge: Barcelona School of Informatics  
Teaching unit: 723 - CS - Department of Computer Science.

Degree: BACHELOR’S DEGREE IN DATA SCIENCE AND ENGINEERING (Syllabus 2017). (Compulsory subject).

Academic year: 2021  ECTS Credits: 7.5  Languages: Catalan, English

LECTURER

Coordinating lecturer: JORDI CORTADELLA FORTUNY

Others: Segon quadrimestre:  
JORDI CORTADELLA FORTUNY - 11  
JORDI PETIT SILVESTRE - 11

PRIOR SKILLS

Those acquired at the course AP1-GCED.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

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.

General:
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:
CT4. Teamwork. Be able to work as a member of an interdisciplinary team, either as a member or conducting management tasks, with the aim of contributing to develop projects with pragmatism and a sense of responsibility, taking commitments taking into account available resources.
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.

Basic:
CBS5. That the students have developed those learning skills necessary to undertake later studies with a high degree of autonomy.
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 techniques.

STUDY LOAD

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours small group</td>
<td>30,0</td>
<td>16.00</td>
</tr>
<tr>
<td>Self study</td>
<td>112,5</td>
<td>60.00</td>
</tr>
<tr>
<td>Hours large group</td>
<td>45,0</td>
<td>24.00</td>
</tr>
</tbody>
</table>

Total learning time: 187.5 h

CONTENTS

Abstract Data Types.

Description:

Algorithm analysis.

Description:

Divide and conquer.

Description:

Memory management.

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

**Description:**
Operations, usage and implementations of stacks, queues, priority queues and lists.

**Graphs.**

**Description:**

**Sets and dictionaries.**

**Description:**

**ACTIVITIES**

**Development of content 1**

**Specific objectives:**

1

**Related competencies:**

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.

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.

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.

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.

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

CT4. Teamwork. Be able to work as a member of an interdisciplinary team, either as a member or conducting management tasks, with the aim of contributing to develop projects with pragmatism and a sense of responsibility, taking commitments taking into account available resources.

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

**Full-or-part-time:** 16h

Theory classes: 5h
Laboratory classes: 3h
Self study: 8h
### Partial examination (with computer)

**Specific objectives:**

1. Related competencies:

   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.

   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.

   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.

   CT4. Teamwork. Be able to work as a member of an interdisciplinary team, either as a member or conducting management tasks, with the aim of contributing to develop projects with pragmatism and a sense of responsibility, taking commitments taking into account available resources.

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

**Full-or-part-time:** 2h  
Guided activities: 2h

### Final examination (on paper)

**Full-or-part-time:** 2h  
Guided activities: 2h

### Final examination (with computer)

**Full-or-part-time:** 2h  
Guided activities: 2h

### Project delivery

**Full-or-part-time:** 9h  
Self study: 9h
Development of content 2

Specific objectives:

1

Related competencies:

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.
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.
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.
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.
CT7. Third language. Know a third language, preferably English, with an adequate oral and written level and in line with the needs of graduates.
CT4. Teamwork. Be able to work as a member of an interdisciplinary team, either as a member or conducting management tasks, with the aim of contributing to develop projects with pragmatism and a sense of responsibility, taking commitments taking into account available resources.
CB5. That the students have developed those learning skills necessary to undertake later studies with a high degree of autonomy

Full-or-part-time: 20h
Theory classes: 4h
Laboratory classes: 4h
Self study: 12h
Development of content 3

Specific objectives:
1

Related competencies:
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.
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.
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.
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.
CT7. Third language. Know a third language, preferably English, with an adequate oral and written level and in line with the needs of graduates.
CT4. Teamwork. Be able to work as a member of an interdisciplinary team, either as a member or conducting management tasks, with the aim of contributing to develop projects with pragmatism and a sense of responsibility, taking commitments taking into account available resources.
CB5. That the students have developed those learning skills necessary to undertake later studies with a high degree of autonomy

**Full-or-part-time:** 35h
Theory classes: 9h
Laboratory classes: 6h
Self study: 20h
Development of content 4

Specific objectives:

1

Related competencies:

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.

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.

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.

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.

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

CT4. Teamwork. Be able to work as a member of an interdisciplinary team, either as a member or conducting management tasks, with the aim of contributing to develop projects with pragmatism and a sense of responsibility, taking commitments taking into account available resources.

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

Full-or-part-time: 11h

Theory classes: 3h
Laboratory classes: 2h
Self study: 6h
Development of content 5

Specific objectives:

1

Related competencies:

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.

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.

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.

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.

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

CT4. Teamwork. Be able to work as a member of an interdisciplinary team, either as a member or conducting management tasks, with the aim of contributing to develop projects with pragmatism and a sense of responsibility, taking commitments taking into account available resources.

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

Full-or-part-time: 27h 30m

Theory classes: 7h
Laboratory classes: 5h
Guided activities: 1h
Self study: 14h 30m
Development of content 6

Specific objectives:
1

Related competencies:
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.
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.
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.
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.
CT7. Third language. Know a third language, preferably English, with an adequate oral and written level and in line with the needs of graduates.
CT4. Teamwork. Be able to work as a member of an interdisciplinary team, either as a member or conducting management tasks, with the aim of contributing to develop projects with pragmatism and a sense of responsibility, taking commitments taking into account available resources.
CB5. That the students have developed those learning skills necessary to undertake later studies with a high degree of autonomy.

Full-or-part-time: 35h
Theory classes: 9h
Laboratory classes: 5h
Guided activities: 1h
Self study: 20h

Development of content 7

Full-or-part-time: 28h
Theory classes: 7h
Laboratory classes: 5h
Guided activities: 1h
Self study: 15h

GRADING SYSTEM

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

The final grade is the maximum of:
* 0.2 NL + 0.25 NP + 0.3 NF1 + 0.25 NF2
* 0.2 NL + 0.4 NF1 + 0.4 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 the computer (R2). In case of not attending any of the tests, the corresponding mark of the final exam will be maintained (NF1 or NF2).

In the case of re-evaluation, the final grade of the course is calculated as 0.2 NL + 0.4 R1 + 0.4 R2
BIBLIOGRAPHY

Basic:
- Cortadella, Jordi; Petit, Jordi. Algorithmics and Programming II (lecture notes in English) [on line]. UPC, 2021 [Consultation: 01/02/2022]. Available on: https://www.cs.upc.edu/~jordicf/Teaching/AP2/index.html.

Complementary:

RESOURCES

Hyperlink:
- http://www.cs.upc.edu/~jordicf/Teaching/AP2
- https://jutge.org