Course guide
270417 - PAA - Advanced Programming and Algorithms

Last modified: 07/02/2023

Unit in charge: Barcelona School of Informatics
Teaching unit: 723 - CS - Department of Computer Science.
Degree: BACHELOR’S DEGREE IN ARTIFICIAL INTELLIGENCE (Syllabus 2021). (Compulsory subject).
Academic year: 2022
ECTS Credits: 6.0
Languages: Catalan, Spanish

LECTURER

Coordinating lecturer: JOSÉ LUIS BALCÁZAR NAVARRO

Others:
Segon quadrimestre:
JOSÉ LUIS BALCÁZAR NAVARRO - 11, 12
PEDRO JESÚS COPADO MENDEZ - 11, 12
JORDI DELGADO PIN - 11, 12

PRIOR SKILLS


DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CE03. To identify and apply the basic algorithmic procedures of computer technologies to design solutions to problems by analyzing the suitability and complexity of the proposed algorithms.
CE13. To evaluate the computational complexity of a problem, identify algorithmic strategies that can lead to its resolution and recommend, develop and implement the one that guarantees the best performance in accordance with the established requirements.
CE02. To master the basic concepts of discrete mathematics, logic, algorithmic and computational complexity, and its application to the automatic processing of information through computer systems. To be able to apply all these for solving problems.
CE04. To design and use efficiently the most appropriate data types and structures to solve a problem.
CE10. To analyze, design, build and maintain applications in a robust, secure and efficient way, choosing the most appropriate paradigm and programming languages.
CE12. To master the fundamental principles and models of computing and to know how to apply them in order to interpret, select, assess, model, and create new concepts, theories, uses and technological developments related to artificial intelligence.

Generical:
CG4. Reasoning, analyzing reality and designing algorithms and formulations that model it. To identify problems and construct valid algorithmic or mathematical solutions, eventually new, integrating the necessary multidisciplinary knowledge, evaluating different alternatives with a critical spirit, justifying the decisions taken, interpreting and synthesizing the results in the context of the application domain and establishing methodological generalizations based on specific applications.
CG2. To use the fundamental knowledge and solid work methodologies acquired during the studies to adapt to the new technological scenarios of the future.
CG8. Perform an ethical exercise of the profession in all its facets, applying ethical criteria in the design of systems, algorithms, experiments, use of data, in accordance with the ethical systems recommended by national and international organizations, with special emphasis on security, robustness, privacy, transparency, traceability, prevention of bias (race, gender, religion, territory, etc.) and respect for human rights.

Transversal:
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.
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.
Basic:
CB2. That the students know how to apply their knowledge to their work or vocation in a professional way and possess the skills that are usually demonstrated through the elaboration and defense of arguments and problem solving within their area of ??study.
CB1. That students have demonstrated to possess and understand knowledge in an area of ??study that starts from the base of general secondary education, and is usually found at a level that, although supported by advanced textbooks, also includes some aspects that imply Knowledge from the vanguard of their field of study.

TEACHING METHODOLOGY

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LEARNING OBJECTIVES OF THE SUBJECT

1. Learning to analyze algorithms and learning about asymptotic notations.
2.-
3.-
4.-

STUDY LOAD

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self study</td>
<td>90,0</td>
<td>60.00</td>
</tr>
<tr>
<td>Hours large group</td>
<td>30,0</td>
<td>20.00</td>
</tr>
<tr>
<td>Hours small group</td>
<td>30,0</td>
<td>20.00</td>
</tr>
</tbody>
</table>

Total learning time: 150 h

CONTENTS

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Description:

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Description:

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- 
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## ACTIVITIES

**Description:**

**Specific objectives:**
1, 3

**Related competencies:**
CG4. Reasoning, analyzing reality and designing algorithms and formulations that model it. To identify problems and construct valid algorithmic or mathematical solutions, eventually new, integrating the necessary multidisciplinary knowledge, evaluating different alternatives with a critical spirit, justifying the decisions taken, interpreting and synthesizing the results in the context of the application domain and establishing methodological generalizations based on specific applications.

CE04. To design and use efficiently the most appropriate data types and structures to solve a problem.

CE10. To analyze, design, build and maintain applications in a robust, secure and efficient way, choosing the most appropriate paradigm and programming languages.

CE12. To master the fundamental principles and models of computing and to know how to apply them in order to interpret, select, assess, model, and create new concepts, theories, uses and technological developments related to artificial intelligence.

CE02. To master the basic concepts of discrete mathematics, logic, algorithmic and computational complexity, and its application to the automatic processing of information through computer systems. To be able to apply all these for solving problems.

CE03. To identify and apply the basic algorithmic procedures of computer technologies to design solutions to problems by analyzing the suitability and complexity of the proposed algorithms.

CE13. To evaluate the computational complexity of a problem, identify algorithmic strategies that can lead to its resolution and recommend, develop and implement the one that guarantees the best performance in accordance with the established requirements.

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.

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.

CB2. That the students know how to apply their knowledge to their work or vocation in a professional way and possess the skills that are usually demonstrated through the elaboration and defense of arguments and problem solving within their area of study.

**Full-or-part-time:** 6h

Theory classes: 2h
Self study: 4h
Description:

Specific objectives:
3

Related competencies:
CG4. Reasoning, analyzing reality and designing algorithms and formulations that model it. To identify problems and construct valid algorithmic or mathematical solutions, eventually new, integrating the necessary multidisciplinary knowledge, evaluating different alternatives with a critical spirit, justifying the decisions taken, interpreting and synthesizing the results in the context of the application domain and establishing methodological generalizations based on specific applications.
CE02. To master the basic concepts of discrete mathematics, logic, algorithmic and computational complexity, and its application to the automatic processing of information through computer systems. To be able to apply all these for solving problems.
CE10. To analyze, design, build and maintain applications in a robust, secure and efficient way, choosing the most appropriate paradigm and programming languages.
CE04. To design and use efficiently the most appropriate data types and structures to solve a problem.
CE03. To identify and apply the basic algorithmic procedures of computer technologies to design solutions to problems by analyzing the suitability and complexity of the proposed algorithms.
CE13. To evaluate the computational complexity of a problem, identify algorithmic strategies that can lead to its resolution and recommend, develop and implement the one that guarantees the best performance in accordance with the established requirements.
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.
CB2. That the students know how to apply their knowledge to their work or vocation in a professional way and possess the skills that are usually demonstrated through the elaboration and defense of arguments and problem solving within their area of study.

Full-or-part-time: 12h
Theory classes: 2h
Laboratory classes: 2h
Self study: 8h
Description:

Specific objectives:

3

Related competencies:

CG4. Reasoning, analyzing reality and designing algorithms and formulations that model it. To identify problems and construct valid algorithmic or mathematical solutions, eventually new, integrating the necessary multidisciplinary knowledge, evaluating different alternatives with a critical spirit, justifying the decisions taken, interpreting and synthesizing the results in the context of the application domain and establishing methodological generalizations based on specific applications.

CE04. To design and use efficiently the most appropriate data types and structures to solve a problem.

CE10. To analyze, design, build and maintain applications in a robust, secure and efficient way, choosing the most appropriate paradigm and programming languages.

CE02. To master the basic concepts of discrete mathematics, logic, algorithmic and computational complexity, and its application to the automatic processing of information through computer systems. To be able to apply all these for solving problems.

CE03. To identify and apply the basic algorithmic procedures of computer technologies to design solutions to problems by analyzing the suitability and complexity of the proposed algorithms.

CE13. To evaluate the computational complexity of a problem, identify algorithmic strategies that can lead to its resolution and recommend, develop and implement the one that guarantees the best performance in accordance with the established requirements.

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.

CB2. That the students know how to apply their knowledge to their work or vocation in a professional way and possess the skills that are usually demonstrated through the elaboration and defense of arguments and problem solving within their area of study.

Full-or-part-time: 14h
Theory classes: 2h
Laboratory classes: 4h
Self study: 8h
Description:

Specific objectives:

4

Related competencies:

CG4. Reasoning, analyzing reality and designing algorithms and formulations that model it. To identify problems and construct valid algorithmic or mathematical solutions, eventually new, integrating the necessary multidisciplinary knowledge, evaluating different alternatives with a critical spirit, justifying the decisions taken, interpreting and synthesizing the results in the context of the application domain and establishing methodological generalizations based on specific applications.

CE13. To evaluate the computational complexity of a problem, identify algorithmic strategies that can lead to its resolution and recommend, develop and implement the one that guarantees the best performance in accordance with the established requirements.

CE02. To master the basic concepts of discrete mathematics, logic, algorithmic and computational complexity, and its application to the automatic processing of information through computer systems. To be able to apply all these for solving problems.

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.

CB1. That students have demonstrated to possess and understand knowledge in an area of ??study that starts from the base of general secondary education, and is usually found at a level that, although supported by advanced textbooks, also includes some aspects that imply Knowledge from the vanguard of their field of study.

CB2. That the students know how to apply their knowledge to their work or vocation in a professional way and possess the skills that are usually demonstrated through the elaboration and defense of arguments and problem solving within their area of ??study.

Full-or-part-time: 8h

Theory classes: 2h

Self study: 6h
Description:

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Specific objectives:

4

Related competencies:

CG4. Reasoning, analyzing reality and designing algorithms and formulations that model it. To identify problems and construct valid algorithmic or mathematical solutions, eventually new, integrating the necessary multidisciplinary knowledge, evaluating different alternatives with a critical spirit, justifying the decisions taken, interpreting and synthesizing the results in the context of the application domain and establishing methodological generalizations based on specific applications.

CE02. To master the basic concepts of discrete mathematics, logic, algorithmic and computational complexity, and its application to the automatic processing of information through computer systems. To be able to apply all these for solving problems.

CE13. To evaluate the computational complexity of a problem, identify algorithmic strategies that can lead to its resolution and recommend, develop and implement the one that guarantees the best performance in accordance with the established requirements.

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.

CB1. That students have demonstrated to possess and understand knowledge in an area of study that starts from the base of general secondary education, and is usually found at a level that, although supported by advanced textbooks, also includes some aspects that imply knowledge from the vanguard of their field of study.

CB2. That the students know how to apply their knowledge to their work or vocation in a professional way and possess the skills that are usually demonstrated through the elaboration and defense of arguments and problem solving within their area of study.

Full-or-part-time: 14h

Theory classes: 2h
Laboratory classes: 4h
Self study: 8h
Description:

Specific objectives:
1, 3, 4

Related competencies:
CG2. To use the fundamental knowledge and solid work methodologies acquired during the studies to adapt to the new technological scenarios of the future.
CG4. Reasoning, analyzing reality and designing algorithms and formulations that model it. To identify problems and construct valid algorithmic or mathematical solutions, eventually new, integrating the necessary multidisciplinary knowledge, evaluating different alternatives with a critical spirit, justifying the decisions taken, interpreting and synthesizing the results in the context of the application domain and establishing methodological generalizations based on specific applications.
CE04. To design and use efficiently the most appropriate data types and structures to solve a problem.
CE10. To analyze, design, build and maintain applications in a robust, secure and efficient way, choosing the most appropriate paradigm and programming languages.
CE02. To master the basic concepts of discrete mathematics, logic, algorithmic and computational complexity, and its application to the automatic processing of information through computer systems. To be able to apply all these for solving problems.
CE03. To identify and apply the basic algorithmic procedures of computer technologies to design solutions to problems by analyzing the suitability and complexity of the proposed algorithms.
CE13. To evaluate the computational complexity of a problem, identify algorithmic strategies that can lead to its resolution and recommend, develop and implement the one that guarantees the best performance in accordance with the established requirements.
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.
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.
CB1. That students have demonstrated to possess and understand knowledge in an area of study that starts from the base of general secondary education, and is usually found at a level that, although supported by advanced textbooks, also includes some aspects that imply knowledge from the vanguard of their field of study.
CB2. That the students know how to apply their knowledge to their work or vocation in a professional way and possess the skills that are usually demonstrated through the elaboration and defense of arguments and problem solving within their area of study.

Full-or-part-time: 14h
Guided activities: 2h
Self study: 12h
Description:

Specific objectives:

4

Related competencies:

CG4. Reasoning, analyzing reality and designing algorithms and formulations that model it. To identify problems and construct valid algorithmic or mathematical solutions, eventually new, integrating the necessary multidisciplinary knowledge, evaluating different alternatives with a critical spirit, justifying the decisions taken, interpreting and synthesizing the results in the context of the application domain and establishing methodological generalizations based on specific applications.

CE02. To master the basic concepts of discrete mathematics, logic, algorithmic and computational complexity, and its application to the automatic processing of information through computer systems. To be able to apply all these for solving problems.

CE13. To evaluate the computational complexity of a problem, identify algorithmic strategies that can lead to its resolution and recommend, develop and implement the one that guarantees the best performance in accordance with the established requirements.

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.

CB1. That students have demonstrated to possess and understand knowledge in an area of study that starts from the base of general secondary education, and is usually found at a level that, although supported by advanced textbooks, also includes some aspects that imply Knowledge from the vanguard of their field of study.

CB2. That the students know how to apply their knowledge to their work or vocation in a professional way and possess the skills that are usually demonstrated through the elaboration and defense of arguments and problem solving within their area of study.

Full-or-part-time: 18h

Theory classes: 2h
Laboratory classes: 4h
Self study: 12h
Description:

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Specific objectives:

4

Related competencies:

CG4. Reasoning, analyzing reality and designing algorithms and formulations that model it. To identify problems and construct valid algorithmic or mathematical solutions, eventually new, integrating the necessary multidisciplinary knowledge, evaluating different alternatives with a critical spirit, justifying the decisions taken, interpreting and synthesizing the results in the context of the application domain and establishing methodological generalizations based on specific applications.

CE13. To evaluate the computational complexity of a problem, identify algorithmic strategies that can lead to its resolution and recommend, develop and implement the one that guarantees the best performance in accordance with the established requirements.

CE02. To master the basic concepts of discrete mathematics, logic, algorithmic and computational complexity, and its application to the automatic processing of information through computer systems. To be able to apply all these for solving problems.

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.

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CB2. That the students know how to apply their knowledge to their work or vocation in a professional way and possess the skills that are usually demonstrated through the elaboration and defense of arguments and problem solving within their area of study.

Full-or-part-time: 19h
Theory classes: 5h
Laboratory classes: 4h
Self study: 10h
Description:

Specific objectives:
2, 4

Related competencies:
CG8. Perform an ethical exercise of the profession in all its facets, applying ethical criteria in the design of systems, algorithms, experiments, use of data, in accordance with the ethical systems recommended by national and international organizations, with special emphasis on security, robustness, privacy, transparency, traceability, prevention of bias (race, gender, religion, territory, etc.) and respect for human rights.

CG4. Reasoning, analyzing reality and designing algorithms and formulations that model it. To identify problems and construct valid algorithmic or mathematical solutions, eventually new, integrating the necessary multidisciplinary knowledge, evaluating different alternatives with a critical spirit, justifying the decisions taken, interpreting and synthesizing the results in the context of the application domain and establishing methodological generalizations based on specific applications.

CE12. To master the fundamental principles and models of computing and to know how to apply them in order to interpret, select, assess, model, and create new concepts, theories, uses and technological developments related to artificial intelligence.

CE02. To master the basic concepts of discrete mathematics, logic, algorithmic and computational complexity, and its application to the automatic processing of information through computer systems. To be able to apply all these for solving problems.

CE03. To identify and apply the basic algorithmic procedures of computer technologies to design solutions to problems by analyzing the suitability and complexity of the proposed algorithms.

CE13. To evaluate the computational complexity of a problem, identify algorithmic strategies that can lead to its resolution and recommend, develop and implement the one that guarantees the best performance in accordance with the established requirements.

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.

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.

CB1. That students have demonstrated to possess and understand knowledge in an area of study that starts from the base of general secondary education, and is usually found at a level that, although supported by advanced textbooks, also includes some aspects that imply knowledge from the vanguard of their field of study.

CB2. That the students know how to apply their knowledge to their work or vocation in a professional way and possess the skills that are usually demonstrated through the elaboration and defense of arguments and problem solving within their area of study.

Full-or-part-time: 23h
Theory classes: 5h
Laboratory classes: 8h
Self study: 10h
Description:

Specific objectives:
2, 4

Related competencies:
CG8. Perform an ethical exercise of the profession in all its facets, applying ethical criteria in the design of systems, algorithms, experiments, use of data, in accordance with the ethical systems recommended by national and international organizations, with special emphasis on security, robustness, privacy, transparency, traceability, prevention of bias (race, gender, religion, territory, etc.) and respect for human rights.

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CE03. To identify and apply the basic algorithmic procedures of computer technologies to design solutions to problems by analyzing the suitability and complexity of the proposed algorithms.

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CB2. That the students know how to apply their knowledge to their work or vocation in a professional way and possess the skills that are usually demonstrated through the elaboration and defense of arguments and problem solving within their area of study.

Full-or-part-time: 22h
Theory classes: 6h
Laboratory classes: 4h
Self study: 12h

GRADING SYSTEM

The assessment of part of the Algorithmic section of the course (beginning of the course) will require the development of a practical work of a modest size that will be presented at the beginning of the Dynamic Programming part and will be evaluated on its completion and delivery (grade P).

In addition, there will be the grade for the partial (E) and the final exam (grade F). The course grade will be obtained using the following criterion:

\[ \max(F \times 0.8, (E \times 0.3 + F \times 0.5)) + P \times 0.2 \]

Reassessment
Only those who have previously taken the final exam and failed it can take the reassessment exam.
BIBLIOGRAPHY

Basic:

Complementary:

RESOURCES

Hyperlink:
- https://www.cs.upc.edu/~balqui/paa.html