

Course guide

270412 - ABIA - Basic Algorithms of Artificial Intelligence

Last modified: 10/07/2025

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: 2025 **ECTS Credits:** 6.0 **Languages:** Catalan, Spanish

LECTURER

Coordinating lecturer: RAMON SANGÜESA SOLE - JAVIER VAZQUEZ SALCEDA

Others: Primer quadrimestre:
SERGIO ÁLVAREZ NAPAGAO - 11, 12
SANTIAGO MARCO SOLA - 11
JAVIER VAZQUEZ SALCEDA - 11, 12

PRIOR SKILLS

Prior skills on Logics acquired in the course Mathematica Foundations (FM) and Knowledge and Automatic Reasoning (CRA):

- Knowledge of the basic concepts: logical propositions and predicates
- Ability to formulate a problem in logical terms.
- Knowledge of logical inference and decision. Understanding resolution strategies.

Prior skills on Algorithmics acquired in the courses on Algorithms and Programming (PA1 and PA2)

- Knowledge on tree and graph structures,
- Knowledge on tree and graph search algorithms.
- Basic notions in algorithmic complexity.

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.

CE14. To master the foundations, paradigms and techniques of intelligent systems and to analyze, designing and build computer systems, services and applications that use these techniques in any field of application, including robotics.

Generical:

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.

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:

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.

TEACHING METHODOLOGY

The classroom sessions are divided into theory, problems and laboratory sessions.

Theory sessions introduce the knowledge of the course concepts, switching between the exhibition of new material with examples and discussion with students on concepts and examples.

Problem sessions deepen the knowledge on techniques and algorithms explained in the Theory sessions. They stimulate the participation of students to discuss possible alternatives.

Laboratory sessions develop small practical assignments by using AI tools and languages in order to practice and enhance the students' knowledge on concepts, techniques and algorithms.

LEARNING OBJECTIVES OF THE SUBJECT

- 1.To know the main algorithms for searching and exploring configuration spaces
- 2.To know the bioinspired and evolutionary algorithms
- 3.To know the automated planning methods
- 4.To be able to analyze problems and choose the best algorithmic strategy

STUDY LOAD

Type	Hours	Percentage
Hours small group	30,0	20.00
Self study	90,0	60.00
Hours large group	30,0	20.00

Total learning time: 150 h

CONTENTS

Introduction to problem solving through search

Description:

Introduction to automatic problem solving methodologies. Representation as a state space. Basic uninformed search algorithms in the state space. Limitations.

Heuristic Search

Description:

Knowing and understanding search methods guided by heuristic functions. Properties that must fulfill heuristic functions.

Local Search

Description:

Local search algorithms and their motivation are presented and studied. They are portrayed as heuristic methods for solving computationally difficult optimization problems, using strategies for maximizing or minimizing some criteria that characterize possible solutions.

Adversarial Search.Games

Description:

Games are presented as an extension of minimization and maximization strategies. They are also explored from the more general perspective of game theory, focusing on a broad taxonomy that includes competitive, cooperative, zero-sum, infinite, repeated games, and so on, with an exploration of concepts and conditions of equilibrium.

Introduction to constraint satisfaction

Description:

Problem-solving methods for constraint satisfaction are presented as a way of exploring space using the constraints imposed on the set of variables that characterize the problem and its possible solutions.

Methods of backpropagation and propagation of constraints are presented, studied and compared and they are also connected with logical forms of expressing the satisfaction of constraints.

Automated Planning

Description:

Strategies for exploring the sequencing of actions over time in order to efficiently achieve the goals of smart agents are presented. They are connected with optimization in a multidimensional space. The main planning algorithms are presented by relating them to exploration, search and optimization strategies: classical, temporal, probabilistic, and hierarchical planning for example, and they are portrayed as an exploration in a space of plans. Reuse of plans is also studied. A planning language is presented to be able to start planning exercises and projects.

ACTIVITIES

Problem Solving through Heuristic Search

Description:

Students not only should attend the teacher lectures, but also do exercises on the use of search algorithms, and participate in discussions with the teacher and other students on when is best to use each of the algorithms. In the laboratory students will apply what they learned in a moderate problem.

Specific objectives:

1, 4

Related competencies :

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.

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CG2. To use the fundamental knowledge and solid work methodologies acquired during the studies to adapt to the new technological scenarios of the future.

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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.

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.

Full-or-part-time: 24h

Self study: 12h

Theory classes: 6h

Laboratory classes: 6h

Problem Solving through Local Search

Description:

Students not only should attend the teacher lectures, but also do exercises on the use of search algorithms, and participate in discussions with the teacher and other students on when is best to use each of the algorithms. In the laboratory students will apply what they learned in a moderate problem.

Specific objectives:

1, 2, 4

Related competencies :

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.

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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.

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.

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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.

Full-or-part-time: 24h

Self study: 12h

Theory classes: 7h

Laboratory classes: 5h

Practical Assignment 1: Problem solving as a Search on a configuration space

Description:

Carrying out the practical assignment on Search algorithms. Students will do most of the practical work independently in non-presencial hours. There will be some face-to-face hours with the teacher to guide the resolution and to resolve doubts. A report must be submitted at the end of the practical assignment.

Specific objectives:

1, 4

Related competencies :

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.

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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.

Full-or-part-time: 18h 30m

Self study: 16h 30m

Laboratory classes: 2h

Problem Solving through Adversarial Search. Games

Description:

Students not only should attend the teacher lectures, but also do exercises on the use of search algorithms, and participate in discussions with the teacher and other students on when is best to use each of the algorithms. In the laboratory students will apply what they learned in a moderate problem.

Specific objectives:

1, 4

Related competencies :

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.

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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.

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.

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.

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.

Full-or-part-time: 12h

Self study: 6h

Theory classes: 3h

Laboratory classes: 3h

Delivery of practical exercise 1: Problem solving as a Search on a configuration space

Description:

Delivery of the report on the search algorithms practical assignment that students have done.

Specific objectives:

1, 4

Related competencies :

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.

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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.

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.

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.

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.

Midterm exam

Specific objectives:

1, 2, 4

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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.

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.

Full-or-part-time: 2h

Guided activities: 2h

Constraint Satisfaction and Optimization

Description:

Students not only should attend the teacher lectures, but also do exercises on the use of search algorithms, and participate in discussions with the teacher and other students on when is best to use each of the algorithms. In the laboratory students will apply what they learned in a moderate problem.

Specific objectives:

1, 4

Related competencies :

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.

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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.

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.

Full-or-part-time: 18h

Self study: 10h

Theory classes: 4h

Laboratory classes: 4h

Automated Planning

Description:

Students not only should attend the teacher lectures, but also do exercises on the use of search algorithms, and participate in discussions with the teacher and other students on when is best to use each of the algorithms. In the laboratory students will apply what they learned in a moderate problem.

Specific objectives:

3, 4

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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.

Full-or-part-time: 30h

Self study: 15h

Theory classes: 8h

Laboratory classes: 7h

Practical Assignment 2: Problem solving through Automated Planning

Description:

Carrying out the practical assignment on Automated Planning. Students will do most of the practical work independently in non-presencial hours. There will be some face-to-face hours with the teacher to guide the resolution and to resolve doubts. A report must be submitted at the end of the practical assignment.

Specific objectives:

3, 4

Related competencies :

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.

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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.

Full-or-part-time: 17h 30m

Self study: 14h 30m

Laboratory classes: 3h

Delivery Practical Exercise 2: Problem solving through Automated Planning

Description:

Delivery of the report on the Automated Planning practical assignment that students have done.

Specific objectives:

3, 4

Related competencies :

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.

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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.

Final Exam

Description:

Final exam for the course contents.

Specific objectives:

1, 2, 3, 4

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Full-or-part-time: 4h

Self study: 4h

GRADING SYSTEM

The student assessment will consist of a partial exam mark, a final exam mark and a laboratory mark.

The partial exam will be done during standard class hours. Passing the partial exam does not mean that those course contents won't appear again in the final exam. People who do not pass the partial will be evaluated their theoretical knowledge only on the final exam mark.

The laboratory mark will come from the practical assignments' reports.

The calculation of the final mark will be as follows:

PM = partial exam mark

FM = final exam mark

LM = laboratory mark

$$\text{MARK} = \max((\text{PM} \cdot 0.2 + \text{FM} \cdot 0.3), \text{FM} \cdot 0.5) + \text{LM} \cdot 0.5$$

Reassessment: Only those who have failed the final exam may take the reassessment. The maximum grade that can be obtained in the reassessment is 7.

Competences' Assessment

The assessment of the competence on teamwork (CT4) is based on work done during the laboratory assignments. The ABCD grade is calculated from a detailed rubric given to students at the beginning of the course.

The assessment of the competence on application of knowledge (CB2) is calculated directly from the course mark, as, in fact, this competence is being evaluated effectively in all evaluation acts.

BIBLIOGRAPHY

Basic:

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- Luger, George F. Artificial intelligence : structures and strategies for complex problem solving. 6th ed. Boston [etc.]: Pearson Education : Addison Wesley, cop. 2009. ISBN 9780321545893.
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Complementary:

- Nilsson, Nils J. Artificial intelligence : a new synthesis. San Francisco, California: Morgan Kaufmann Publishers, cop. 1998. ISBN 1558604677.
- Escolano Ruiz, Francisco. Inteligencia artificial : modelos, técnicas y áreas de aplicación. Madrid: Thomson, cop. 2003. ISBN 8497321839.