

Course guide

270403 - FC - Fundamentals of Computers

Last modified: 10/07/2024

Unit in charge: Barcelona School of Informatics
Teaching unit: 701 - DAC - Department of Computer Architecture.

Degree: BACHELOR'S DEGREE IN ARTIFICIAL INTELLIGENCE (Syllabus 2021). (Compulsory subject).

Academic year: 2024 **ECTS Credits:** 6.0 **Languages:** Catalan

LECTURER

Coordinating lecturer: JAVIER VERDU MULA

Others: Primer quadrimestre:
XAVIER MARTORELL BOFILL - 11, 12
JAVIER VERDU MULA - 11, 12

PRIOR SKILLS

No one in particular. Students should have the expected skills for starting a bachelor's degree in Informatics.

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.

CE05. To be able to analyze and evaluate the structure and architecture of computers, as well as the basic components that make them up.

CE06. To be able to identify the features, functionalities and structure of Operating Systems and to design and implement applications based on their services.

CE07. To interpret the characteristics, functionalities and structure of Distributed Systems, Computer Networks and the Internet and design and implement applications based on them.

CE11. To identify and apply the fundamental principles and basic techniques of parallel, concurrent, distributed and real-time programming.

CE19. To use current computer systems, including high-performance systems, for the processing of large volumes of data from the knowledge of its structure, operation and particularities.

CE28. To plan, ideate, deploy and direct projects, services and systems in the field of artificial intelligence, leading its implementation and continuous improvement and assessing its economic and social impact.

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.

CG3. To define, evaluate and select hardware and software platforms for the development and execution of computer systems, services and applications in the field of artificial intelligence.

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.

CG5. Work in multidisciplinary teams and projects related to artificial intelligence and robotics, interacting fluently with engineers and professionals from other disciplines.

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.

CG9. To face new challenges with a broad vision of the possibilities of a professional career in the field of Artificial Intelligence. Develop the activity applying quality criteria and continuous improvement, and act rigorously in professional development. Adapt to organizational or technological changes. Work in situations of lack of information and / or with time and / or resource restrictions.

Transversal:

CT2. Sustainability and Social Commitment. To know and understand the complexity of economic and social phenomena typical of the welfare society; Be able to relate well-being to globalization and sustainability; Achieve skills to use in a balanced and compatible way the technique, the technology, the economy and the sustainability.

CT3. Efficient oral and written communication. Communicate in an oral and written way with other people about the results of learning, thinking and decision making; Participate in debates on topics of the specialty itself.

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.

Basic:

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.

CB4. That the students can transmit information, ideas, problems and solutions to a specialized and non-specialized public.

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

TEACHING METHODOLOGY

The course is based on classroom theory and laboratory. The lectures follow the program set out in this syllabus, are usually based on material provided through slides.

On the lectures, the course promotes a dialogue between teacher and students by providing activities carried out jointly based on particular aspects of the current topic.

Laboratory sessions follow the same subjects and are based on two different types of lectures: 1) practice sessions using a computer and using some wordings; 2) exercises/problems to be solved in the whiteboard or through a presentation/explanation for the other students.

LEARNING OBJECTIVES OF THE SUBJECT

1. Knowledge about the features and limitations, especially about accuracy error, of the different data representation formats in a computer
2. Knowledge about a processor architecture based on Von Neumann model, as well as its key components
3. Knowledge about logical memory space, from how it is used to how some contents are managed
4. Knowledge about the basic concepts of an Operating System and understand the impact on performance and energy consumption of a system
5. Knowledge about the procedure to create and debug a program, as well as its requirements
6. Ability to discuss and compare the resolution of problems and practical exercises
7. Understand the relation between the course and the AI area

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

Course Introduction

Description:

A brief introduction about the course, topics, and its relation with the AI area

Data Representation

Description:

This lesson is focused on the data representation with different complexity levels, their limitations and the implementation of basic operations

Processor Architecture

Description:

Introduction of the processor architecture, based on the Von Neumann's model, and its components

Memory Hierarchy

Description:

Present the memory hierarchy properties, especially the concepts of locality and reutilization, and the potential impact on performance and energy consumption

Introduction of parallelism based on SIMD

Description:

Introduction of the concept and key aspects of SIMD parallelism

Implications of executing an instruction

Description:

Description of consequences related to cost, potential bottlenecks and energy consumption, from the architecture point of view, when executing an instruction

Logical Memory Space

Description:

Presentation of basic points to understand the aim, build, usage, and management of the logical memory space

Introduction of libraries

Description:

Presentation of the concept and purpose behind the libraries as well as the required management from the point of view of the logical memory space

Create Executables

Description:

Introduction of compilation and interpretation processes, including the debugging as well. Comparison of requirements and limitations of generated executables

Impact of Operating Systems on performance and energy consumption

Description:

Define Operating Systems and their key aspects that impact on the system performance and energy consumption

Basic components of Operating Systems

Description:

Present I/O and File System subsystems of the Operating System, from the point of view and detail level of program developer. Besides, aspects of memory management are also introduced

ACTIVITIES

Course Introduction

Description:

This activity presents the goals, contents, and the way to work in the course. Besides, in the lab, useful key points will be introduced required to fulfill the practice sessions.

Specific objectives:

7

Related competencies :

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Full-or-part-time: 9h 30m

Self study: 3h

Theory classes: 0h 30m

Laboratory classes: 6h

Data Representation and Basic Operations

Description:

This lesson includes the data representation, from basic concepts, types of numbers, and finally, advanced data representation. Besides, other points, such as data precision and basic operations will be also addressed

Specific objectives:

1

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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.

Full-or-part-time: 19h 30m

Self study: 10h

Theory classes: 5h 30m

Laboratory classes: 4h

Processor Architecture

Description:

We introduce the architecture of uniprocessor systems, from the Von Neumann architecture and its key components. Besides, we also present the consequences of executing an instruction, among other reasons to understand potential bottlenecks and the cost of executing an instruction, especially in relation to the energy consumption and its relation with the architecture.

Specific objectives:

2

Related competencies :

CB4. That the students can transmit information, ideas, problems and solutions to a specialized and non-specialized public.

CE05. To be able to analyze and evaluate the structure and architecture of computers, as well as the basic components that make them up.

CE11. To identify and apply the fundamental principles and basic techniques of parallel, concurrent, distributed and real-time programming.

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

CG3. To define, evaluate and select hardware and software platforms for the development and execution of computer systems, services and applications in the field of artificial intelligence.

CT3. Efficient oral and written communication. Communicate in an oral and written way with other people about the results of learning, thinking and decision making; Participate in debates on topics of the specialty itself.

Full-or-part-time: 32h

Self study: 16h

Theory classes: 8h

Laboratory classes: 8h

Theory mid-term

Specific objectives:

1, 2

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Full-or-part-time: 12h

Self study: 10h

Guided activities: 2h

Program Execution and its environment

Description:

This lesson comprises two parts. The first one explains how to generate a program (both if it was a compiled or an interpreted program). The second part presents the Operating System and a set of concepts and features to understand its relevance for the program execution and its impact on the performance and the energy.

Specific objectives:

4, 5

Related competencies :

CB5. That the students have developed those learning skills necessary to undertake later studies with a high degree of autonomy
CE06. To be able to identify the features, functionalities and structure of Operating Systems and to design and implement applications based on their services.

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.

CE11. To identify and apply the fundamental principles and basic techniques of parallel, concurrent, distributed and real-time programming.

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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.

Full-or-part-time: 24h

Self study: 14h

Theory classes: 6h

Laboratory classes: 4h

Logical memory

Description:

We present the logical memory address space and its key features, as well as understand the concept behind the libraries and their main aspects.

Specific objectives:

3

Related competencies :

CB4. That the students can transmit information, ideas, problems and solutions to a specialized and non-specialized public.

CE19. To use current computer systems, including high-performance systems, for the processing of large volumes of data from the knowledge of its structure, operation and particularities.

Full-or-part-time: 24h

Self study: 12h

Theory classes: 6h

Laboratory classes: 6h

Lab Exam

Specific objectives:

6

Related competencies :

CB4. That the students can transmit information, ideas, problems and solutions to a specialized and non-specialized public.

CE06. To be able to identify the features, functionalities and structure of Operating Systems and to design and implement applications based on their services.

CE07. To interpret the characteristics, functionalities and structure of Distributed Systems, Computer Networks and the Internet and design and implement applications based on them.

CE28. To plan, ideate, deploy and direct projects, services and systems in the field of artificial intelligence, leading its implementation and continuous improvement and assessing its economic and social impact.

CG5. Work in multidisciplinary teams and projects related to artificial intelligence and robotics, interacting fluently with engineers and professionals from other disciplines.

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.

CT2. Sustainability and Social Commitment. To know and understand the complexity of economic and social phenomena typical of the welfare society; Be able to relate well-being to globalization and sustainability; Achieve skills to use in a balanced and compatible way the technique, the technology, the economy and the sustainability.

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.

Full-or-part-time: 12h

Self study: 10h

Guided activities: 2h

Final Theory Exam

Specific objectives:

1, 2, 3, 4, 5, 6, 7

Related competencies :

CB4. That the students can transmit information, ideas, problems and solutions to a specialized and non-specialized public.

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

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.

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Full-or-part-time: 17h

Self study: 15h

Guided activities: 2h



GRADING SYSTEM

There are two exams for the theory part:

- PT: The partial theory control (20%)
- FT: The final theory exam (35%)
- FL: The final lab exam (35%)
- SL: the marks of tracking lab (10%) come from individual tests performed in particular lab sessions.

Regular Assessment: The final mark (NF) of the course comes from

$$NF = 35\%FL + 10\%SL + \text{MAX}(55\%FT; (20\%PT+35\%FT))$$

Reassessment: will be done on June. Only the students that have failed the course (i.e. those have done the partial and/or final theory exams) can have the chance to do the Reassessment exam (only theory). If the student pass the exam, the highest mark of the exam and, thus the highest final mark of the course will be 7.

BIBLIOGRAPHY

Basic:

- Bryant, Randal E; O'Hallaron, David. Computer systems : a programmer's perspective. 3rd ed. Essex: Pearson, 2016. ISBN 9781292101767.

RESOURCES

Hyperlink:

- <https://docencia.ac.upc.edu/FIB/GIA/FC/>