Course guide
270424 - SBC - Knowledge-Based Systems

Last modified: 13/07/2023

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: 2023 **ECTS Credits:** 6.0 **Languages:** Catalan, Spanish

LECTURER

Coordinating lecturer: RAMON SANGÜESA SOLE - JAVIER VAZQUEZ SALCEDA

Others: Primer quadrimestre:
SANTIAGO MARCO SOLA - 11
RAMON SANGÜESA SOLE - 11, 12
JAVIER VAZQUEZ SALCEDA - 11, 12

PRIOR SKILLS

Knowledge and Automatic Reasoning. (1rst Term, of the 1st Year)

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
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.
CE15. To acquire, formalize and represent human knowledge in a computable form for solving problems through a computer system in any field of application, particularly those related to aspects of computing, perception and performance in intelligent environments or environments.
CE18. To acquire and develop computational learning techniques and to design and implement applications and systems that use them, including those dedicated to the automatic extraction of information and knowledge from large volumes of data.

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

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.

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

TEACHING METHODOLOGY

The classes are divided into theory, problem and laboratory sessions.

In the theory sessions, knowledge of the subject will be developed, interspersed with the presentation of new theoretical material with examples and interaction with the students in order to discuss the concepts.

The problem classes will allow you to deepen the techniques and algorithms explained in the theory sessions. Student participation will be encouraged in order to comment on possible alternatives.

In the laboratory classes, small practices will be developed using tools and languages specific to Artificial Intelligence that will allow practicing and reinforcing the knowledge of the theory classes.

LEARNING OBJECTIVES OF THE SUBJECT

1.To know and understand the concept of a knowledge-based system, its relationship with cognition and with the representation of knowledge
2.To know and understand the different architectures of knowledge-based systems
3.To know and understand the various forms of knowledge representation, reasoning and to practice their design and implementation implementation in the various architectures of knowledge-based systems

STUDY LOAD

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

Total learning time: 150 h

CONTENTS

Introduction to Knowledge-Based Systems Systems based on knowledge. Characteristics. components Problems solvable through SBCs.

Description:
A thorough exploration of the different types of Knowledge-Based Systems, their components and applications.

Reasoning Based on Semantic/Procedural Knowledge

Description:
Types of Knowledge. Knowledge representation schemes.
Semantic Knowledge: Semantic Networks. Logical description. Networks of Frames. Ontologies. Ontological reasoning
Procedural knowledge. Rule-based reasoning systems. Fact bases, knowledge bases, inference engine, meta-knowledge, ...
Knowledge engineering. Phases of knowledge engineering. Knowledge management.
SBCs with more than one Knowledge Representation Scheme. Meta-knowledge, combination of results.

Reasoning Based on Experience

Description:
Reasoning Based on Experience
Episodic knowledge: Reasoning based on experience. Modeling experience with Cases, Case-Based Reasoning (CBR).
Fundamentals of CBR: Introduction, Cognitive theory, Basic cycle of reasoning. Academic Examples/Demonstrators.
Components of a CBR system: Structure of the cases. Organization of the Library/Case Base. Recovery of cases. Adaptation of cases. Case evaluation. Case study.
Application of a CBR system to a real case. Important aspects in the development of CBR systems.
Reflexive Reasoning in CBR systems. Maintenance of a CBR system. Industrial applications of CBR systems. CBR system development tools
Evaluation of CBR systems. Advanced topics in CBR: Temporal CBR, Spatial CBR, Hybrid CBR Systems

Collaborative Reasoning

Description:
Collaborative Reasoning
Introduction: Intelligent Decision Support Systems (IDSS), Recommender Systems. General architecture of a recommender system.
Classification of Recommender Systems. Basic Recommendation techniques: Collaborative Filtering, Content-based Filtering.
Other Recommendation techniques: knowledge-based (case-based, constraint-based), community-based, demographic-based, hybrid approaches
KPIs in Recommendation Systems: performance, competence. Evaluation of the quality of a Recommendation System: quantitative measures, qualitative measures
Applications of Recommendation Systems (Amazon, Netflix, ...). Future trends in Recommendation Systems

ACTIVITIES

Introduction to Knowledge-Based Systems

Description:
Knowledge-Based Systems. Characteristics. components Problems solvable through SBCs.

Specific objectives:
1, 2, 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.
CG5. Work in multidisciplinary teams and projects related to artificial intelligence and robotics, interacting fluently with engineers and professionals from other disciplines.
CG2. To use the fundamental knowledge and solid work methodologies acquired during the studies to adapt to the new technological scenarios of the future.
CE15. To acquire, formalize and represent human knowledge in a computable form for solving problems through a computer system in any field of application, particularly those related to aspects of computing, perception and performance in intelligent environments or environments.
CE18. To acquire and develop computational learning techniques and to design and implement applications and systems that use them, including those dedicated to the automatic extraction of information and knowledge from large volumes of data.
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.
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.
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.
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: 4h
Self study: 4h

Reasoning Based on Semantic and Procedural Knowledge

Description:
Reasoning Based on Semantic and Procedural Knowledge

Specific objectives:
1, 2, 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.
CG5. Work in multidisciplinary teams and projects related to artificial intelligence and robotics, interacting fluently with engineers and professionals from other disciplines.
CG2. To use the fundamental knowledge and solid work methodologies acquired during the studies to adapt to the new technological scenarios of the future.
CE15. To acquire, formalize and represent human knowledge in a computable form for solving problems through a computer system in any field of application, particularly those related to aspects of computing, perception and performance in intelligent environments or environments.
CE18. To acquire and develop computational learning techniques and to design and implement applications and systems that use them, including those dedicated to the automatic extraction of information and knowledge from large volumes of data.
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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CB4. That the students can transmit information, ideas, problems and solutions to a specialized and non-specialized public.
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: 30h
Theory classes: 10h
Laboratory classes: 10h
Self study: 10h

Reasoning Based on Experience

Description:
Reasoning Based on Experience

Specific objectives:
3

Related competencies :
CG5. Work in multidisciplinary teams and projects related to artificial intelligence and robotics, interacting fluently with engineers and professionals from other disciplines.
CE18. To acquire and develop computational learning techniques and to design and implement applications and systems that use them, including those dedicated to the automatic extraction of information and knowledge from large volumes of data.
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.

Full-or-part-time: 20h
Theory classes: 8h
Laboratory classes: 4h
Self study: 8h

Collaborative Reasoning

Description:
Collaborative Reasoning

Specific objectives:
3

Related competencies :
CG5. Work in multidisciplinary teams and projects related to artificial intelligence and robotics, interacting fluently with engineers and professionals from other disciplines.
CE18. To acquire and develop computational learning techniques and to design and implement applications and systems that use them, including those dedicated to the automatic extraction of information and knowledge from large volumes of data.
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.

Full-or-part-time: 22h
Theory classes: 8h
Laboratory classes: 6h
Self study: 8h

Reasoning practice with ontologies and rule systems control

Description:
Reasoning practice with ontologies and rule systems control

Specific objectives:
1, 2, 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.
CG5. Work in multidisciplinary teams and projects related to artificial intelligence and robotics, interacting fluently with engineers and professionals from other disciplines.
CG2. To use the fundamental knowledge and solid work methodologies acquired during the studies to adapt to the new technological scenarios of the future.
CE15. To acquire, formalize and represent human knowledge in a computable form for solving problems through a computer system in any field of application, particularly those related to aspects of computing, perception and performance in intelligent environments or environments.
CE18. To acquire and develop computational learning techniques and to design and implement applications and systems that use them, including those dedicated to the automatic extraction of information and knowledge from large volumes of data.
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.
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.
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.
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.

CBR practical project control.

Description:
CBR practical project control.

Reasoning with Ontologies and rule systems practical work

Description:
Reasoning with Ontologies and rule systems practical wo

Full-or-part-time: 34h
Laboratory classes: 4h
Self study: 30h

CBR practical project

Description:
CBR practical project

Full-or-part-time: 36h
Laboratory classes: 6h
Self study: 30h

GRADING SYSTEM

Assessment will be based on practicals only

NP1: note of the first practice
NP2: note of the second practice
NFinal = 0.5*NP1+0.5*NP2

Assessment of skills

The assessment of teamwork competence (CT4) is based on the work done during the laboratory practices. The grade A B C D is calculated from a detailed rubric that will be given to students at the beginning of the year.
The evaluation of the competence of the information resources (CT5). it is based on the work done during the internship. The grade A B C D is calculated from a detailed rubric that will be given to students at the beginning of the year.
Weight of transversal skills in the evaluation of the specific part of the subject
10% - That 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 development and defense of arguments and the resolution of problems within their area of expertise study
10% - Teamwork. Be able to work as a member of an interdisciplinary team, either as another member or performing management tasks, in order to contribute to developing projects with pragmatism and a sense of responsibility, making commitments taking into account the available resources.

BIBLIOGRAPHY

Basic:
- Brachman, Ronald J; Levesque, Hector J. Knowledge representation and reasoning [Recurs electrònic] [on line]. Amsterdam: Elsevier, 2004 [Consultation: 21/07/2023]. Available on: https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=333988. ISBN 9781558609327.
- Kendal, S. L; Creen, M. An Introduction to knowledge engineering. London: Springer, [2007]. ISBN 9781846284755.