Universitat de Lleida

DEGREE CURRICULUM

COMPUTATIONAL LOGIC

Coordination: MARTÍNEZ RODRÍGUEZ, SANTIAGO

Academic year 2021-22

2021-22

Subject's general information

Subject name	COMPUTATIONAL LOGIC
Code	102366
Semester	1st Q(SEMESTER) CONTINUED EVALUATION
Typology	Degree: Bachelor's degree in Digital Interaction and Computing Techniques; Course: 1; Character: COMMON; Modality: Attendance-based
Course number of credits (ECTS)	6
Type of activity, credits, and groups	Activity type: PRALAB / TEORIA Number of credits: 3 / 3 Number of groups: 1 / 1
Coordination	MARTÍNEZ RODRÍGUEZ, SANTIAGO
Department	COMPUTER SCIENCE AND INDUSTRIAL ENGINEERING
Teaching load distribution between lectures and independent student work	6 ECTS = 25x6 = 150 working hours: 40% -> 60 in-class hours, 60% -> 90 autonomous work hours.
Important information on data processing	Consult this link for more information.
Language	Catalan.
Distribution of credits	Theory: 3 Practices: 3

Teaching staff	E-mail addresses	Credits taught by teacher	Office and hour of attention
MARTÍNEZ RODRÍGUEZ, SANTIAGO	santi.martinez@udl.cat	6	Arrange with the teacher. Optionally, by videoconference.

Subject's extra information

To address this subject, properly skills on analysis and logical reasoning are recommended.

For any question, please, send an email to the teacher.

Learning objectives

At the end of the course, the student will be able to:

- Model sentences in propositional logic.
- Reason about the validity of propositional logic formulas.
- Apply systems of automatic reasoning to propositional logic formulas.
- Model sentences in first order logic.
- Reason about the validity of first order logic formulas.
- Apply systems of automatic reasoning to first order logic formulas.

Competences

Basic Competences

- **B01**. 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 coming from the vanguard of his/her field of study.

Transversal Competences

- **CT3**. Acquire training in the use of new technologies and information and communication technologies.
- **CT5**. Acquire essential notions of scientific thought.

General Competences

- **CG2**. Design, develop, evaluate and guarantee the accessibility, ergonomics, usability and security of computer systems.
- **CG3**. Use adequate hardware and software platforms to develop and execute interactive digital applications.
- **CG5**. Know the basic subject areas and technologies needed to learn and develop new methods and technologies, and those that help to adapt to new situations.
- **CG7**. Solve problems through initiative, determination, independence and creativity.
- **CG8**. Capacity for abstraction and critical, logical and mathematical reasoning.

Specific Competences

- **CE2**. Capacity to understand and master the basic concepts of discrete mathematics, logics, algorithmic and computational complexity, and its application to solve computational problems.
- **CE3**. Basic knowledge of the use and programming of computers, operating systems and databases, and their use in the development of interactive applications.
- **CE4**. Capacity to know, understand and evaluate the structure and architecture of computers, as well as the basic components that conform them.
- **CE16**. Capacity to design and evaluate person-computer interfaces that guarantee the usability of systems, services and computer applications.
- **CE17**. Capacity to apply knowledge on design to propose and defend a design concept for an interactive system and use proper creative technologies to develop each project.
- **CE24**. Capacity to understand the human factors involved in any interactive process between humans and technology, as well as being able to adequately apply them in the design of interactive products and services, and their interfaces.

Subject contents

The contents of the subject are the following:

Unit 1: Introduction to Logic Systems and Automated Reasoning

Unit 2: Propositional Logic

- Syntax, Semantics and Truth Tables
- Taxonomy of Sentences (satisfiable, unsatisfiable and tautology)
- Logic Equivalence, Equisatisfiability and Logic Consequence
- Modelling Sentences
- Normal Forms: Translations into Clausal Form
- Resolution Principle
- Automated Reasoning to Prove Validity of Formulas

Unit 3: First Order Logic

- Syntax and Semantics
- Taxonomy of Sentences (satisfiable, unsatisfiable and tautology)
- Logic Equivalence
- Modelling Sentences
- Substitution, Composition of Substitutions and Application of Substitutions to Expressions
- Unification of Expressions and Most General Unifier
- Normal Forms: Translations into Clausal Form
- Resolution Principle
- Automated Reasoning to Prove Validity of Formulas

Methodology

The course contents are divided into two blocks. The first block presents the logical system of propositional logic. The second presents the logical system of logic predicates. For each logical system we study: the syntax and semantics of the language and the proof procedure based on resolution. Additionally, for each system we study how to model problems and use state-of-the-art tools for solving them. In this sense, for propositional logic we use a SAT solver.

For each block we propose a collection of problems that student must solve independently. This work is supervised during the Large Group and Medium Group sessions.

Each week students attend 2 hours with a Large Group and 2 hours with a Medium Group.
Medium Group sessions are practices.

Development plan

Week	Description	Large Group Activity	Medium Group Activity	Autonomous Work
1	Introduction to Logic Systems	U1: Introduction to Logic Systems	Linux tutorial	Bibliography and subject program
2	Syntax and representation	U2: Propositional Logic	Exercices Unit 2	Exercices Unit 2
3	Semantics and classification of statements	U2: Propositional Logic	Exercices Unit 2	Exercices Unit 2
4	Normal Forms	U2: Propositional Logic	Description of Activity 1, Exercices Unit 2	Activity 1 Exercices Unit 2
5	Transformation to CNF	U2: Propositional Logic	SAT solvers	SAT solvers Exercices Unit 2
6	Resolution principle	U2: Propositional Logic	Exercices Unit 2	Activity 1 Exercices Unit 2
7	Automated proof	U2: Propositional Logic	Doubts on Units 1 and 2	Activity 1 Exercices Unit 2
8		**1st Midterm Exam**		Study

Week	Description	Large Group Activity	Medium Group Activity	Autonomous Work
9	Syntax and representation	U3: First Order Logic	Exercices Unit 3	Exercices Unit 3
10	Semantics and classification of statements	U3: First Order Logic	Exercices Unit 3	Exercices Unit 3
11	Logic equivalences	U3: First Order Logic	Exercices Unit 3	Exercices Unit 3
12	Normal Forms	U3: First Order Logic	Description Activity 2 Exercices Unit 3	Activity 2 Exercices Unit 3
13	Substitution and Unification	U3: First Order Logic	Exercices Unit 3	Activity 2 Exercices Unit 3
14	Resolution principle	U3: First Order Logic	Exercices Unit 3	Activity 2 Exercices Unit 3
15	Resolution principle	U3: First Order Logic	Doubts on Unit 3	Activity 2 Exercices Unit 3
16		**2nd Midterm Exam**		Study
17		**2nd Midterm Exam**		Study
18				
19		**Improvement Exam**		Study

Evaluation

Evaluation activities

Acronym	Evaluation Activity	Weight	Minimum Score	Group	Compulsory	Recoverable
EP1	1st Midterm Exam	35%	No	No	No	Yes
EP2	2nd Midterm Exam	35%	No	No	No	Yes
PR1	Activity 1	15%	No	Yes (≤ 2)	No	No
PR2	Activity 2	15%	No	Yes (≤ 2)	No	No
To pass the subject the final score must be ≥ 5.						
Final Score = 0.35 · EP1 + 0.35 · EP2 + 0.15 · PR1 + 0.15 · PR2						

Remarks:

If the final score < 5, the student can recover / improve these exams (the student can choose one exam or both).

Bibliography

Basic

- Teresa Hortalá, Narciso Martí, Miguel Palomino, Mario Rodríguez, Rafael del Vado: Lógica matemática para informáticos. Pearson, Prentice Hall, 2008.
- Enrique Paniagua, Juan Luís Sánchez, Fernando Martín: Lógica computacional. Thomson-Paraninfo, 2003.
- John Wylie Lloyd: Foundations of Logic Programming. Springer-Verlag, second edition, 1987.

Complementary

- Jean H. Gallier: Logic for Computer Science: Foundations of Automatic Theorem Proving, 2003 (http://www.cis.upenn.edu/~jean/gbooks/logic.html).
- Uwe Schöning: Logic for Computer Scientists. Birkhäuser, Boston, 1989.
- Tom Tymoczko, Jim Henle: Razón, dulce razón: Una Guía de Campo de la Lógica Moderna. Ariel, 2002.