Universitat de Lleida

DEGREE CURRICULUM

COMPUTATIONAL LOGIC

Coordination: MARTINEZ RODRIGUEZ, SANTIAGO

Academic year 2022-23

COMPUTATIONAL LOGIC 2022-23

Subject's general information

<table>
<tr><td>Subject name</td><td>COMPUTATIONAL LOGIC</td></tr>
<tr><td>Code</td><td>105004</td></tr>
<tr><td>Semester</td><td>1st Q(SEMESTER) CONTINUED EVALUATION</td></tr>
<tr><td>Typology</td><td>
<table>
<tr><th>Degree</th><th>Course</th><th>Character</th><th>Modality</th></tr>
<tr><td>Bachelor's Degree in Computer Engineering</td><td>1</td><td>COMMON/CORE</td><td>Attendance-based</td></tr>
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</td></tr>
<tr><td>Course number of credits (ECTS)</td><td>6</td></tr>
<tr><td>Type of activity, credits, and groups</td><td>
<table>
<tr><th>Activity type</th><th>PRALAB</th><th>TEORIA</th></tr>
<tr><td>Number of credits</td><td>3</td><td>3</td></tr>
<tr><td>Number of groups</td><td>2</td><td>1</td></tr>
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</td></tr>
<tr><td>Coordination</td><td>MARTINEZ RODRIGUEZ, SANTIAGO</td></tr>
<tr><td>Department</td><td>COMPUTER SCIENCE AND INDUSTRIAL ENGINEERING</td></tr>
<tr><td>Teaching load distribution between lectures and independent student work</td><td>6 ECTS = 25x6 = 150 working hours:
40% -> 60 in-class hours,
60% -> 90 autonomous work hours.</td></tr>
<tr><td>Important information on data processing</td><td>Consult this link for more information.</td></tr>
<tr><td>Language</td><td>Catalan.</td></tr>
<tr><td>Distribution of credits</td><td>Theory: 3
Practices: 3</td></tr>
</table>

COMPUTATIONAL LOGIC 2022-23

Teaching staff	E-mail addresses	Credits taught by teacher	Office and hour of attention
MARTINEZ RODRIGUEZ, SANTIAGO	santi.martinez@udl.cat	9	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

Cross-Disciplinary Competences

- **EPS1.** Capacity to solve problems and prepare and defence arguments inside the area of studies.
- **EPS5.** Capacity of abstraction and of critical, logical and mathematical thinking.
- **EPS9.** Capacity for unidisciplinary and multidisciplinary teamwork.
- **EPS12.** To be motivated for the quality and steady improvement.

Specific Competences / Module of basic training

- **GII-FB3.** Capacity to understand and master the basic concepts of discreet mathematics, logical, algorithmic and computational complexity, and its application to solve engineering problems.
- **GII-FB4.** Basic knowledge of the use and programming of computers, operating systems, databases and computer programs with applications in engineering.
- **GII-FB5.** Knowledge of the structure, organisation, operation and interconnection of the computer systems, the basics of programming, and its application to solve engineering problems.

Specific Competences / Module of common training in the computer branch

- **GII-CRI7.** Knowledge, design and efficient use of the types and data structure more suitable for solving a problem.
- **GII-CRI9.** Capacity to know, comprise and evaluate the structure and architecture of computers, as well as the basic components that conform them.

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, Exercices Unit 2	Activity 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 Exercices Unit 2
7	Automated proof	U2: Propositional Logic	Doubts on Units 1 and 2	Activity Exercices Unit 2
8	Syntax and representation	U3: First Order Logic	Exercices Unit 3	Exercices Unit 3
9		**1st Midterm Exam**		Study
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	Exercices Unit 3	Activity Exercices Unit 3
13	Substitution and Unification	U3: First Order Logic	Exercices Unit 3	Activity Exercices Unit 3

Week	Description	Large Group Activity	Medium Group Activity	Autonomous Work
14	Resolution principle	U3: First Order Logic	Exercices Unit 3	Activity Exercices Unit 3
15	Resolution principle	U3: First Order Logic	Doubts on Unit 3	Activity 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	40%	No	No	No	Yes
PRA	Activity	25%	No	Yes (≤ 2)	No	No
PCL	Participation in Class	0.5 p.	No	No	No	No
To pass the subject the final score must be ≥ 5.						
Final Score = 0.35 · EP1 + 0.4 · EP2 + 0.25 · PRA + PCL						

Remarks:

If the final score < 5, the student can recover the 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.