DEGREE CURRICULUM

COMPUTATIONAL LOGIC

Coordination: ANSOTEGUI GIL, CARLOS JOSE

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>102004</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>
<tr><td>Double bachelor's degree: Degree in Computer Engineering and Degree in Business Administration and Management</td><td>1</td><td>COMMON/CORE</td><td>Attendance-based</td></tr>
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<tr><td>Course number of credits (ECTS)</td><td>6</td></tr>
<tr><td>Type of activity, credits, and groups</td><td>
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<tr><th>Activity type</th><td>PRALAB</td><td>TEORIA</td></tr>
<tr><th>Number of credits</th><td>3</td><td>3</td></tr>
<tr><th>Number of groups</th><td>4</td><td>2</td></tr>
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<tr><td>Coordination</td><td>ANSOTEGUI GIL, CARLOS JOSE</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 = 25*6 = 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 and Spanish</td></tr>
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Teaching staff	E-mail addresses	Credits taught by teacher	Office and hour of attention
ALÒS PASCUAL, JOSEP	josep.alos@udl.cat	3	
ANSOTEGUI GIL, CARLOS JOSE	carlos.ansotegui@udl.cat	15	

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 teachers.

This subject is scheduled in the fall semester of the 1st year.

Learning objectives

Al 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 algorithms of automatic reasoning to first order logic formulas.

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.

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.

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:

Theme 1: Introduction to Logic Systems and Automated Reasoning

Theme 2: Propositional Logic

Theme 3: First Order Logic

Theme 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

Theme 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
- Herbrand's Theorem
- 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 solve them.

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.

Every week the student attends to two online classes of the Large Group and 2 hours with the Small Group. Small Group Sessions will be taught in the laboratory. At Large Group we present the classical logical systems : propositional logic and first order logic .

Finally, in Small Group sessions we give support to complete the mandatory lab exercises.

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Development plan

Semana	Descripción	Actividad Presencial GG	Actividad Presencial GM	Trabajo autónomo
1	Presentation of the subject . Introduction to the subject: Formal languages and logical systems.	Topic 1: Introduction to Logic Systems and Automated Reasoning	Syntax, semantics and proof procedures	Bibliography and Linux tutorial
2	Propositional Logic : Syntax, Semantics and Truth Tables	Topic 2: Propositional Logic	Introduction to user environment: interpreters, simulators and solvers to use **Description and organization of the first compulsory lab activity (A1)**	Linux tutorial, SAT solvers
3	Classification of statements (satisfiable , unsatisfiable and tautology) and Modeling	Topic 2: Propositional Logic	A1 T2 Exercices	A1 T2 Exercices
4	Normal forms	Topic 2: Propositional Logic	A1 T2 Exercises	A1 T2 Exercices
5	Propositonal resolution	Topic 2: Propositional Logic	A1 T2 Exercices	A1 T2 Exercices
6	Satisfiability problem	Topic 2: Propositional Logic	A1 T2 Exercices	A1 T2 Exercices
7	Satisfiability problem	Topic 2: Propositional Logic	A1 T2 Exercices	A1 T2 Exercices
8	Satisfiability problem	Topic 2: Propositional Logic	Doubts session on T2	T2 Exercices
9		1st Exam		To study
10	Syntax and semantics Classification of statements, Modeling.	Topic 3: First Order Logic	A1 T3 exercises	A1 T3 Exercises
11	Modelling, normal forms	Topic 3: First Order Logic	A1 T3 exercises	A1 T3 exercises
12	Herbrand's theorem	Topic 3: First Order Logic	A1 T3 exercises	A1 T3 exercises
13	Herbrand's theorem	Topic 3: First Order Logic	Deliverable A1 T3 exercises	A1 T3 exercises
14	First Order Logic Resolution	Topic 3: First Order Logic	T3 exercises	T3 exercises
15	First Order Logic Resolution	Topic 3: First Order Logic	Doubts session on T3	T3 exercises
16		Second exam		Study
17		Second exam		Study
18				

19	Recovery	Study

Evaluation

Evaluation

Acronym	Evaluation activity	Weighing	Minimum grade	Group activity	Compulsory activity	Recoverable
PE1	*First Exam*	35%	-	NO	YES	YES
PE2	*Second Exam*	40%	-	NO	YES	YES
P1	Laboratory activity 1	25%	-	YES (maximum 2 students)	YES	NO
PCL	Participation in class	Maximum 0,5 points	NO	NO	NO	NO
Final grade = 0,35*PE1 + 0,40*PE2 + 0,25*P1 + PCL						

Recovery of exams 1 and 2:

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

First exam: Percentatge 35% Type Compulsory / Individual

Evaluation: The activity will be evaluated over 10 points .

Objectives

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

Laboratory activity 1:

Percentatge 25% Type Compulsory / Group

Evaluation: The activity will be evaluated over 10 points . This activity can not be recovered.

Objectives

Use a SAT solver.
Model sentences as logic formulas.
Reason about the validity of logic formulas.
Automate proof systems.
Reason about proof systems.
Apply proof systems.

Apply automated reasoning logic systems of propositional logic to mathematical and computer science problems.

Second exam:

Percetatge 40% Type Compulsory / Individual

Evaluation: The activity will be evaluated over 10 points.

Objectives:

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.

Bibliography

B*asic References:*

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

Complementary Bibliography

- Jean Gallier: Logic for Computer Science: Foundations of AutomaticTheorem Proving, 2003.
- Uwe Schöning. Logic for Computer Scientists. Birkhäuser, Boston, 1989.
- Tom Tymoczko and Jim Henle: Razón, dulce razón. Una Guía de Campo de la Lógica Moderna. Ariel, 2002.