DEGREE CURRICULUM

COMPUTATIONAL LOGIC

Coordination: ANSOTEGUI GIL, CARLOS JOSE

Academic year 2017-18

COMPUTATIONAL LOGIC 2017-18

Subject's general information

Subject name	COMPUTATIONAL LOGIC
Code	102004
Semester	1st Q(SEMESTER) CONTINUED EVALUATION
Typology	<table><tr><th>Degree</th><th>Course</th><th>Typology</th><th>Modality</th></tr><tr><td>Double bachelor's degree: Degree in Computer Engineering and Degree in Business Administration and Management</td><td>1</td><td>COMMON</td><td>Attendance-based</td></tr><tr><td>Bachelor's Degree in Computer Engineering</td><td>1</td><td>COMMON</td><td>Attendance-based</td></tr></table>
ECTS credits	6
Groups	1GG,4GM
Theoretical credits	3
Practical credits	3
Coordination	ANSOTEGUI GIL, CARLOS JOSE
Department	INFORMATICA I ENGINYERIA INDUSTRIAL
Teaching load distribution between lectures and independent student work	6 ECTS = 25*6 = 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 and Spanish
Distribution of credits	ALSINET BERNADO, MA.TERESA 10,5 ANSOTEGUI GIL, CARLOS JOSE 4,5
Office and hour of attention	Maria Teresa Alsinet Bernadó Contact me to arrange a mutually suitable time

COMPUTATIONAL LOGIC 2017-18

Teaching staff	E-mail addresses	Credits taught by teacher	Office and hour of attention
ALSINET BERNADÓ, MARIA TERESA	tracy@diei.udl.cat	10,5	
ANSOTEGUI GIL, CARLOS JOSE	carlos@diei.udl.cat	4,5	Office 2.16 Contact by email.

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 systems 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 4: Logic Programming

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
- Resolution Principle
- Automated Reasoning to Prove Validity of Formulas

Theme 4: Logic Programming

- Logic Programs
- SLD Resolution
- Introduction to Prolog

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 SAT solvers and Prolog for predicate logic .

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 physical 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.

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	Exercices Topic 2	A1 Exercices Topic 2
4	Transformation of statements in Normal Forms : clausal form	Topic 2: Propositional Logic	A1	A1 Exercices Topic 2
5	Resolution principle	Topic 2: Propositional Logic	Exercices Topic 2	A1 Exercices Topic 2
6	Demonstration automatic	Topic 2: Propositional Logic	Exercices Topic 2	A1 Exercices Topic 2
7	Validity of statements	Topic 2: Propositional Logic	A1 Exercices Topic 2	A1 Exercices Topic 2
8	Syntax and Semantics	T3- Lógica Primer Orden	Deliverable A1 Doubts session on Topic 2	Exercices Topic 2
9		1st Exam		To study
10	Classification of statements (satisfiable , unsatisfiable and tautology) and Modeling.	Topic 3: First Order Logic	Description and organization of the second compulsory lab activity (A2) Exercices Topic 3	A2 Exercices Topic 3
11	Substitutions, compositions and application of substitutions. Unification and most general unifier.	Topic 3: First Order Logic	A2	A2 Exercices Topic 3
12	Transformation into Conjunctive Normal Form.	Topic 3: First Order Logic	A2 Exercices Topic 3	A2 Exercices Topic 3
13	Resolution principle. Automatic demonstration of validity of statements.	Topic 3: First Order Logic	Exercices Topic 3	A2 Exercices Topic 3

14	Programs and Resolution	Topic 4: Logic Programming	P2, PROLOG Exercices Topic 4	A2, PROLOG Exercices Topic 4
15	Introduction to SLD Prolog	Topic 4: Logic Programming	Doubts on Topics 3 and 4	Exercices Topic 4
16		Second exam	Deliverable A2	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*	35%	-	NO	YES	YES
P1	Laboratory activity 1	15%	-	YES (maximum 2 students)	YES	NO
P2	Laboratory activity 2	15%	-	YES (maximum 2 students)	YES	NO
PCL	Participation in class	Maximum 0,5 points	NO	NO	NO	NO
Final grade = 0,35*PE1 + 0,35*PE2 + 0,15*P1 + 0,15*P2 + 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 15% 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 35% 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.

Laboratory activity 2:

Percentatge 15% Type Compulsory / Group

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

Use the Prolog environment.

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 first order logic to mathematical and computer science problems.

Bibliography

B*asic References:*

- *Teresa Hortalá, Narciso Martí, Miguel Palomino, Mario Rodríguez, Rafael del Vado. Lógica matemática par informáticos. Pearson, Prentice Hall, 2008.*
- *Paniagua E., Sánchez J.L. y Martín F.: Lógica Computacional. Thomson-Paraninfo, 2003.*
- *J.W. Lloyd. Foundations of Logic Programming. Springer-Verlag, second edition, 1987.*

Complementary Bibliography

- Gallier, J.: Logic for Computer Science: Foundations of AutomaticTheorem Proving, 2003. (http://www.cis.upenn.edu/~jean/gbooks/logic.html)
- U. Schöning. Logic for Computer Scientists. Birkhäuser, Boston, 1989.
- Tymoczko T. and Henle J.: Razón, dulce razón. Una Guía de Campo de la Lógica Moderna. Ariel, 2002.