# Logic Programming

## Mestrado Integrado em Engenharia Informática e Computação

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# Logic Programming
# Course Presentation

# Objectives

- Extend the student's knowledge and experience in the paradigm of Declarative Programming
- Develop skills for abstract reasoning and of declarative problem representations
- Learn and experiment with Logic Programming
- Learn and experiment with Constraint Logic Programming
- Learn Prolog
- Learn Constraint Logic Programming
- Be aware of commercial and scientific applications using PROLOG and CLP

# Learning outcomes

At the end of this course, students should be able to:

- Identify classes of problems where (Constraint) Logic Programming is particularly relevant
- Apply Prolog programming and constraint logic programming techniques
- Build full Prolog applications, with possible connections to other programming languages.

students should have acquired programming skills useful for other courses in the domain of Artificial Intelligence

# Course Contents (I)

- Foundations of Logic Programming
  - Propositional logic
    Predicate logic
    Inference rules
    Horn clauses. Unification
    Resolution
    Conjunctive normal form
  - From logic to logic programming
    Origins of Prolog

# Course Contents (II)

- Logic Programming
  - Clauses, Predicates, Facts
    Queries
    Rules
    Logic variables
    Instantiating
  - Logic programming and databases
    Recursion
    Lists, Trees
    Symbolic expressions
  - Computation model of a logic program
    The unification algorithm
    Abstract interpreter
    Traces
    Search trees
    Negation

# Course Contents (III)

- The Prolog Language
  - Execution model
    Backtracking
    Rule and goal order
    Termination
  - Arithmetic
    Iteration
    Structure inspection
    Meta-logical predicates
    Control: cuts and negation
    Extra-logical predicates
- Advanced Prolog Programming Techniques
  - Non-deterministic programming
    Incomplete data structures
    Meta-interpreters
    Search techniques

# Course Contents (IV)

- Constraint Logic Programming
    - Constraints
      Constraint satisfaction
      Constraints in finite domains
    - Constraint logic programming (CLP)
      Search control
      Variable and value ordering
      Modeling problems in CLP
      Constraint programming using SICStus Prolog

# Bibliography

**Main references:**

- Sterling, Leon; The Art of Prolog. ISBN: 0-262-69163-9
- Marriot, Kim; Programming with constraints. ISBN: 0-262-13341-5
- Clocksin, W. F.; Programming in prolog. ISBN: 0-387-58350-5

**Complementary references:**

- Christopher Hogger, Essentials of logic programming,Oxford University Press, 1990 ISBN:0-19-853832-4
- Torres, Delfim Fernando Marado; Introdução à programação em lógica. ISBN: 972-8021-93-3
- Bratko, Ivan; Prolog programming for artificial intelligence. ISBN: 0-201-40375-7
- O.Keefe, Richard A.; The craft of Prolog. ISBN: 0-262-15039-5
- Stuart Russell, Peter Norvig; Artificial intelligence. ISBN: 978-0-13-207148-2

# Software

- **SICStus Prolog (http://www.sics.se/sictus/) used in classes and in the exams**

- Yap Prolog (http://www.dcc.fc.up.pt/∼vsc/Yap/) — free
- SWI Prolog (http://www.swi-prolog.org/) —- free

# Teaching Procedures

Two Types of lectures:

- Theoretical classes are used for exposition of the main (constraint) logic programming concepts, presentation and discussion of practical examples.
- Practical classes are used to solve programming exercises and for assisting students on their practical assignments.

# Student's Assessment (I)

- Two intermediate "exams" made using Moodle (E1, E2)
- Two project Assignments (TP1, TP2)

## Important Dates:

| | |
|---|---|
| Week of 28th September | TP1 presentation |
| 2nd October | TP1 choice by student's groups (2 students per group) |
| 1st November | TP1 progress report due |
| Week of 2nd November | TP1 progress assessment [in class] |
| week of 23rd of November | TP2 presentation |
| **28th November** | first exam E1 (Prolog) (Saturday!) |
| 29th November | TP1 final report + source code |
| week of 30th November | demonstration of TP1 [in class] |
| 30th November | TP2 choice by student's groups (2 students per group) |
| 4th January 2021 | TP2 final report + source code |
| week of 5th January 2021 | Demonstration and Evaluation of TP2 |
| **8th January 2021** | second exam E2 (PLR) |

## Compulsory minimal classification:

TP1 minimum mark of 7 in 20
TP2 minimum mark of 7 in 20
E1 minimum of 7 in 20
E2 minimum of 5 in 20

# Student's Assessment (II)

Final Grade decomposition:

**Final Grade:** = 50% Exams (E1,E2) + 50% Assignments (TP1,TP2)

Exam's grades:

**Exams** = 65% Exam E1 + 35% Exam E2

Assignments grades:

**Assignments** = 65% Assignment 1 (TP1) + 35% Assignment 2 (TP2)

**TP1** = 25% (Intermediate report of TP1) + 75% (final eval. of TP1)

# Prolog Applications

- Artifitial Intelligence:
  - Game Playing
  - Knowledge Based Systems
  - Natural Language Understanding
  - Checking VLSI circuits
- Multi-relational Data Mining: (comprehensible models)
  - Rational Drug Design
  - Genomics Applications (Bioinformatics)
  - Predicting [3D] structures of proteins (Chemoinformatics/Biology)
  - *Inductive Logic Programming* Systems
  - Prediction of Adverse drugs side effects