Course title: Principles of Computation

Course code: 74017

Scientific sector: ING-INF/05

Degree: European Master’s Program in Computational Logic (LM-18)

Semester: 1

Year: 2

Credits: 12

Modular: Yes

University: UniBZ

Total lecturing hours: 48

Total lab hours: 24

Total exercise hours: --

Attendance: Not compulsory

Prerequisites: There are no prerequisites in terms of courses to attend. Students should be familiar with notions of mathematics and set theory, and with basic proof techniques, as taught in the mathematics courses of a bachelor in computer science.

Course page: To be announced

Specific educational objectives: The course belongs to the type “A scelta della/o studente”. The course is part of the advanced topics offered within the degree and can be selected by the student as one of the three which must be completed according to the study plan.

This course deals with the theoretical foundations of computation. It aims at getting acquaintance with abstract, mathematical models of computation, and the use of such models for assessing the ability to solve computational problems, by identifying both the intrinsic limitations of computing devices, and the practical limitations due to limited availability of resources.

To this end the course covers in its core theory of computability including models of computation, computable functions, recursion theory, limits of solvability, as well as computational complexity theory, including complexity measures, complexity classes, problem reduction and completeness. Topical aspects (e.g., emerging models of computation, applications in computational logic, or advanced algorithmic techniques) allow to gain additional knowledge and skills.

The main objective is that after completing this course, the students have a deep understanding of the theoretical foundations and the limits of computation. They also have a solid knowledge of complexity theory, which they can apply to establish complexity bounds and characterizations of computational problems in applications, and to develop algorithms for the solution of such problems. A further objective is that the students are able to reason and prove properties about computations in a precise, formal, abstract way.

Module 1: Theory of Computing

Module code: 74017A

Module scientific sector: ING-INF/05

Lecturer: Diego Calvanese
## Contact

Piazza Domenicani 3, Room 2.07, calvanese@inf.unibz.it, 0471-016160

<table>
<thead>
<tr>
<th>Scientific sector of lecturer</th>
<th>ING-INF/05</th>
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</thead>
<tbody>
<tr>
<td>Teaching language</td>
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<td>Office hours</td>
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### List of topics

- Formal languages
- Formal grammars
- Turing Machines
- Recursive functions
- Undecidability
- Computational complexity
- NP-completeness
- Time and space complexity classes

### Teaching format

Frontal lectures.

## Module 2

**Research Project in Foundations of Knowledge Representation Languages**

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</tr>
<tr>
<td>Lecturer</td>
<td>Diego Calvanese</td>
</tr>
<tr>
<td>Contact</td>
<td>Piazza Domenicani 3, Room 2.07, <a href="mailto:calvanese@inf.unibz.it">calvanese@inf.unibz.it</a>, 0471-016160</td>
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### List of topics

The student will further investigate a specific topic covered by the first module.

The selection of the topic and the research activity shall be carried out under the supervision of a tutor selected in agreement with the lecturer of the first module.

### Teaching format

Supervised project activities.

## Learning outcomes

**Knowledge and understanding:**

- Thoroughly understand the scientific method of investigation.
- Understand the methods of mathematics and statistics which are of support to information technology and its applications.

**Applying knowledge and understanding:**

- Be able to extend or modify a formal calculation model in an
original way, taking into account altered conditions or requirements.

- Be able to define an algorithmic solution to a computational problem and to estimate its complexity.

**Ability to make judgments**

- Be able to identify reasonable work goals and estimate the resources required to achieve the objectives.

**Communication skills**

- Ability to structure and write technical reports concerning project activities.

**Ability to learn**

- Be able to autonomously extend the knowledge acquired during the study course by reading and understanding scientific and technical documentation mostly in English.
- Be able, in the context of a problem-solving activity, to extend even incomplete knowledge taking into account the objective of the project.

### Assessment

The assessment of the course consists of different parts:

- midterm or final exam on the first half of the syllabus (35%);
- final exam on the second half of the syllabus (35%);
- evaluation of the project activities (30%).

Each part of the examination may be either written or oral.

### Assessment language

English

### Evaluation criteria and criteria for awarding marks

At the exam, the student has to solve exercises and answer questions on the course topics in written or oral form. The solution of the exercises requires the ability to apply the notions and techniques studied in the course to novel contexts.

The two parts of the examination can be taken independently of each other within the three exam sessions of an academic year. In case of a positive mark for one of the two parts (obtained at the midterm or at one of the first two regular exam sessions), that part will count for all 3 regular exam sessions.

The main criteria for the assessment of the project work are:

- original contribution of the student
- quality of presentation
- technical quality of the work
- quality of the report

### Required readings


### Supplementary readings