UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Languages and Computability

2526-2-E3101Q111

Aims

Knowledge and Understanding
Students will learn the fundamentals of formal language theory and its connections to lexical and syntactic analysis, including those relevant to programming languages.

Applied Knowledge and Understanding
Students will be able to define regular and context-free grammars necessary for the use of lexical and syntactic analyzers. They will also acquire the ability to use analyzers in practical contexts.

Independent Judgment
Students will develop the ability to evaluate which grammar is most appropriate for describing different languages.

Communication Skills
The great attention paid to formal aspects will allow students to understand the importance of unambiguous communication, using the correct terminology to express the notions and concepts learned.

Learning Skills
The formalization of concepts will facilitate deductive learning mechanisms. Furthermore, presenting examples and exercises on the board, immediately after explaining a technique or algorithm, helps clarify any doubts and particular cases.

Contents

Finite automata, regular languages and regular expressions. Context-free languages, context-free grammars and pushdown automata. Elements of the theory of computation: Turing machine, the Church-Turing thesis, the Universal Turing machine, unsolvable problems. Lexical analyzers and parsers.

Detailed program

1. Introduction and motivations. Basic mathematical concepts for automata theory
2. Deterministic finite state automata. Non-deterministic finite state automata. An application: searching in texts. Finite state automata with epsilon-moves
3. Regular expressions. Finite state automata and regular expressions. Applications of regular expressions. Algebraic properties of regular expressions
4. Properties of regular languages. The Pumping Lemma as a tool to (dis)prove regularity of a language. Regular languages closure in respect to boolean operations. Equivalence and minimization of automata
5. Grammars. Context free grammars. Parse trees. Applications of context free grammars. Ambiguity of grammars and of languages. Pumping Lemma for context free grammars
6. Turing Machines. Uncomputable problems. The basic Turing machine. Extensions of the basic Turing machine. Reduced Turing Machines
7. Computability. Non Recursively Enumerable languages. Recursively Enumerable and Recursive languages. Undecidable problems and Turing Machines
8. Lexical and syntactic parsers. Parsing algorithms

Prerequisites

The contents of the first year's courses

Teaching form

28 lessons of 2 hours held in the classroom, in delivery mode, in person.
4 exercises of 3 hours held in the laboratory, in delivery mode in the initial part which is aimed at involving students in an interactive way in the subsequent part. All activities are held in person.

The course is delivered in Italian.

Some self-assessment exercises will be weekly published on the eLearning (Moodle) web page.

Textbook and teaching resource

Textbook (the english version is also available):

- J.E. Hopcroft, R. Motwani, J.D. Ullman, Automi, linguaggi e calcolabilità, Addison Wesley
- Keith D. Cooper, Linda Torczon, Engineering a Compiler (Third Edition), Morgan Kaufmann

Learning material provided on the e-learning platform

Semester

First semester

Assessment method

The assessment method consists of written and oral examination.

The written exam consists of some exercises, which are similar to the ones made in class during the lectures and present on the e-learning platform, and in some open questions on the theory of computability. The evaluation objective of the written test consists in the intensive control of the preparation on some fundamental topics of the exam program, and in the control of disciplinary problem solving skills.

During the course, there are two mid-term written tests. These tests have the same format and the same objectives as the written examination, and focus respectively on the first half and the second half of the course program.

The student is admitted to the oral exam if he/she has passed the written test or both of the mid-term tests, and if the exercises related to the laboratory have been delivered, as specified on the web page of the course on the eLearning platform (Moodle). The objective of the laboratory exercises is to evaluate the student's ability to apply some of the course topics to a practical problem. During the oral interview, in addition to the discussion of the written exam, questions are asked on the topics of the course. The objective of the oral interview is to evaluate the student's ability to present the topics of the course, and to make brief thoughts on them.

The assessment is comprehensive and is defined at the end of the oral interview.

Office hours

On appointment

Sustainable Development Goals

QUALITY EDUCATION