

# Formal languages and automata

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## Overview

This is an introductory course about certain mathematical models of computation (*automata*) and the patterns they can be programmed to recognise (*formal languages*). Throughout the semester we will define what a pattern is and what it means to recognise or generate a pattern, study the properties that may make a pattern more complex than another, and relate these notions to some relevant questions in theoretical linguistics.

## Requirements

There will be homework assignments every week (except for the weeks of the tests), whose submission deadline is always the beginning of the next class. There will also be two short tests, written in class. Each homework is worth 3 points and each test is worth 5 points, for a total of 37 points. The final grade is a 5 for 29 points and above, 4 for 25–28.5 points, 3 for 22–24.5 points, and 2 for 18–21.5 points. However, in order to get a 4 or a 5, students must score at least 4 points on the two tests together.

## Syllabus

| Class | Date   | Topic  |
|-------|--------|--|
| 1.    | 09.11. | Formal languages, finite state automata            |
| 2.    | 09.18. | Non-deterministic automata, regular expressions    |
| 3.    | 09.25. | Kleene's theorem, the Myhill–Nerode theorem        |
| 4.    | 10.02. | Context-free languages and grammars                |
| 5.    | 10.09. | Chomsky (1957) on automata and natural languages   |
| 6.    | 10.16. | Summary, first test                                |
| —     | 10.23. | <i>National holiday</i>                            |
| —     | 10.30. | <i>Autumn break</i>                                |
| 7.    | 11.06. | Pushdown automata, non-context-freeness            |
| 8.    | 11.13. | Context-sensitive languages and grammars           |
| 9.    | 11.20. | Turing machines, decidability, undecidability      |
| 10.   | 11.27. | Time complexity, reducibility                      |
| 11.   | 12.04. | Summary, second test                               |
| 12.   | 12.11. | The learnability of formal (and natural) languages |

## Recommended literature

Chomsky (1957): *Syntactic structures* (chapters 3, 4, 5)  
Sipser (2012): *Introduction to the theory of computation*