

Preface

Aim

This book is addressed to undergraduate students as a complement to programming courses. The general aim of the book is to present and compare alternative programming language paradigms, and to provide the foundations and tools needed to design new programming languages and understand the existing ones. These are ambitious goals, and to achieve our aims, we have chosen to introduce and explain in a concise way the most significant constructs of modern imperative, functional and logic programming languages, and describe their operational semantics first in an informal way, and then using transition systems.

About this Book

This book provides a concise introduction to the essential concepts in programming languages, using operational semantics techniques. The book is for the most part self-contained, but we assume readers have some basic programming skills and have used at least one programming language. Knowledge of more programming languages will be helpful but is not necessary.

Each chapter includes exercises that provide an opportunity to apply the concepts and techniques presented. Doing exercises is an important part of the learning process: to understand how a programming language works and be able to use it, it is not sufficient to read about it. Of course, the same can be said about many other topics (learning to play a musical instrument or learning to ride a bicycle are familiar examples). Since practice is unavoidable, we have included not just exercises to be done on paper, but also some programming exercises that require checking on a computer. Although some of the exercises are just introductory, most of the questions are designed with the goal of testing the *understanding* of the subject (for instance, by requiring students to adapt a given technique to different contexts). Some challenging exercises for more advanced students are also included; these are marked with (†). Answers to selected exercises are given in the final chapter of the book.

The book is organised as follows:

Part I provides an introduction to programming languages and operational semantics in [Chap. 1](#), followed by basic mathematical background for the rest of the book in [Chap. 2](#).

In Part II we study the main components of imperative languages. We first give an informal description in [Chap. 3](#), and then give a formal specification of the main constructs in imperative languages using transition systems in [Chap. 4](#).

Part III is dedicated to functional languages and their type systems. In [Chap. 5](#) we give an overview of functional programming (using Haskell for our examples), and then give some examples of semantic descriptions of functional languages in [Chap. 6](#).

Finally, in Part IV ([Chaps. 7 and 8](#)) we briefly study logic programming languages and describe the operational semantics of Prolog.

The last chapter of the book ([Chap. 9](#)) contains answers to a selection of exercises.

We have not included chapters on object-oriented languages, but we do study aspects of these languages in [Chaps. 1 and 3](#).

Each chapter includes a list of recommended further reading, a list of exercises, and a bibliographical section with references to relevant articles and books where the interested reader can find more information. In particular, for each programming language there is a reference to its definition, which is indicated the first time the language is mentioned.

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