

Preface

Probabilistic concurrency theory aims to specify and analyse quantitative behaviour of concurrent systems, which necessarily builds on solid semantic foundations of probabilistic processes. This book adopts an operational approach to describing the behaviour of nondeterministic and probabilistic processes, and that the semantic comparison of different systems are based on appropriate behavioural relations such as bisimulation equivalence and testing preorders.

It mainly consists of two parts. The first part provides an elementary account of bisimulation semantics for probabilistic processes from metric, logical and algorithmic perspectives. The second part sets up a general testing framework and specialises it to probabilistic processes with nondeterministic behaviour. The resulting testing semantics is treated in depth. A few variants of it are shown to coincide, and they can be characterised in terms of modal logics and coinductively defined simulation relations. Although in the traditional (nonprobabilistic) setting, simulation semantics is in general finer than testing semantics because it distinguishes more processes for a large class of probabilistic processes, the gap between simulation and testing semantics disappears. Therefore, in this case, we have a semantics where both negative and positive results can be easily proved: to show that two processes are not related in the semantics, we just give a witness test, and to prove that two processes are related, we only need to establish a simulation relation.

While most of the results have been announced before, they are spread over several papers in the period from 2007 to 2014, and sometimes with different terminology and notation. This prevents us from having a comprehensive understanding of the bisimulation and testing semantics of probabilistic processes. In order to improve the situation, the current work brings all the related concepts and proof techniques to form a coherent and self-contained text.

Besides presenting the recent research advances in probabilistic concurrency theory, the book exemplifies the use of many mathematical techniques to solve problems in Computer Science, which is intended to be accessible to postgraduate students in Computer Science and Mathematics. It can also be used by researchers and practitioners either for advanced study or for technical reference. The reader is assumed to have some basic knowledge in discrete mathematics. Familiarity with real analysis is not a prerequisite, but would be helpful.

Most of the work reported in this book was carried out during the last few years with a number of colleagues. The testing semantics for probabilistic processes was developed in conjunction with Rob van Glabbeek, Matthew Hennessy, Carroll Morgan and Chenyi Zhang. The various characterisations of probabilistic bisimulation in Chap. 3 are based on joint work with Wenjie Du.

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