
Preface

Model checking is a very popular technique for the automatic verification of systems, widely applied by the hardware industry and already receiving considerable attention from software companies. It is based on the (possibly exhaustive) exploration of the states reached by the system along all its executions.

Model checking is very successful in finding bugs in concurrent systems. These systems are notoriously hard to design correctly, mostly because of the inherent uncertainty about the order in which components working in parallel execute actions. Since n independent actions can occur in $n!$ different orders, humans easily overlook some of them, often the one causing a bug. On the contrary, model checking exhaustively examines all execution orders. Unfortunately, naive model checking techniques can only be applied to very small systems. The number of reachable states grows so quickly, that even a modern computer fails to explore them all in reasonable time.

In this book we show that concurrency theory, the study of mathematical formalisms for the description and analysis of concurrent systems, helps to solve this problem. Unfoldings are one of these formalisms, belonging to the class of so-called *true concurrency* models. They were introduced in the early 1980s as a mathematical model of causality. Our reason for studying them is far more pragmatic: unfoldings of highly concurrent systems are often far smaller and can be explored much faster than the state space.

Being at the crossroads of automatic verification and concurrency theory, this book is addressed to researchers and graduate students working in either of these two fields. It is self-contained, although some previous exposure to models of concurrent systems, like communicating automata or Petri nets, can help to understand the material.

We are grateful to Ken McMillan for initiating the unfolding technique in his PhD thesis, and for agreeing to write the Foreword. Our appreciation goes to Eike Best, Ilkka Niemelä, and Leo Ojala for their guidance when we started work on this topic. We thank Pradeep Kanade, Victor Khomenko, Maciej Koutny, Stephan Melzer, Stefan Römer, Claus Schröter, Stefan Schwoon, and

Walter Vogler, the coauthors of our work on the unfolding technique, for their ideas and efforts. We are indebted to Burkhard Graves, Stefan Melzer, Stefan Römer, Patrik Simons, Stefan Schwoon, Claus Schröter, and Frank Wallner for implementing prototypes and other tools that very much helped to test and refine the ideas of the book. Some of them were integrated in the PEP tool, a project led by Eike Best, and coordinated by Bernd Grahmann and Christian Stehno, and others in the Model Checking Kit, coordinated by Claus Schröter and Stefan Schwoon. We thank them for their support. Thomas Chatain, Stefan Kiefer, Victor Khomenko, Kari Kähkönen, Beatriz Sánchez, Stefan Schwoon, and Walter Vogler provided us with valuable comments on various drafts, for which we express our gratitude. We thank Wilfried Brauer for his continuous support and his help in finding a publisher, and Ronan Nugent, from Springer, for his smooth handling of the publication process.

München, Germany and Espoo, Finland,
October 2007

Javier Esparza
Keijo Heljanko

Unfoldings

A Partial-Order Approach to Model Checking

Esparza, J.; Heljanko, K.

2008, XII, 172 p. 51 illus., Hardcover

ISBN: 978-3-540-77425-9