

## Preface

This textbook presents Coloured Petri Nets (also known as CP-nets or CPNs). Coloured Petri Nets is a language for the modelling and validation of concurrent and distributed systems and other systems in which concurrency plays a major role. The book introduces the constructs of the CPN modelling language and presents its analysis methods, and provides a comprehensive road map to the practical use of CP-nets. Furthermore, this book presents some selected industrial case studies illustrating the practical use of CPN modelling and validation for design, specification, simulation, and verification in a variety of application domains.

This book is aimed at use both in university courses and for self-study. It contains more than sufficient material for a one semester course at undergraduate or graduate level. A typical course will cover the basics of CP-nets and it is optional whether to include the formal definition of the language as part of this. A typical course will also cover some selected case studies depending on the aim and focus of the course. The last chapter in this book discusses how we have used the book to teach CP-nets at Aarhus University.

Slide sets, CPN models, and suggestions for exercises and projects are available from the Web pages accompanying this book, at

<http://www.cs.au.dk/CPnets/cpnbook/>

These Web pages also contain links to courses where this book has been used. For the practically oriented exercises involving construction and validation of CPN models, we recommend using CPN Tools. CPN Tools is an elaborate computer tool supporting the construction, simulation, state space analysis, and performance analysis of CPN models. A licence for educational, research, and commercial use of CPN Tools can be obtained free of charge.

This book is primarily aimed at readers interested in the practical use of CP-nets. This is reflected in the presentation of the material which is organised into the following main parts:

- **Basic concepts** (Chapters 1-4) presenting the basic constructs of the CPN modelling language, including the CPN ML inscription language.

- **Hierarchical Coloured Petri Nets** (Chapters 5-6) explaining how large CPN models can be structured as a set of hierarchically organised modules.
- **State spaces and verification** (Chapters 7-9) showing how state spaces can be used to verify and validate behavioural properties of CPN models.
- **Timed Coloured Petri Nets** (Chapters 10-12) explaining how timing information can be added to CPN models, making it possible to reason about real-time systems and conduct simulation-based performance analysis.
- **Behavioural visualisation** (Chapter 13) showing how CPN models can be augmented with graphics that can be used to visualise and interact with the behaviour of a system using system- and domain-specific concepts.
- **Industrial case studies** (Chapter 14) presenting four examples of representative projects where CP-nets and their supporting computer tools have been used for system development in an industrial context.
- **Teaching** (Chapter 15) describing a course at Aarhus University on the modelling and validation of concurrent systems based on the content of this textbook.

We recommend that the reader starts by studying the first part on basic concepts. The remaining parts are organised such that the readers can skip some of them according to their interest and knowledge. All parts are organised such that concepts and constructs are first informally introduced through examples, followed by the formal definition of the concept (when applicable). The material is, however, organised such that the practically-oriented reader can skip the chapters containing the formal definitions. This underpins the important property that CP-nets can be taught and learned without studying the associated formal definitions. We have decided to include the formal definitions of the CPN modelling language and analysis methods for the following reasons. Firstly, including the formal definitions resolves any ambiguity that may be left in the informal explanations. Secondly, it means that this book can be used by readers interested in studying the underlying theory of CP-nets.

This book assumes that the reader is familiar with conventional programming-language concepts such as variables, types, procedures, and modules. We also assume that the reader is familiar with the basic concepts of concurrent systems, such as processes, concurrency, communication, and synchronisation.

This book can be seen as an update of the three-volume textbook *Coloured Petri Nets: Basic Concepts, Analysis Methods, and Practical Use* authored by Kurt Jensen in 1992–1997. The CPN language and analysis methods described in this new book are very close to those presented in the three-volume textbook. This new book gains from the experience in teaching and using CP-nets over the last 10 years of the authors and of the more than 8,000 people who have been using CPN Tools.

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