Preface

If an information system is able to perform useful actions for persons working in a given domain, it is because the system knows something about that domain. The more knowledge it has, the more useful it can be to its users. Without that knowledge, the system is useless.

Most of the knowledge a system has is concrete or particular. It refers to concrete objects and the relationships they have in the domain at some point in time. Given that many systems work in domains with a very high number of objects and relationships, it is hardly surprising that the concrete knowledge they have is very large. Think, for instance, of bank management systems, where it is usual to find a large number of accounts, loans, etc. for which many details must be known (account holders, balances, transactions, etc.).

However, it is not possible to have concrete knowledge about a domain without a prior *general* knowledge about that domain. A bank management system may know the balances of accounts once it knows that there are accounts in the domain, and that accounts always have a balance. Similarly, the system may know the holders of accounts because it knows that accounts do have holders. Concrete knowledge requires prior general knowledge, which is independent of the concrete objects and relationships existing at any point in time.

This general knowledge also includes rules that must be obeyed (for instance, balances may not be negative), definitions that allow new knowledge to be obtained from existing knowledge (for instance, what is understood as the return on investment), and details of the actions that the users want the system to perform when some condition is satisfied (for example, how to calculate the interest earned by savings accounts).

In the information systems field, we use the name *conceptual modeling* for the activity that elicits and describes the general knowledge a particular information system needs to know. The main objective of conceptual modeling is to obtain that description, which is called a *conceptual schema*. Conceptual schemas are written in languages called conceptual

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modeling languages. Conceptual modeling is an important part of requirements engineering, the first and most important phase in the development of an information system.

The elicitation of the general knowledge required by an information system is a necessary activity. Information systems cannot be designed or programmed without prior elicitation of the knowledge they need to know. This is captured by one of the principles that guide this book, called the *principle of necessity*: “to develop an information system, it is necessary to define its conceptual schema”.

The only option we have is whether or not to explicitly describe that knowledge. That is, whether or not to write the conceptual schema. Sometimes, system development projects choose not to write the conceptual schema, or they do not have the time to do so. In these cases, the general knowledge is in the designers’ heads only. This has many disadvantages. If there are several designers, they must share this knowledge without an explicit description. User participation is hampered. Once the system has been built, it is likely that the general knowledge will be forgotten. The future evolution of the system will require that general knowledge to be rediscovered. The explicit description of the conceptual schema brings many advantages, especially when it is done in a machine-readable language.

Furthermore, many researchers have put forward, many times, a vision in which the conceptual schema is the only important description that needs to be created in the development of an information system. According to this vision, the building of information systems is completely automated. The only things to be done are to determine the functions that the information system has to perform and to define its conceptual schema (and, probably, the design and construction of the input/output user interface). The huge potential economic benefit of this vision justifies the research and development efforts currently devoted to it, which are being made mainly in the framework of OMG’s Model Driven Architecture. The progress made in other branches of computer science (especially in the field of databases) makes this vision feasible in the mid-term. On the day when the vision becomes a reality we shall be able to say that “to develop an information system it is necessary and sufficient to define its conceptual schema”.

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Objectives

The main objectives of this book are:

1. To describe the principles of conceptual modeling independently of particular methods and languages.
2. To describe these principles in the detail required to correctly apply them in real projects and to be able to assess the methods, languages, and tools that are most suitable in those projects.
3. To describe the formal bases of conceptual schemas. However, in this book, the logical formalization is only sketched and is not pushed too far. The book describes the formal bases with extensive use of intuitive ideas and examples.
4. To describe in detail the use of standard UML/OCL as a particular conceptual modeling language.
5. To provide exercises for readers who want to practice and deepen their knowledge by solving exercises.
6. To give bibliographical references for the concepts presented in the book and for the extensions suggested to readers, including further formalizations.

Audience

The book has two intended audiences:

1. Computer science and information systems students who, after an introduction to information systems, databases, and UML, want to know more about conceptual modeling in their preparation for professional practice.
2. Professionals with some experience in the development of information systems who feel a need to formalize their practical experiences or to update their knowledge, as a way to improve their professional activity.

Some prerequisite knowledge is assumed – and necessary – in order to benefit from the book:

1. Knowledge of the fundamental concepts of the language of first-order logic.
2. Knowledge of fundamental concepts of object technology, such as classes, operations, and inheritance.

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3. Knowledge of the fundamental constructs of ER and UML for information modeling. A basic knowledge of OCL is necessary from Chap. 8 onwards.

Structure of the Book

The 18 chapters of this book are divided into five logical parts:

- *Chapter* 1: *introduction*. Here we give a general view of conceptual modeling. Readers with prior knowledge about the field may skip this chapter, but it may be useful to those who want to recall concepts and terms learnt long ago.
- *Chapters* 2–10: *structural modeling*. Here we study the concepts of entity types, relationship types, constraints, derivation rules and taxonomies.
- *Chapters* 11–15: *behavioral modeling*. Here we describe the concepts of events, their constraints, and their effects. We also describe behavioral modeling with state machines and statecharts. We include a review of the concept of the use case and its relationship to the conceptual schema.
- *Chapter* 16: *a case study*. In the preceding chapters, we follow a bottom-up approach, starting with the basic elements of entity and relationship types, and then proceeding to more complex elements until we reach state transition diagrams and statecharts. In this chapter, we provide an integrated view of conceptual modeling by means of a case study.
- *Chapters* 17 and 18: *metamodeling*. Here we introduce the main concepts of metamodeling and describe their use. We study two important standards related to metamodeling: the MOF and XMI.

Figure I.1 shows the main precedence relationships among the chapters of this book.

The book also includes a companion website (http://www-pagines.fib.upc.edu/~modeling) where students and professionals can find additional exercises, case studies, reading material and presentations on selected topics. If you have any comments on the book, any typos you have noticed, or any suggestion on how it can be improved, I would like to hear from you. The companion website includes information on how to contact me.

For the convenience of the reader, in this book I use “he” to refer to both genders.

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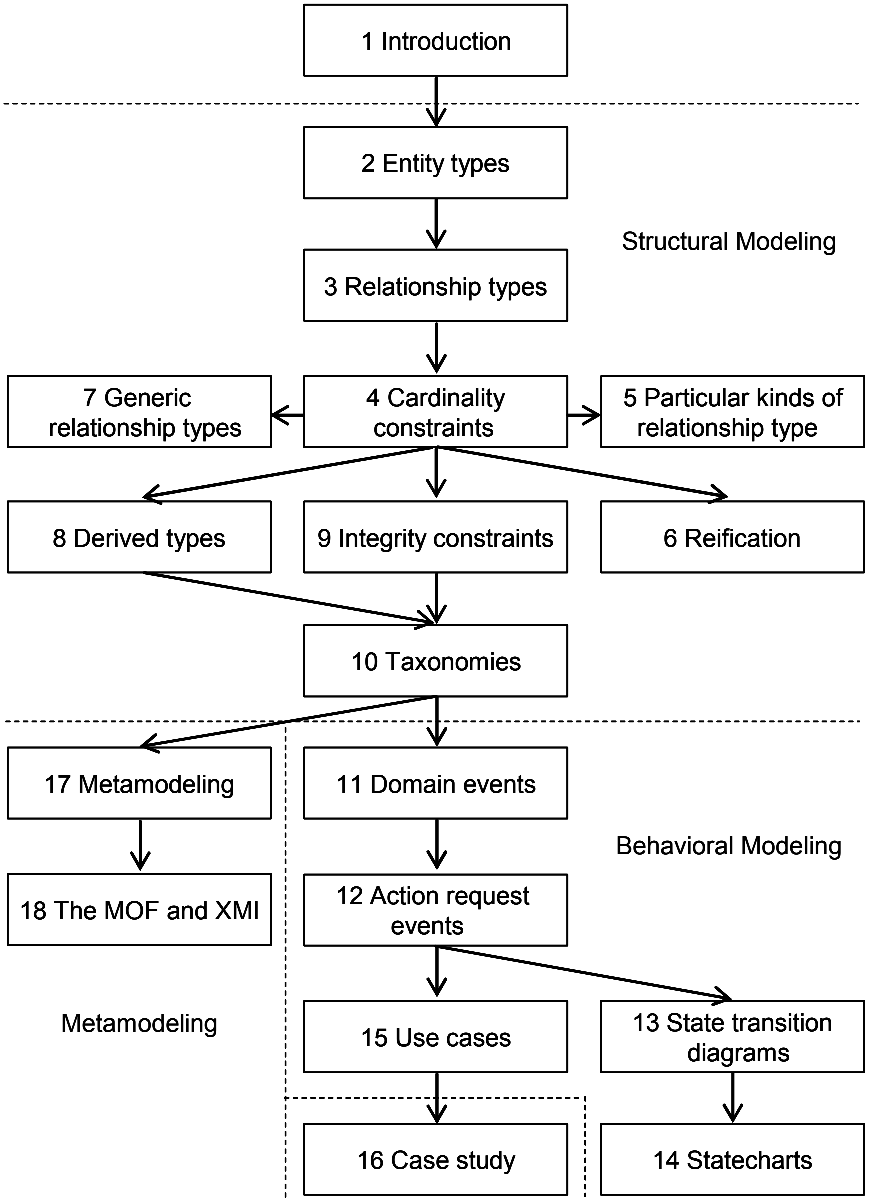

Fig. I.1. Main precedence relationships among the chapters of this book

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This book explains part of what I have learnt over the years that I have dedicated to the study of conceptual modeling. I have learnt a lot from other people's work. The extensive bibliography shows clearly enough how the ideas and realizations of others have contributed to this book. My first thanks to all these people. I also express my gratitude to the members and friends of the IFIP WG8.1, CAiSE, and ER communities for the many opportunities they have given to me to share and discuss views on what this book is about.

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Barcelona, June 2007 Antoni Olivé

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