# DATABASE ANALYSIS AND DESIGN

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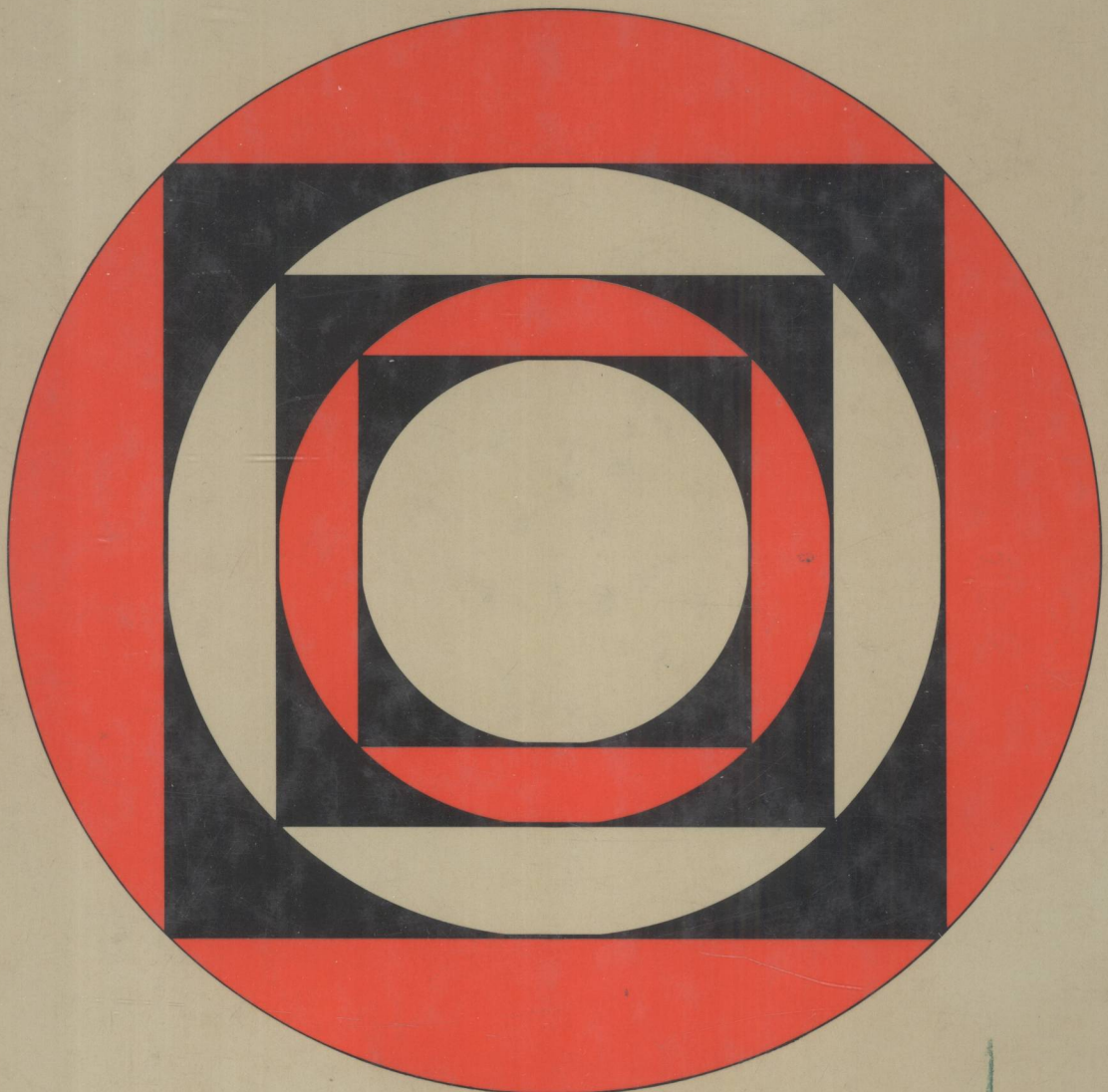

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**To Daria, Helen, and Adrian**


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# Preface

Database management is now widely practiced and has become an important field of study in computing. The last few years have seen considerable evolution in database practical application and in the theoretic database foundations. This evolution has been accomplished by the development of many areas of study that together fall under the database umbrella. Some of these areas are practical while others are theoretically oriented. Examples are relational theory, data semantics, database management software, or physical file design.

To the new student it is easy to treat these areas of study as unrelated topics of interest. What, after all, is the link between relational theory and physical file design or between data semantics and database management system software. Thus one may become familiar with all these areas of study and yet not be aware of how they combine together.

One goal of this text is to unite areas of database study into a coherent field within the context of database design. One may, of course, ask why use database design for this purpose? To answer we can postulate that database design is to some extent the peak of application of the database field. Ultimately our goal is to design and use databases. If a field of database study is to be ultimately useful then it must somehow fit into the design cycle.

Apart from serving as a framework for unifying fields of database study, database design also provides the criteria to judge good databases. Again the elements of database study must provide designers with the ability to evaluate databases against these criteria. Design criteria met in practice include

- all user relevant relationships can be easily deduced from the chosen database structure
- the database can evolve to meet changes to user requirements without requiring extensive changes to the database structure and programs
- user access requests are met within reasonable performance criteria.

The fields of database study must contribute towards these criteria. It should be noted that database design itself is still not a very structured process. Early designers had few techniques or tools to assist them. In general, early designers used file design techniques for database design; many of these techniques concentrated on physical design criteria and emphasized performance rather than data structure or flexibility.

The last few years, however, have seen the development of many new approaches to database design. The trend has been to methodologies that commence with a formal analysis of the user data structure and then reduce such requirements to a physical design through a sequence of structured steps. Thus we must first study the data that we are to store and then choose its computer representation. Much of this work commenced after the development of relational theory, which provided a formal basis for choosing data structures and can be readily translated into practical terms.

Since then a variety of database analysis and design techniques has developed. Some use the relational model as their basis; others are guided by data abstractions such as entities and relationships, role or generalization, and aggregation to structure databases.

The system design cycle thus provides a basis for integrating the various database fields. Relational theory and semantic models are useful for analyzing and structuring data. The structures developed are then converted to a logical model based on some data model, which in turn is implemented by commercial database software. Hence the relationship between semantic models and commercial software. Finally the implementation may be adjusted, taking into account access requirements and physical structures available to the designer. Hence a relationship evolves from logical structure to physical design. This book follows this design cycle, outlining the database fields of study and the theory behind them as it proceeds. The book itself evolved from the author's experiences during his Doctoral dissertation at the Massachusetts Institute of Technology, where he was first introduced to relational theory by Professor Jack Dennis. Subsequently the author has drawn on his practical experiences in database design and in developing and teaching database courses to college students and in database research, both in Australia and the United States, where he spent time with Professor Edgar Sibley at the University of Maryland. It has also benefited from update courses taught by the author to database practitioners, which over the years has led to many interesting examples with practical orientations. These examples are included throughout the book.

The book has also benefited from the many constructive comments from its reviewers and in this context the author would like to acknowledge the contributions of Marilyn Bohl of IBM, Caroline M. Eastman of Southern Methodist University, and Kenneth M. Hunter of San Francisco State University, and Nancy D. Griffith of Georgia Institute of Technology. Finally, the book would not have been possible without the constant help of SRA staff, in particular the patient guidance of Alan Lowe through its initial stages and the support provided by E. Ann Wood and the SRA editorial staff in the final production stages.

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