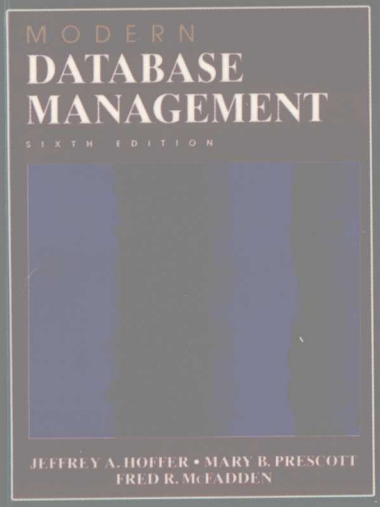
国外计算机科学教材系列

现代数据库管理

（第六版）

Modern Database Management

Sixth Edition



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内容简介

本书反映了信息系统领域的主趋势，介绍了学生学习现代信息系统所需的技巧。书中包含数据库管理、数据库分析、数据库设计和执行以及更多高级主题。具体涉及数据库环境和发展过程、数据库分析、逻辑数据库设计和关系模型，物理数据库设计及性能，分布式数据库、面向对象的数据建模和数据库开发等内容。通过讨论系统的客户/服务器体系结构中的Web系统设计和编程、大规模数据库和数据仓库、在线环境下的数据库性能以及数据库标准查询工具SQL，反映了这些领域的最新变化。

本书适合作为高等院校研究生或本科生教材，亦可作为从事数据库管理工作人员的参考资料。

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出 版 说 明

21世纪初的5至10年是我国国民经济和社会发展的重要时期，也是信息产业快速发展的关键时期。在我国加入WTO后的今天，培养一支适应国际化竞争的一流IT人才队伍是我国高等教育的重要任务之一。信息科学和技术方面人才的优劣与多寡，是我国面对国际竞争时成败的关键因素。

当前，正值我国高等教育特别是信息科学领域的教育调整、变革的重大时期，为使我国教育体制与国际化接轨，有条件的高等院校正在为某些信息学科和技术课程使用国外优秀教材和优秀原版教材，以使我国在计算机教学上尽快赶上国际先进水平。

电子工业出版社秉承多年来引进国外优秀图书的经验，翻译出版了“国外计算机科学教材系列”丛书，这套教材覆盖学科范围广、领域宽、层次多，既有本科专业课程教材，也有研究生课程教材，以适应不同院系、不同专业、不同层次的师生对教材的需求，广大师生可自由选择和自由组合使用。这些教材涉及的学科方向包括网络与通信、操作系统、计算机组织与结构、算法与数据结构、数据库与信息处理、编程语言、图形图像与多媒体、软件工程等。同时，我们也适当引进了一些优秀英文原版教材，本着翻译版本和英文原版并重的原则，对重点图书既提供英文原版又提供相应的翻译版本。

在图书选题上，我们大都选择国外著名出版公司出版的高校教材，如Pearson Education培生教育出版集团、麦格劳－希尔教育出版集团、麻省理工学院出版社、剑桥大学出版社等。撰写教材的许多作者都是蜚声世界的教授、学者，如道格拉斯·科默（Douglas E. Comer）、威廉·斯托林斯（William Stallings）、哈维·戴特尔（Harvey M. Deitel）、尤利斯·布莱克（Uyless Black）等。

为确保教材的选题质量和翻译质量，我们约请了清华大学、北京大学、北京航空航天大学、复旦大学、上海交通大学、南京大学、浙江大学、哈尔滨工业大学、华中科技大学、西安交通大学、国防科学技术大学、解放军理工大学等著名高校的教授和骨干教师参与了本系列教材的选题、翻译和审校工作。他们中既有讲授同类教材的骨干教师、博士，也有积累了几十年教学经验的老教授和博士生导师。

在该系列教材的选题、翻译和编辑加工过程中，为提高教材质量，我们做了大量细致的工作，包括对所选教材进行全面论证；选择编辑时力求达到专业对口；对排版、印制质量进行严格把关。对于英文教材中出现的错误，我们通过与作者联络和网上下载勘误表等方式，逐一进行了修订。

此外，我们还将与国外著名出版公司合作，提供一些教材的教学支持资料，希望能为授课老师提供帮助。今后，我们将继续加强与各高校教师的密切联系，为广大师生引进更多的国外优秀教材和参考书，为我国计算机科学教学体系与国际教学体系的接轨做出努力。

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Preface

This text is designed for an introductory course in database management. Such a course is usually required as part of an information systems curriculum in business schools, computer technology programs, and applied computer science departments. The Association of Information Technology Professionals (AITP), Association for Computing Machinery (ACM), and International Federation of Information Processing Societies (IFIPS) curriculum guidelines (for example, IS '97) all outline this type of database management course. Previous editions of our text have been used successfully for more than 15 years at both the undergraduate and graduate levels, as well as in management and professional development programs.

This text represents an extensive revision and updating of the fifth edition of *Modern Database Management.* These revisions are necessary to accommodate the technical, managerial, and methodological changes occurring at an ever-increasing pace in this field. However, we have endeavored to retain the best features of our previous editions. We have made every effort to justify the title *Modern Database Management,* which was introduced in the fourth edition.

In this sixth edition we have changed the order of authorship because of the reduced involvement of Fred McFadden as he eases into retirement. Fred has reviewed every page of the manuscript and provided sage guidance on the direction of the revisions. Fred McFadden is the "father" of this text, and his words and ideas will always be present on its pages.

New to This Edition

The sixth edition of *Modern Database Management* updates and expands materials in areas undergoing rapid change due to improved managerial practices, database design tools and methodologies, and database technology. The themes of the sixth edition reflect the major trends in the informations systems field and the skills required of modern information systems graduates:

- Web-enabled systems design and programming within an overall client/server architecture for systems
- Large-scale databases and data warehouses
- Clarifying system requirements through thorough system modeling and design
- Criticality of database performance in an increasingly on-line environment
- SQL as a standard for database querying

In all the chapters, new screen captures are included to reflect the latest database technologies and a new Web Resources section lists Websites that can provide the student with the information on the latest database trends and expanded background

details on important topics covered in the text. The major structural changes to the text are:

- The two object-oriented database chapters are now adjacent chapters, and have been moved to the end of the text, where they are presented as a continuous coverage of this emerging database technology and where they do not break up the natural flow among the other chapters.
- The client/server section of the book has been extensively rewritten and now emphasizes the Internet, intranet, and extranet as implementations of a client/server architecture.
- SQL is now covered in more depth and in two chapters.
- The data warehousing chapter has been significantly rewritten and moved forward as a chapter in the implementation section of the book, representing the explosive growth of this form of database.

The following presents a chapter-by-chapter description of the major changes in this edition. Each chapter description presents a statement of the purpose of that chapter, followed by a description of the changes and revisions that have been made since the fifth edition. Each paragraph concludes with a description of the strengths that have been retained from the fifth edition.

Part I: The Context of Database Management

Chapter 1: The Database Environment This chapter discusses the role of databases in organizations and previews the major topics in the remainder of the text. The chapter introduces a revised classification scheme that now recognizes the four types of databases outlined in the fifth edition—personal, work group, departmental, and enterprise—and now includes Internet/intranet/extranet databases. The explanation of enterprise databases is expanded to include databases that are part of enterprise resource planning systems and data warehouses. The chapter updates the discussion of the evolution of database technologies from pre-database files to modern object-relational and Web-enabled systems. The chapter continues to present a well-organized comparison of database technology compared to conventional file-processing systems.

Chapter 2: Database Development Process This chapter presents a detailed discussion of the role of database development within the broader context of information systems development. The chapter explains the process of database development for both structured life cycle and prototyping methodologies. The chapter continues to discuss important issues in database development, including management of the diverse group of people involved in database development and frameworks for understanding database architectures and technologies. The chapter also continues to emphasize the information engineering methodology in database development, including the role of the enterprise data model. Reviewers frequently note the compatibility of this chapter with what students learn in systems analysis and design classes.

Part II: Database Analysis

Chapter 3: Modeling Data in the Organization This chapter, with a new title, presents a thorough introduction to conceptual data modeling with the entity-relationship model. The new chapter title reflects a refocusing of the chapter on the reason for the entity-relationship model: to unambiguously document the rules of the business that influence database design. The chapter contains a thoroughly updated section on the latest approaches to modeling business rules, which has been moved from Chapter 4. Specific subsections explain in detail how to name and define ele-

ments of a data model, which are essential in developing an unambiguous E-R diagram. A new section addresses an issue many students face as they learn data modeling: whether to represent data as attributes or relationships. The chapter continues to proceed from simple to more complex examples, and it concludes with a comprehensive E-R diagram for Pine Valley Furniture Company.

Chapter 4: The Enhanced E-R Model and Business Rules This chapter presents a discussion of several advanced E-R data model constructs. New to the chapter is an introduction of entity clustering, which is a way to present simpler versions of an E-R diagram. The chapter extensively updates coverage of the GUIDE business rules methodology based on the latest guidelines, and now shows the structure of these guidelines, which will facilitate student understanding. The chapter continues to present a thorough coverage of supertype/subtype relationships.

Part III: Database Design

Chapter 5: Logical Database Design and the Relational Model This chapter describes the process of converting a conceptual data model to the relational data model. It features an improved discussion of the characteristics of foreign keys and introduces the important concept of a non-intelligent enterprise key. Enterprise keys (also called surrogate keys for data warehouses) are being emphasized as some concepts of object-orientation migrate into the relational technology world. The discussion of functional dependencies and normalization has been somewhat enhanced. The chapter continues to emphasize the basic concepts of the relational data model and the role of the database designer in the logical design process.

Chapter 6: Physical Database Design and Performance This chapter describes the steps that are essential in achieving an efficient database design. The chapter contains a new emphasis on ways to improve database performance. Several sections have been enhanced with references to specific techiniques available in Oracle and other DBMSs to improve database processing performance. The discussion of indexes has been expanded to include descriptions of types of indexes (primary and secondary indexes, join index, hash index table) that are more widely available in database technologies as techniques to improve query processing speed. The discussion of RAID has been updated to reflect the latest thinking on this important technology. The chapter continues to emphasize the physical design process and the goals of that process.

Part IV: Implementation

Chapter 7: SQL This chapter presents a thorough introduction to the SQL used by most DBMSs (SQL-92) and introduces the changes that are included in the latest standard (SQL-99). The major change for the sixth edition is that the overall coverage of SQL is expanded and divided into this and the next chapter. This chapter includes more examples of SQL code, using mostly SQL-99 syntax and some Oracle 8i syntax. There is an improved coverage of views, both dynamic and materialized. Chapter 7 explains the SQL commands to create and maintain a database and to program single-table queries. The chapter continues to use the Pine Valley Furniture Company case to illustrate a wide variety of practical queries and query results.

Chapter 8: Advanced SQL This new chapter continues the explanation of SQL with a careful explanation of multiple-table queries, transaction integrity, data dictionary, triggers and stored procedures, and embedded SQL in other programming language programs. All forms of the OUTER JOIN command are now covered. This chapter illustrates how to store the results of a query in a derived table, the CAST

command to convert data between different data types, and the CASE command for doing conditional processing in SQL. The chapter also outlines the new on-line analytical processing (OLAP) features of SQL-99, which are necessary for SQL to be useful as a data access tool for data warehouses. As in Chapter 7, most SQL code illustrations are written using SQL-99 syntax and some Oracle 8i syntax. The chapter continues to contain a clear explanation of subqueries and correlated subqueries, two of the most complex and powerful constructs in SQL.

Chapter 9: The Client/Server Database Environment This extensively rewritten chapter combines content from two chapters in the fifth edition. The purpose of the chapter is to provide a thoroughly modern discussion of the client/server architecture, applications, middleware, and client database access in contemporary database environments. This chapter lays the technology groundwork for the Internet topics in the remainder of the text. Many figures have been updated to more clearly show the options in multi-tiered networks, including application and database servers, database processing distribution alternatives among network tiers, and browser (thin) clients. Important new topics include security for Web-enabled databases, and ODBC and JDBC connectivity (including a detailed example of code to access a JDBC-compliant database). The chapter continues to contain a discussion of the three-tier client/server architecture, application partitioning, role of the mainframe, use of parallel computer architectures, middleware, and Microsoft Access 2000 Query-by-Example. Symmetric multiprocessing (SMP) and massively parallel processing (MPP) architectures are described and compared.

Chapter 10: The Internet Database Environment The purpose of this new chapter is to describe the connectivity to databases from Web-based applications. This chapter includes a discussion of scripting languages and embedded SQL in scripts, with examples from ASP and ColdFusion for a shopping cart application (all of the code for these examples appears on the book's Website). The chapter also includes a review of the Internet-related terminology and concepts (such as firewall, proxy server, static and dynamic Web pages, HTML/SGML/XML/XHTML languages, cascading style sheets, Common Gateway Interface, and servlets) necessary to understand connecting a database to a Web page. The role of Web servers and server-side extensions for database connectivity is addressed. Web security and privacy issues are also covered.

Chapter 11: Data Warehousing This chapter is extensively revised from the fifth edition. Its purpose is to describe the basic concepts of data warehousing, the reasons data warehousing is regarded as critical to competitive advantage in many organizations, and the database design activities and structures unique to data warehousing. Topics include alternative data warehouse architectures, techniques for data transformation and reconciliation, and the dimensional data model (or star schema) for data warehouses. Operational data store; independent, dependent, and logical data mart; and various forms of on-line analytical processing are defined. The most extensive changes to the chapter are in the sections dealing with database design for data marts (the derived data layer), in which the topics of surrogate keys, fact table grain, modeling dates and time, conformed dimensions, factless fact tables, and helper/hierarchy/reference tables are thoroughly explained and illustrated. User interfaces, including on-line analytical processing (OLAP) and data mining, are also described.

Part V: Advanced Database Topics

Chapter 12: Data and Database Administration This chapter presents a thorough discussion of the importance and roles of data and database administration and describes a number of the key issues that arise when these functions are being performed. This chapter emphasizes the changing roles and approaches of data and

database administration, with increasing emphasis on tuning the database and queries for improved performance. It contains a thorough discussion of database backup procedures and data security threats and responses and provides a detailed description of managing data quality. There is a new discussion of transaction integrity properties for better recovery and concurrency control. The chapter continues to emphasize the critical importance of data and database management in managing data as a corporate asset.

Chapter 13: Distributed Databases This chapter reviews the role, technologies, and unique database design opportunities of distributed databases. There is an expanded and updated coverage of the objectives and trade-offs for distributed databases, data replication alternatives, factors in selecting a data distribution strategy, and distributed database vendors and products. This chapter, along with Chapter 12, provides thorough coverage of database concurrency access controls.

Chapter 14: Object-Oriented Data Modeling This chapter presents an introduction to object-oriented modeling using the Unified Modeling Language (UML) of Booch, Jacobson, and Rumbaugh. This chapter has been thoroughly updated to illustrate the latest UML notations. Using UML provides an industry-standard notation for representing classes and objects. The chapter continues to emphasize basic OO concepts, such as inheritance and aggregation. The chapter includes an extensive example of an OO data model for Pine Valley Furniture.

Chapter 15: Object-Oriented Database Development The purpose of this chapter is to show how to translate object-oriented models (explained in Chapter 14) into class, object, relationship, and operation definitions for an object-oriented DBMS. The chapter also introduces the latest format for object defintion language (ODL) and object query language (OQL), the standard language for ODBMSs. The chapter includes an OO database definition using ODL for the Pine Valley Furniture database design of the previous chapter. The chapter concludes with a survey of ODBMSs—both vendors and products.

Appendices

The sixth edition contains four appendices intended for persons who wish to explore certain topics in greater depth.

Appendix A: E-R Modeling Tools and Notation This new appendix addresses a need raised by many readers—how to translate the E-R notation in the text into the form used by the CASE tool or DBMS used in class. Specifically, this appendix compares the notations of Visible Analyst 7.4, ERwin 3.5.2, Microsoft Access 2000, and Oracle Designer 6.0. Tables and illustrations show the notations used for the same constructs in each of these popular software packages.

Appendix B: Advanced Normal Forms This appendix presents a description (with examples) of Boyce/Codd and Fourth normal forms. A new, additional example is included on BCNF to show how to handle overlapping candidate keys.

Appendix C: Data Structures This appendix describes several data structures that often underlie database implementations. Topics include the use of pointers, stacks, queues, sorted lists, inverted lists, and trees.

Appendix D: Object-Relational Databases This appendix presents a description of object-relational database management systems (ORDBMS). Topics include features of an ORDBMS, enhanced SQL, advantages of the object-relational approach, and a summary of ORDBMS vendors and products.

Pedagogy

A number of additions and improvements have been made to chapter-end materials to provide a wider and richer range of choices for the user. The most important of these improvements are the following:

1. *Review Questions* This section now includes matching questions previously in the Problems and Exercises. Many new questions have been added to support new chapter material.
2. *Problems and Exercises* This section has been expanded in every chapter and contains many new problems and exercises to support updated chapter material.
3. *Field Exercises* This section provides a set of "hands-on" minicases that can be assigned to individual students or to small teams of students. Field exercises range from directed field trips to Internet searches and other types of research exercises.

4. *Project Case* The Mountain View Community Hospital case continues to be included as a student project. New cases have been written for the new and expanded chapters. In each chapter the case begins with a brief description of the project as it relates to that chapter. The case then presents a series of project questions and exercises to be completed by individual students or by small project teams. This case provides an excellent means for students to gain hands-on experience with the concepts and tools they have studied.
5. *Web Resources* Each chapter contains a list of URLs for Websites with information useful to supplement the chapter. These Websites cover on-line publication archives, vendors, electronic publications, industry standards organizations, and many other sources. These sites allow students and faculty to find updated product information, innovations that appear since the printing of the book, background information to explore topics in greater depth, and resources for writing research papers.

We have also updated the pedagogical features that helped make the sixth edition widely accessible to instructors and students. These features include the following:

1. **Learning objectives** appear at the beginning of each chapter to preview the major concepts and skills students will learn from that chapter. The learning objectives also provide a great study review aid for students as they prepare for assignments and examinations.
2. **Chapter introductions and summaries** both encapsulate the main concepts of each chapter and link material to related chapters, providing students with a comprehensive conceptual framework for the course.
3. The **chapter review**, which includes the review questions, problems and exercises, and field exercises discussed earlier, also contains **key terms** to test the student's grasp of important concepts, basic facts, and significant issues.
4. A **running glossary** defines key terms in the page margins as they are discussed in text. These terms are also defined at the end of the text in the **glossary of terms**. Also included is an end-of-book **glossary of acronyms** for abbreviations commonly used in database management.

Organization

We encourage instructors to customize their use of this book to meet the needs of both their curriculum and student career paths. The modular nature of the text, its broad coverage, extensive illustrations, and inclusion of advanced topics and emerging issues make customization easy. The many references to current publica-

tions and Websites can help instructors develop supplemental reading lists or expand classroom discussion beyond material presented in the text. The use of appendices for several advanced topics allow instructors to easily include or omit these topics.

The modular nature of the text allows the instructor to omit certain chapters or to cover chapters in a different sequence. For example, an instructor who wishes to emphasize data modeling may cover Chapter 14 on object-oriented data modeling along with or instead of Chapters 3 and 4. Another instructor who wishes to cover only basic entity/relationship concepts (but not the enhanced E-R model or business rules) may skip Chapter 4.

Case Tools

Modern Database Management, sixth edition, offers adopters the option of acquiring outstanding CASE tools software packages from Oracle and Visible Systems. Students can purchase this book packaged with the full editions of Oracle Designer, Oracle Forms and Reports (Developer), and Personal Oracle, or with Visible Analyst at a greatly reduced fee. We are proud to offer such highly valued, powerful software packages to students at such a low cost. These packages can be used to draw data models, generate normalized relations from conceptual data models, and generate database defintion code, among other tasks. These tools also are useful in other courses on information systems development.

The Supplement Package

A comprehensive and flexible technology support package is available to enhance the teaching experience:

Instructor's Resource CD-ROM The Instructor's Resource CD-ROM features the following:

- *Instructor's Resource Manual* provides chapter-by-chapter instructor objectives, classroom ideas, and answers to review questions, problems and exercises, field exercises, and project case questions. The Instructor's Resource Manual is also available in print and from the faculty area of the text's Website.
- *Test Item File* and *Windows PH Test Manager* include a comprehensive set of test questions in multiple-choice, true-false, and short-answer format, ranked according to level of difficulty, and referenced with page numbers and topic headings from the text. The Test Item File is available in print and on the IR CD-ROM in Microsoft Word and as the computerized Prentice Hall Test Manager. Test Manager is a comprehensive suite of tools for testing and assessment. It allows instructors to easily create and distribute tests for their courses, either by printing and distributing through traditional methods or by on-line delivery via a Local Area Network (LAN) server. Test Manager features Screen Wizards to assist you as you move through the program, and the software is backed with full technical support.
- *PowerPoint Presentation Slides* feature lecture notes that highlight key text terms and concepts. Professors can customize the presentation by adding their own slides or editing the existing ones.
- *Image Library* is a collection of the text art organized by chapter. This includes all figures, tables, and screenshots, as permission allows.
- *Accompanying Databases* Two versions of the Pine Valley Furniture case have been created and populated for the sixth edition. One version is scoped to match the textbook examples. The other version is fleshed out with sample

forms, reports, and modules coded in Visual Basic. This version is not complete, however, so that students may create missing tables and additional forms, reports, and modules. A preliminary version of the Mountain View Community Hospital case is also included. Oracle scripts are included to create the tables and insert sample data for both Pine Valley Furniture and Mountain View Community Hospital. Robert Lewis, of the University of South Florida, has created these data sets and applications for us. The database files are available on the Instructor's Resource CD-ROM and on the text Website in the instructor's section.

MyCW Companion Website (http://www.prenhall.com/hoffer) The Companion Website accompanying *Modern Database Management* includes:

1. Totally new data sets and sample database applications in Access and Oracle for use with the Pine Valley Furniture case and the Mountain View Community Hospital case; provided in the secure Instructor's Area.
2. An interactive study guide with multiple choice, true/false, and essay questions. Students receive automatic feedback to their answers. Responses to the essay questions, and results from the multiple choice and true/false questions can be emailed to the instructor after a student finishes a quiz.
3. Web Resources module includes the Web links referenced at the end of each chapter in the text, to help students further explore database management topics on the Web.
4. PowerPoint presentations for each chapter are available in the student area of the site.
5. A full glossary is available both alphabetically and by chapter, along with a glossary of acronyms.
6. New case studies have been added to the Website. Some are designed to become the basis of semester-long student projects. Others are designed as teaching cases. Additional cases will be added over time.

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Acknowledgments

We are grateful to numerous individuals who contributed to the preparation of *Modern Database Management*, sixth edition. First, we wish to thank our reviewers for their detailed suggestions and insights, characteristic of their thoughtful teaching

style. Because of the extensive changes made from the fifth edition of *Modern Database Management*, analysis of topics and depth of coverage provided by the reviewers was crucial. Our reviewers include the following:

Cyrus Azarbod, *Mankato State University*
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