

数据库原理

高等学校双语教学推荐教材
信息管理与信息系统系列

(英文版·第六版)
Sixth Edition

Database Concepts

戴维·M·克伦克 戴维·J·奥尔 / 著

David M. Kroenke David J. Auer

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中国人民大学出版社
· 北京 ·

图书在版编目(CIP)数据

数据库原理：第六版：英文/(美)戴维·M·克伦克，(美)戴维·J·奥尔著. —影印本. —北京：中国人民大学出版社，2016.10

高等学校双语教学推荐教材·信息管理与信息系统系列

ISBN 978-7-300-23365-9

I. ①数… II. ①戴… ②戴… III. ①数据库系统-双语教学-高等学校-教材-英文 IV. ①TP311.13

中国版本图书馆 CIP 数据核字 (2016) 第 217965 号

高等学校双语教学推荐教材·信息管理与信息系统系列

数据库原理 (英文版·第六版)

戴维·M·克伦克 著

戴维·J·奥尔

Shujuku Yuanli

出版发行 中国人民大学出版社

社 址 北京中关村大街 31 号

电 话 010-62511242 (总编室)

010-82501766 (邮购部)

010-62515195 (发行公司)

网 址 <http://www.crup.com.cn>

<http://www.ttrnet.com>(人大教研网)

经 销 新华书店

印 刷 三河市汇鑫印务有限公司

规 格 215 mm×275 mm 16 开本

印 张 30.5 插页 1

字 数 899 000

邮政编码 100080

010-62511770 (质管部)

010-62514148 (门市部)

010-62515275 (盗版举报)

版 次 2016 年 10 月第 1 版

印 次 2016 年 10 月第 1 次印刷

定 价 65.00 元

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Preface

Colin Johnson is a production supervisor for a small manufacturer in Seattle. Several years ago, Colin wanted to build a database to keep track of components in product packages. At the time, he was using a spreadsheet to perform this task, but he could not get the reports he needed from the spreadsheet. Colin had heard about Microsoft Access, and he tried to use it to solve his problem. After several days of frustration, he bought several popular Microsoft Access books and attempted to learn from them. Ultimately, he gave up and hired a consultant who built an application that more or less met his needs.

Colin was a successful businessperson who was highly motivated to achieve his goals. A seasoned Windows user, he had been able to teach himself how to use Microsoft Excel, Microsoft PowerPoint, and a number of production-oriented application packages. He was flummoxed at his inability to use Microsoft Access to solve his problem. "I'm sure I could do it, but I just don't have any more time to invest," he thought. This story is especially remarkable because it has occurred tens of thousands of times over the past decade, to many other people.

Microsoft, Oracle, IBM, and other database management system (DBMS) vendors are aware of such scenarios and have invested millions of dollars in creating better graphical interfaces, hundreds of multipanel wizards, and many sample applications. Unfortunately, such efforts treat the symptoms and not the root of the problem. In fact, most users have no clear idea what the wizards are doing on their behalf. As soon as these users require changes to database structure or to components such as forms and queries, they drown in a sea of complexity for which they are unprepared. With little understanding of the underlying fundamentals, these users grab at any straw that appears to lead in the direction they want. The consequence is poorly designed databases and applications that fail to meet the users' requirements.

Why can people like Colin learn to use a word processor or a spreadsheet product yet fail when trying to learn to use a DBMS product? First, the underlying database concepts are unnatural to most people. Whereas everyone knows what paragraphs and margins are, no one knows what a relation is. Second, it seems as though using a DBMS product ought to be easier than it is. "All I want to do is keep track of something. Why is it so hard?" people ask. Without knowledge of the relational model, breaking a sales invoice into five separate tables before storing the data is mystifying to business users.

This book is intended to help people like Colin understand, create, and use databases in a DBMS product, whether they are individuals who found this book in a bookstore or students using this book as their textbook in a class.

NEW TO THIS EDITION

Students and other readers of this book will benefit from new content and features in this edition. These include the following:

- *Big Data* is the new theme of Chapter 8, which now includes material on the *NoSQL movement*, the development of non-relational structured data stores (such as Cassandra and HBase), and the Hadoop Distributed File System (HDFS).
- The coverage of Web database applications in Chapter 7 now includes data input Web form pages. This allows Web database applications to be built with both data-input and data-reading Web pages.

- The coverage of Microsoft Access 2010 now includes Microsoft Access switchboard forms (covered in Appendix H “The Access Workbench—Section H—Microsoft Access 2010 Switchboards”), which are used to build menus for database applications. Switchboard forms are helpful in database applications; they provide a user-friendly main menu that simplifies the step users need to display forms, print reports, and run queries.
- Each chapter now features an independent Case Question set. The Case Question sets are problem sets that generally do not require the student to have completed work on the same case in a previous chapter (there is one intentional exception that ties data modeling and database design together).
- Support for Oracle Database 11g Release 2 Express Edition is now included. A new appendix—Appendix B, “Getting Started with Oracle Database 11g Release 2 Express Edition”—has been added to show you how to use the product and the Oracle SQL Developer GUI utility.
- The book has been updated to reflect the use of the new Microsoft SQL Server 2012 Express edition. Although most of the topics covered are backward compatible with Microsoft SQL Server 2008 R2 Express Edition, all material in the book now uses SQL Server 2012 in conjunction with Office 2010 exclusively.
- The book has been updated to reflect the use of MySQL 5.5 and the MySQL Workbench.
- A new online appendix—Appendix J, “Business Intelligence Systems”—has been added to provide the detailed material on business intelligence that was previously included in Chapter 8 for those instructors who still want to cover this topic in depth.

THE NEED FOR ESSENTIAL CONCEPTS

With today’s technology, it is impossible to utilize a DBMS successfully without first learning fundamental concepts. After years of developing databases with business users, we believe that the following database concepts are essential:

- Fundamentals of the relational model
- Structured Query Language (SQL)
- Data modeling
- Database design
- Database administration

And because of the increasing use of the Internet, the World Wide Web, commonly available analysis tools, and the emergence of Big Data and the NoSQL movement, four more essential concepts need to be added to the list:

- Web database processing
- Data warehouse structures
- Business intelligence (BI) systems
- Nonrelational structured data storage and processing

Users like Colin—and students who will perform jobs similar to his—need not learn these topics to the same depth as future information systems professionals. Consequently, this textbook presents only essential concepts—those that are necessary for users like Colin who want to create and use small databases. Many of the discussions in this book are rewritten and simplified explanations of topics that you will find fully discussed in David M. Kroenke and David J. Auer’s *Database Processing: Fundamentals, Design, and Implementation*.¹ However, in creating the material for this text, we have endeavored to

¹David M. Kroenke and David J. Auer, *Database Processing: Fundamentals, Design, and Implementation*, 12th edition (Upper Saddle River, NJ: Pearson/Prentice Hall, 2012).

ensure that the discussions remain accurate and do not mislead. Nothing here will need to be unlearned if students take more advanced database courses.

TEACHING CONCEPTS INDEPENDENT OF DBMS PRODUCTS

This book does not assume that students will use any particular DBMS product. The book does illustrate database concepts with Microsoft Access 2010, Microsoft SQL Server 2012, Oracle Database 11g Release 2, and Oracle MySQL 5.5 so that students can use these products as tools and actually try out the material, but all the concepts are presented in a DBMS-agnostic manner. When students learn the material this way, they come to understand that the fundamentals pertain to any database, from the smallest Microsoft Access database to the largest Microsoft SQL Server or Oracle Database database.

All this is not to say that a DBMS should not be used in this class. On the contrary, students can best master these concepts by applying them using a commercial DBMS product. This edition of the book was written to include enough basic information about Microsoft Access, SQL Server, Oracle Database, and MySQL so that you can use these products in your class without the need for a second book or other materials.

Because Microsoft Access is widely used in introductory database classes, each chapter has an accompanying section of “The Access Workbench,” which illustrates the chapter’s concepts and techniques using Microsoft Access. “The Access Workbench” topics start with creating a database and a single table in Chapter 1 and move through various topics, finishing with Web database processing against a Microsoft Access database in Chapter 7 and using Microsoft Access (together with Microsoft Excel) to produce PivotTable OLAP reports in Chapter 8. The Microsoft Access material covers all the necessary basic topics to enable your students to effectively build and use Microsoft Access databases, but is not intended to provide comprehensive coverage of Microsoft Access.

If you need to cover Microsoft Access or another DBMS product in more depth than is found in this book, you may need to supplement this book with another, DBMS specific text or additional material.

KEY TERMS, REVIEW QUESTIONS, EXERCISES, CASES, AND PROJECTS

Because it is important for students to apply the concepts they learn, each chapter concludes with sets of key terms, review questions, exercises (including exercises tied to “The Access Workbench”), case questions, and three projects that run throughout the book. Students should know the meaning of each of the key terms and be able to answer the review questions if they have read and understood the chapter material. Each of the exercises requires students to apply the chapter concepts to a small problem or task.

Three projects—Garden Glory, James River Jewelry, and the Queen Anne Curiosity Shop—provide ongoing projects spanning all the chapters in the book. In each instance, students are asked to apply the project concepts from the chapter. Instructors will find more information on the use of these projects in the instructor’s manual and can obtain databases and data from the password-protected instructor’s portion of this book’s Web site (www.pearsonhighered.com/kroenke).

SOFTWARE USED IN THE BOOK

Just as we have treated our discussions in a DBMS-agnostic way, whenever possible, we have selected software to be as operating system independent as possible. It is amazing how much excellent software is available online.

So although the examples in this book were created using a Microsoft operating system, SQL Server 2012 Express edition, Microsoft Access 2010, Microsoft Excel 2010, and the IIS Web Server, most of them could just as easily be accomplished using Linux, MySQL 5.5

Community Server Edition, OpenOffice.org Base, OpenOffice.org Calc, and the Apache Web server. Some software products used in the book, such as PHP and Eclipse, are available for multiple operating systems.

CHANGES FROM THE FIFTH EDITION

The most significant change in this edition is the coverage of the rapidly evolving use of *Big Data* and the associated *NoSQL movement*. The need to be able to store and process extremely large datasets is transforming the database world. Although these developments leave the database fundamentals covered in this book unchanged, they do require us to put the relational databases that are the core of this text into the context of the overall database picture and to provide the reader with an understanding of the nonrelational structured storage used in the Big Data environment. Therefore, Chapter 8 is now organized around the topic of Big Data, and the topics of data warehouses, clustered database servers, distributed databases, and an introduction to business intelligence (BI) systems find a natural home in that chapter. For those wanting the same coverage of BI found in the previous edition of *Database Concepts*, we have moved BI material that no longer fit in Chapter 8 to Appendix J.

Another significant change is the support for Oracle Database 11g Release 2 that has been added to the book. Although *Database Concepts* has always focused on concepts instead of specific DBMS products, we have also provided enough coverage of Microsoft Access 2010, Microsoft SQL Server 2012, and MySQL 5.5 so that these concepts could be put into practice. We have extended the coverage to include the same level of in-text references and illustration for Oracle Database and have added a new appendix to introduce Oracle Database 11g Release 2 Express Edition and the Oracle SQL Developer GUI utility (see Appendix B, “Getting Started with Oracle Database 11g Release 2 Express Edition”).

Finally, we have added chapter-independent Case Question sets. Although the chapter projects tie the topics in each chapter together, the case questions do not require the student to have completed work on the same case in a previous chapter or chapters. There is one intentional exception that spans Chapters 4 and 5 that ties data modeling and database design together, but each of these chapters also includes a standalone case. Although in some instances the same basic named case may be used in different chapters, each instance is still completely independent of any other instance, and we provide needed Microsoft Access 2010 database and SQL scripts at the text Web site at www.pearsonhighered.com/kroenke.

We have, of course, also updated information on all the other products in the book. In particular, we cover the MySQL 5.5 and the newly released Microsoft SQL Server 2012.

We have kept and improved upon several features introduced in earlier editions of the book:

- The use of “The Access Workbench” sections in each chapter to provide coverage of Microsoft Access fundamentals now includes Microsoft Access switchboards (Appendix H, “The Access Workbench—Section H—Microsoft Access 2010 Switchboards,” available online).
- Introductions to the use of Microsoft SQL Server 2012 Express Edition (Appendix A, “Getting Started with Microsoft SQL Server 2012 Express Edition,” available online) and MySQL 5.5 Community Server Edition (Appendix C, “Getting Started with MySQL 5.5 Community Server Edition,” available online)
- The use of fully developed datasets for the three example databases that run throughout various portions of the book—Wedgewood Pacific Corporation, Heather Sweeney Designs, and Wallingford Motors
- The use of the PHP scripting language and the Eclipse IDE in the Web database processing topics now includes code for Web page input forms
- Coverage of the dimensional database model is maintained in the restructured Chapter 8, together with coverage of OLAP

In order to make room for this new material, we have had to move some valuable material previously found in the book itself to online appendices. This includes the James River Jewelry set of project questions, which is now in online Appendix D “James River Jewelry Project Questions,” the material on SQL Views (formerly Chapter 3A), which is now in online Appendix E “SQL Views,” and the Business Intelligence Systems material on reporting systems and data mining, which is now in online Appendix J “Business Intelligence Systems.”

BOOK OVERVIEW

This textbook consists of eight chapters and ten online appendices (all the appendices are readily available online at www.pearsonhighered.com/kroenke). Chapter 1 explains why databases are used, what their components are, and how they are developed. Students will learn the purpose of databases and their applications, as well as how databases differ from and improve on lists in spreadsheets. Chapter 2 introduces the relational model and defines basic relational terminology. It also introduces the fundamental ideas that underlie normalization and describe the normalization process.

Chapter 3 presents fundamental SQL statements. Basic SQL statements for data definition are described, as are SQL SELECT and data modification statements. No attempt is made to present advanced SQL statements; only the essential statements are described. Online Appendix E adds coverage of SQL views.

The next two chapters consider database design. Chapter 4 addresses data modeling, using the entity-relationship (E-R) model. This chapter describes the need for data modeling, introduces basic E-R terms and concepts, and presents a short case application (Heather Sweeney Designs) of E-R modeling. Chapter 5 describes database design and explains the essentials of normalization. The data model from the case example in Chapter 4 is transformed into a relational design in Chapter 5.

In this edition, we continue to use the more effective discussion of normalization added in an earlier edition. We have presented a prescriptive procedure for normalizing relations through the use of a four-step process. This approach not only makes the normalization task easier, it also makes normalization principles easier to understand. Therefore, this approach has been retained in this edition. For instructors who want a bit more detail on normal forms, short definitions of most normal forms are included in Chapter 5.

The last three chapters consider database management and the uses of databases in applications. Chapter 6 provides an overview of database administration. The chapter surveys concurrency control, security, and backup and recovery techniques. Database administration is an important topic because it applies to all databases, even personal, single-user databases.

Chapter 7 introduces the use of Web-based database processing, including a discussion of Open Database Connectivity (ODBC) and the use of the PHP scripting language. It also discusses the emergence and basic concepts of Extensible Markup Language (XML).

Chapter 8 discusses the emerging world of Big Data and the NoSQL movement. Business intelligence (BI) systems and the data warehouse architectures that support them are discussed, but many details of BI systems have been moved to online Appendix J. Chapter 8 also discusses dimensional databases. The chapter also walks through how to build a dimensional database for Heather Sweeney Designs and then use it to produce a PivotTable Online Analytical Processing (OLAP) report.

Appendix A provides a short introduction to SQL Server 2012 Express Edition, Appendix B provides an introduction to Oracle Database 11g Release 2 Express Edition, and Appendix C provides a similar introduction to MySQL 5.5. Microsoft Access is covered in “The Access Workbench” sections included in each chapter. Appendix D now contains the James River Jewelry project questions, and the material on SQL Views is located in Appendix E. Appendix F provides an introduction to systems analysis and design and can be used to provide context for Chapter 4 (data modeling) and Chapter 5 (database design). Appendix G is a short introduction to Microsoft Visio 2010, which

can be used as a tool for data modeling (Chapter 4) and database design (Chapter 5). Another useful database design tool is the MySQL Workbench, and this use of the MySQL Workbench is discussed in Appendix C. Appendix H extends Chapter 5's section of "The Access Workbench" by providing coverage of Microsoft Access 2010 switchboards. Appendix I provides support for Chapter 7 by giving detailed instructions on getting the Microsoft IIS Web server, PHP, and the Eclipse PHP Development Tools (PDT) up and running. Finally, Appendix J provides additional material on business intelligence (BI) systems to supplement and provide support to Chapter 8 by providing more discussion of report systems and data mining.

In order to keep *Database Concepts* up-to-date between editions, we post updates on the book's Web site at www.pearsonhighered.com/kroenke, as needed. Instructor resources and student materials are also available on the site, so be sure to check it from time to time.

ACKNOWLEDGMENTS

Over the past 30-plus years, working with databases and database applications has been an enjoyable and rewarding activity. We believe that database applications and their supporting databases will increase in importance in the future, as is currently illustrated by the evolving Big Data structures found in Google, Facebook, and other products that did not exist when the first edition of this book was published. It is our hope that the concepts, knowledge, and techniques presented in this book will help students to successfully participate in this emerging database world.

We would like to thank the following reviewers for their insightful and helpful comments:

David Chou, Eastern Michigan University
 Geoffrey Decker, Northern Illinois University
 Deena Engel, New York University
 Jean Hendrix, University of Arkansas at Monticello
 Malini Krishnamurthi, California State University, Fullerton
 Rashmi Malhotra, Saint Joseph's University
 Gabriel Petersen, North Carolina Central University
 Eliot Rich, University at Albany, State University of New York
 Bond Wetherbe, Texas Tech University
 Diana Wolfe, Oklahoma State University, Oklahoma City

We would like to thank Bob Horan, our editor; Kelly Loftus, our editorial project manager; Jane Bonnell, our production project manager; and Jennifer Welsch, our project manager, for their professionalism, insight, support, and assistance in the development of this project. We would also like to thank Marcia Williams for her detailed comments on the final manuscript. Finally, David Kroenke would like to thank his wife, Lynda, and David Auer would like to thank his wife, Donna, for their love, encouragement, and patience while this project was being completed.

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About the Authors

David M. Kroenke entered the computing profession as a summer intern at the RAND Corporation in 1967. Since then, his career has spanned education, industry, consulting, and publishing.

He has taught at the University of Washington, Colorado State University, and Seattle University. Over the years, he has led dozens of teaching seminars for college professors. In 1991 the International Association of Information Systems named him Computer Educator of the Year.

In industry, Kroenke has worked for the U.S. Air Force and Boeing Computer Services, and he was a principal in the start up of three companies. He was also vice president of product marketing and development for the Microrim Corporation and was chief technologist for the database division of Wall Data, Inc. He is the father of the semantic object data model. Kroenke's consulting clients include IBM Corporation, Microsoft, Computer Sciences Corporation, and numerous other companies and organizations.

His text *Database Processing: Fundamentals, Design, and Implementation*, first published in 1977, is now in its 12th edition. He introduced *Database Concepts* (now in the 6th edition that you are reading) in 2003. Kroenke has published many other textbooks, including the classic *Business Computer Systems* (1981). Recently, he has authored *Experiencing MIS* (3rd edition), *MIS Essentials* (2nd edition), and *Using MIS* (5th edition).

An avid sailor, Kroenke also wrote *Know Your Boat: The Guide to Everything That Makes Your Boat Work*. Kroenke lives in Seattle, Washington. He is married and has two children and three grandchildren.

Since 1994, **David J. Auer** has been the director of Information Systems and Technology Services at Western Washington University's College of Business and Economics (CBE) and a lecturer in CBE's Department of Decision Sciences. Since 1981, he has taught CBE courses in quantitative methods, production and operations management, statistics, finance, and management information systems. Besides managing CBE's computer, network, and other technology resources, he also teaches management information systems courses. He has taught the Principles of Management Information Systems and Business Database Development courses, and he was responsible for developing CBE's network infrastructure courses, including Computer Hardware and Operating Systems, Telecommunications, and Network Administration. He has coauthored several MIS-related textbooks.

Auer holds a bachelor's degree in English literature from the University of Washington, a bachelor's degree in mathematics and economics from Western Washington University, a master's degree in economics from Western Washington University, and a master's degree in counseling psychology from Western Washington University. He served as a commissioned officer in the U.S. Air Force, and he has also worked as an organizational development specialist and therapist for an employee assistance program (EAP).

Auer and his wife, Donna, live in Bellingham, Washington. He has two children and five grandchildren.

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