Practical Database Programming with Java

Ying Bai
Department of Computer Science and Engineering
Johnson C. Smith University
Charlotte, North Carolina

IEEE PRESS

A John Wiley & Sons, Inc., Publication

Practical Database Programming with Java

IEEE Press
445 Hoes Lane
Piscataway, NJ 08854

Practical Database Programming with Java

Ying Bai
Department of Computer Science and Engineering
Johnson C. Smith University
Charlotte, North Carolina

IEEE PRESS

A John Wiley & Sons, Inc., Publication

Published by John Wiley & Sons, Inc., Hoboken, New Jersey
Published simultaneously in Canada

Library of Congress Cataloging-in-Publication Data:
Bai, Ying, 1956-
Practical database programming with Java / Ying Bai.
p. cm.
ISBN 978-0-470-88940-4 (pbk.)
1. Database management–Computer programs. 2. Database design. 3. Java (Computer program language) 4. Computer software–Development. I. Title.
QA76.9.D3B314 2011
005.13'3–dc22

2011009323

obook ISBN 9781118104651
ePDF ISBN 9781118104668
ePub ISBN 9781118104699

Printed in the United States of America

10 9 8 7 6 5 4 3 2 1

This book is dedicated to my wife, Yan Wang,
and to my daughter, Xue Bai.

Contents

Preface

Databases have become an integral part of our modern day life. We are an information-driven society. Database technology has a direct impact on our daily lives. Decisions are routinely made by organizations based on the information collected and stored in databases. A record company may decide to market certain albums in selected regions based on the music preference of teenagers. Grocery stores display more popular items at the eye level and reorders are based on the inventories taken at regular intervals. Other examples include patients' records in hospitals, customers' account information in banks, book orders by the libraries, club memberships, auto part orders, winter cloth stock by department stores, and many others.

In addition to database management systems, in order to effectively apply and implement databases in real industrial or commercial systems, a good graphic user interface (GUI) is needed to enable users to access and manipulate their records or data in databases. NetBeans IDE is an ideal candidate to be selected to provide this GUI functionality. Unlike other programming languages, Java is a kind of language that has advantages, such as easy to earn and easy to be understood, with little learning curves. Beginning from Java 1.0, Sun has integrated a few programming languages, such as C++, JavaFX, and PHP, with some frameworks into dynamic models that make Internet and Web programming easy and simple, and any language integrated in this model can be used to develop professional and efficient Web applications that can be used to communicate with others via Internet.

This book is mainly designed for college students and software programmers who want to develop practical and commercial database programming with Java and relational databases, such as Microsoft Access, SQL Server 2008, and Oracle Database 10g XE. The book provides a detailed description about the practical considerations and applications in database programming with Java and authentic examples and detailed explanations. More important, a new writing style is developed and implemented in this book, combined with real examples, to provide readers with a clear picture as how to handle the database programming issues in NetBeans IDE environment.

The outstanding features of this book include but are not limited to the following.

1. A novel writing style is adopted to attract students or beginning programmers who are interested in learning and developing practical database programs, with the hope of avoiding the headaches caused by huge blocks of codes found in traditional database programming books.
2. A real completed sample database, CSE_DEPT, with three versions (Microsoft Access 2007, SQL Server 2008, and Oracle Database 10g XE Release 2), is provided and used for the entire book. A step-by-step, detailed description about how to design and build a practical relational database is provided.

3. Both fundamental and advanced database programming techniques are covered, for the convenience of both beginning students and experienced programmers.
4. Updated Java database programming techniques, such as Java Persistence API, Java Enterprise Edition 6, JavaServer Pages, JavaServer Faces, and Enterprise Java Beans, are discussed and analyzed with real projects to enable readers to have a clear picture and easy-to-learn path for Java database applications.
5. More than 30 real sample database programming projects are covered, with detailed illustrations and explanations to help students to understand key techniques and programming technologies.
6. Three types of popular databases are covered and discussed in detail with practical sample examples: Microsoft Access, SQL Server 2008, and Oracle Database 10g Express Edition (XE).
7. The various actual JDBC APIs and JDBC drivers are discussed and presented with real example coding explanations. The working structure and principle of using a JDBC driver to establish a valid database connection, build an SQL statement, and process the query results are introduced in detail with example codes. JDBC RowSet, a useful tool, is also discussed and analyzed with some example codes.
8. Problems and selected solutions are provided for each chapter to strengthen and improve understanding of the topics.
9. Power Point teaching slides are also provided to help instructors.

I sincerely hope that this book will be useful to all who adopt it, as a textbook for college students, as well as a reference book for programmers, software engineers, and academic researchers. I would be more than happy to know that you have been able to develop and build professional and practical database applications with the help of this book.

YING BAI

Acknowledgments

First, I thank my wife, Yan Wang, in particular. I could not have finished this book without her sincere encouragement and support.

I also thank Satish Bhalla, who made important contributions to Chapter 2. Dr. Bhalla is a specialist in database programming and management, in particular, in SQL Server, Oracle, and DB2. Dr. Bhalla spent much time preparing materials for the first part of Chapter 2, and this is gratefully acknowledged.

Many thanks also go to Mary Mann at Wiley, who helped to make this book available to the public, and for her deep perspective and hard work. The same thanks are extended to the editorial team, without whose contributions the book would not have been published.

Thanks should also be extended to the following book reviewers for their important feedback on the manuscript:

- Dr. Jifeng Xu, Research Scientist, Boeing Company
- Dr. Xiaohong Yuan, Associate Professor, Department of Computer Science, North Carolina A&T State University
- Dr. Daoxi Xiu, Application Analyst Programmer, North Carolina Administrative Office of the Courts
- Dr. Dali Wang, Assistant Professor, Department of Physics and Computer Science, Christopher Newport University

Finally, thanks should be given to all of the people who supported me in the completion of this book.

Chapter 1

Introduction

For years while teaching database programming, I found it difficult to find a good textbook for this topic, so I had to combine a few different books together in order to teach the course. Most of those books are designed for programmers or software engineers, which cover a lot of programming strategies and huge blocks of coding, a headache to college students or beginning programmers who are new to programming. I dreamed that one day I would find a good textbook that is suitable for college students or beginning programmers, and that would help them to learn and master database programming easily and conveniently. Finally, I decided to realize this dream myself.

Another reason to write this book was the job market. Most companies in the United States, such as manufacturers, retailers, banks, and hospitals, use database applications extensively. The majority need professionals to develop and build database-related applications, but not necessarily database management and design. To enable our students to be good candidates for those jobs, a book such as this one is needed.

Unlike most database programming books on the current market, which discuss and present database programming techniques with huge blocks of programming codes from the first page to the last page, this book uses a new writing style to show readers, especially the college students, how to develop professional and practical database programs with Java, by using Java Persistence API (JAPI), Java Enterprise Edition (J2EE), Enterprise Java Beans (EJB), and plug-in tools related to NetBeans IDE, and to apply codes that are autogenerated by using those tools. Thus, the huge blocks of programming codes can be removed, and, instead, a simple and easy way to create database programs using plug-in tools can be developed to attract students' interests, and furthermore to enable students to build professional and practical database programming in more efficient and interesting ways.

To meet the needs of some experienced or advanced students or software engineers, the book contains two programming methods: the interesting fundamental database programming method (JAPI and plug-in tools method) and the advanced database programming method (runtime object method). In the second method, all database-related objects are created and applied during or when your project is running by utilizing quite a few blocks of codes.

Practical Database Programming with Java, First Edition. Ying Bai.

WHAT THIS BOOK COVERS

The contents of each chapter can be summarized as follows. Chapter 1 provides an introduction to the book. Chapter 2 provides a detailed discussion and analysis of the structure and components about relational databases. Some key technologies in developing and designing databases are also given and discussed. The procedure and components used to develop a practical relational database with three database versions, such as Microsoft Access, SQL Server 2008, and Oracle Database 10g XE, are analyzed in detail with some real data tables in our sample database CSE_DEPT.

Chapter 3 provides an introduction to JDBC APIs and JDBC drivers. A detailed introduction to components and architecture of JDBC is given with step-by-step illustrations. Four popular types of JDBC drivers are discussed and analyzed with their advantages and disadvantages in actual database applications. The working structure and operational principle of using JDBC drivers to establish a valid database connection, build a SQL statement, and process the query results are discussed and presented in detail. JDBC RowSet, a useful tool, is also discussed and analyzed with some example codes.

Chapter 4 provides a detailed discussion and analysis of JDBC design and actual application considerations. The fundamentals of using JDBC to access and manipulate data against databases are discussed and introduced with example codes. Different JDBC interfaces, including the ResultSet, ResultSetMetaData, DatabaseMetaData, and ParameterMetaData, are introduced and discussed with example codes.

Chapter 5 provides a detailed description of the NetBeans IDE, including the components and architecture. This topic is necessary for college students who have no knowledge of NetBeans IDE. Starting with an introduction to installing NetBeans IDE, this chapter goes through each aspect of NetBeans IDE, including the NetBeans Platform, NetBeans Open Source, and all plug-in tools. Different projects built with NetBeans IDE are discussed and presented in detail with 14 example projects.

Starting with Chapter 6, the real database programming techniques with Java, query data from database, are provided and discussed. Two parts are covered in this chapter: Part I contains detailed descriptions of how to develop professional data-driven applications with the help of the JAPI and plug-in tools with some real projects, and this part contains a lot of hiding codes that are created by NetBeans IDE automatically when using those tools and wizards. Therefore, the coding for this part is very simple and easy. Part II covers an advanced technique, the runtime object method, in developing and building professional data-driven applications. Detailed discussions and descriptions of how to build professional and practical database applications using this runtime method are provided combined with two real projects. In addition to basic query techniques, advanced query methods, such as PreparedStatement, CallableStatement, and stored procedure, are also discussed and implemented in this chapter with some real sample projects.

Chapter 7 provides detailed discussions and analyses of how to insert, update, and delete data from three popular databases: Microsoft Access, SQL Server 2008, and Oracle.

This chapter is also divided into two parts: In Part I, JAPI and plug-in tools to perform data manipulations are discussed. Part II covers the technique to manipulate data in our sample database using the runtime object method. Four real projects illustrate how to perform the data manipulations against three different databases: Microsoft Access, SQL Server 2008, and Oracle Database 10g XE. Professional and practical data validation