

ORACLES

PROGRAMMING:

A PRIMER

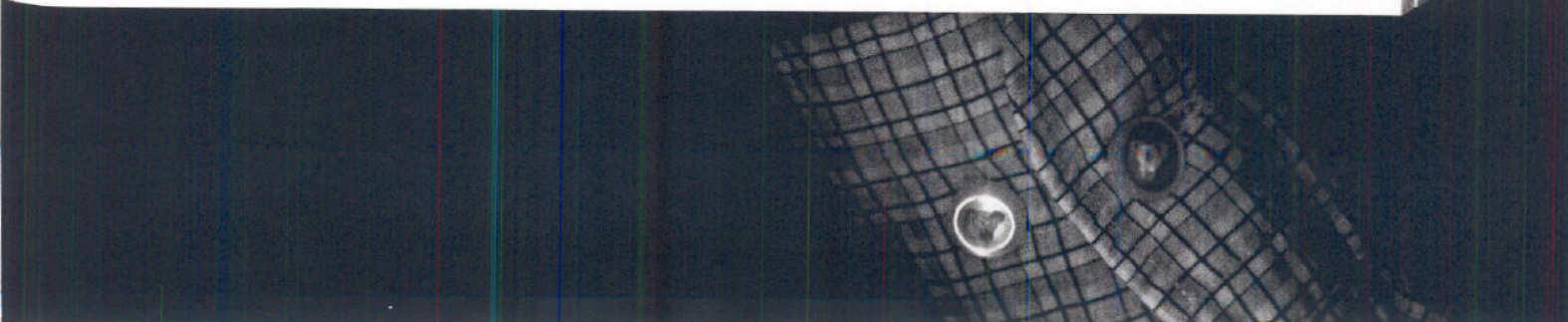
Rajshekhar Sunderraman

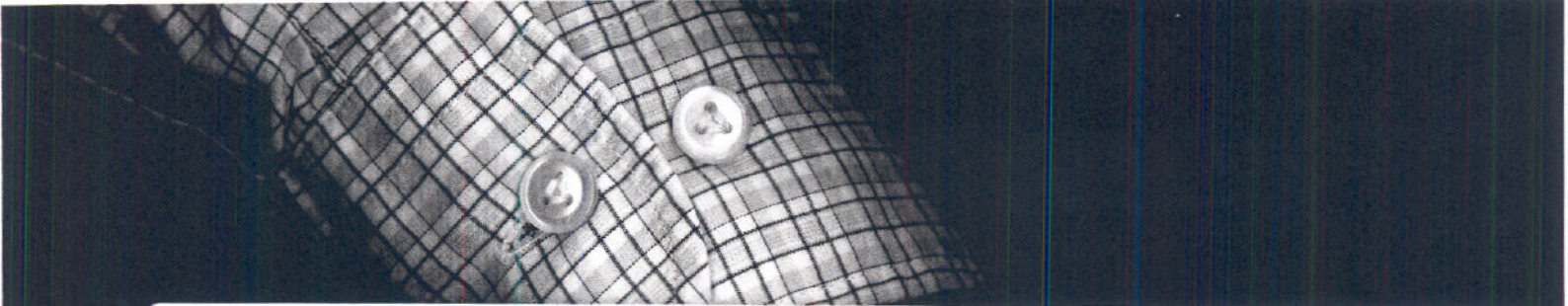
Georgia State University

 **ADDISON-WESLEY**

An imprint of Addison Wesley Longman, Inc.

Reading, Massachusetts • Menlo Park, California
New York • Harlow, England • Don Mills, Ontario
Sydney • Mexico City • Madrid • Amsterdam





Acquisitions Editor: Maite Suarez-Rivas
Project Manager: Trillium Project Management
Composition: Windfall Software, Paul C. Anagnostopoulos
Copyeditor: Donald Lafferty
Proofreader: Trillium Project Management
Cover Designer: Lynne Reed

Access the latest information about Addison-Wesley books from our World Wide Web site:
<http://www.awl.com/cseng>

Many of the designations used by manufacturers and sellers to distinguish their products are claimed as trademarks. Where those designations appear in this book, and Addison-Wesley was aware of a trademark claim, the designations have been printed in initial caps or all caps.

The programs and applications presented in this book have been included for their instructional value. They have been tested with care, but are not guaranteed for any particular purpose. The publisher does not offer any warranties or representations, nor does it accept any liabilities with respect to the programs or applications.

Library of Congress Cataloging-in-Publication Data

Sunderraman, Rajshekhar.

Oracle8 programming : a primer / Rajshekhar Sunderraman.

p. cm.

ISBN 0-201-61258-5

1. Oracle (Computer file) 2. Relational databases. I. Title.

QA76.9.D3 S2953 2000

005.75'85—dc21

99-047984

This book was composed with the Z_zT_EX typesetting system on a PC. The text is set in ITC Berkeley Oldstyle and the open-face titles in Monotype Old Style Bold Outline. The monospaced computer program font is Z_ztexMono-Regular. The book was printed on Lynx Opaque Plus.

Copyright © 2000 by Addison Wesley Longman, Inc.

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of the publisher. Printed in the United States of America.

3 4 5 6 7 8 9 10—CRS—03020100

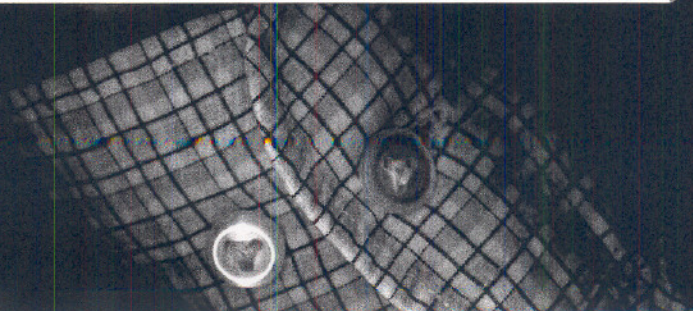
To

My mother
Saraswathi Sunderraman
for her love and hard work

My father
Sqn. Ldr. Rajagopala Sunderraman
for his love and encouragement

My wife
Radhika
for her love and caring

My children
Nandita and Naveen
for their love and innocence



PREFACE

Oracle is the most widely used database system in the world. It runs on virtually all platforms ranging from the PC to mainframes. It also comes with an array of programming tools and environments and provides access to the database from a variety of high-level programming languages.

In recent years, more and more universities in the United States and elsewhere are using Oracle in their database courses as the primary vehicle to illustrate database concepts and principles. This has resulted in the need for a concise book on Oracle programming to supplement the traditional texts in the database courses. The main motivation for writing this book is to satisfy this need. This book can also be used by a non-academic professional who is interested in learning about SQL, PL/SQL, embedded-SQL programming, JDBC, and SQLJ.

The topics discussed in this book are Oracle SQL, PL/SQL, embedded programming with Pro*C/C++, JDBC, and SQLJ. A brief introduction to the object features of Oracle8 is also presented in the book. To work with Oracle, it is absolutely essential to learn about SQL and PL/SQL, the two languages at the core of the Oracle database engine. Embedded-SQL (Pro*C/C++), JDBC access to Oracle, and the relatively new SQLJ standard are some of the important environments in which to develop applications. Java is an emerging language that will have a significant impact on computing in the coming years and Oracle is investing in this technology by providing JDBC drivers, SQLJ translators, and other related tools to develop applications, especially on the Web. Embedded-SQL is part of the SQL standards and is also an important technique for database programmers to learn.

Three sample databases are introduced early in the book and most of the chapters use these databases for illustration purposes. Several application programs are developed in their entirety in the different programming environments discussed in the text¹.

Book Use

This book is suitable as a supplemental text for an introductory database course which covers the relational model and uses Oracle as the database system for the course projects and assignments. Course projects can be developed using embedded-SQL (Pro*C/C++), JDBC, or SQLJ. An entire chapter is devoted to suggestions for course projects. These course projects are typically assigned in introductory database courses where a team of students start with a problem statement, write the problem specifications, design the database, create the database in Oracle, and write application programs that access the database. Some of the chapters also have review problems for the reader to go over to consolidate their understanding of the concepts presented in these chapters.

This book is also appropriate for a non-academic individual who is interested in learning about Oracle. He or she can find materials on SQL, PL/SQL, Pro*C/C++, JDBC, and SQLJ, all in one text. This book can be considered a starting point in the exploration of what Oracle has to offer.

World Wide Web Support

Most of the code presented in the book can also be found at the following World Wide Web site:

<http://www.awl.com/cseng/titles/0-201-61258-5>

In addition, the author will attempt to include other related materials to be developed in the near future at this Web site.

1. The programs and the applications presented in this book have been included for their instructional value. They have been tested with care but are **not guaranteed for any particular purpose**. The publisher does not offer any warranties or representations, nor does it accept any liabilities with respect to the programs or applications.

Acknowledgments

First of all, I would like to acknowledge Katherine Harutunian at Addison-Wesley for working with me closely and diligently to get this book out in time. The staff at Addison-Wesley is always a pleasure to work with. The reviewers, Akira Kawaguchi (City College of New York), Louis Mazzucco (SUNY Cobleskill), Mark Barnard (Marquette University), Willie Favero (Professional) and Ashesh Parekh (Professional) deserve special mention, as they made very useful and critical observations to improve the presentation and content of the book.

I would also like to acknowledge all my students who have diligently worked on various projects using Oracle over the past several years at Wichita State University and Georgia State University. In particular, I would like to acknowledge the effort put forth by Krissy Echols, Veena Pujari, and Radhika Venkataraman in designing and implementing the investment portfolio database application introduced in this edition of the text.

Finally, I would like to acknowledge the support my family has shown to me during the writing of this edition of the book. Thank you, Radhu, for all the hard work and understanding and thanks, Nannu and Nammi, for encouraging me to write this book so that I can buy you candy and toys from the money I get!

CONTENTS

Preface

vii

1 The Relational Data Model 1

- 1.1 The Relational Database 1
- 1.2 Integrity Constraints 2
- 1.3 Tabular View of a Relation 4
- 1.4 Sample Databases 4
- 1.5 Relational Algebra 12
 - 1.5.1 Set-Theoretic Operations 12
 - 1.5.2 Relation-Theoretic Operations 13
 - 1.5.3 Queries in Relational Algebra 16

2 Oracle SQL 19

- 2.1 Oracle SQL*Plus 19
 - 2.1.1 Entering and Exiting SQL*Plus 19
 - 2.1.2 Executing Commands in SQL*Plus 20
 - 2.1.3 Buffer Manipulation Commands 24
 - 2.1.4 Formatting Query Results 26
 - 2.1.5 Screen Capture of an SQL*Plus Session 27
- 2.2 Creating, Dropping, and Altering Tables 29
 - 2.2.1 drop table 29
 - 2.2.2 create table 31
 - 2.2.3 alter table 37
- 2.3 Inserting Rows 37

xi

2.4	Querying the Database	38
2.4.1	Simple <code>select</code> Statement	38
2.4.2	Sub-Selects	43
2.4.3	Union	50
2.4.4	Forall Queries	51
2.4.5	Aggregate Functions	52
2.4.6	The <code>group by</code> and <code>having</code> Clauses	54
2.4.7	The Full Select Statement	56
2.4.8	String, Number, and Date Functions	57
2.5	Views	69
2.5.1	<code>create view</code>	69
2.5.2	<code>drop view</code>	70
2.6	Modifying the Database	71
2.6.1	<code>insert</code>	71
2.6.2	<code>update</code>	72
2.6.3	<code>delete</code>	73
2.6.4	<code>commit</code> and <code>rollback</code>	73
2.7	Sequences	74
2.8	Oracle Data Dictionary	75
2.8.1	The <code>user_catalog</code> Table	75
2.8.2	The <code>user_objects</code> Table	75
2.8.3	The <code>user_tables</code> Table	76
2.8.4	The <code>user_tab_columns</code> Table	76
2.8.5	The <code>user_views</code> Table	76
2.9	Oracle8 Object Features	76
2.9.1	The <code>create type</code> Statement	77
2.9.2	The <code>varying array</code> Collection Type	78
2.9.3	Inserting Rows	80
2.9.4	User-Defined Methods	81
2.9.5	Nested Tables	82
2.9.6	Object Tables	83
2.9.7	Inserting Rows into Nested Tables	84
2.9.8	Querying and Accessing Data	85
	Exercises	88
3	Embedded SQL	93
3.1	Host Variables	93
3.2	Indicator Variables	96
3.3	SQL Communications Area (<code>sqlca</code>)	97

3.5	Cursors	100	
3.6	Mail-Order Database Application	103	
3.6.1	Customer Functions	107	
3.6.2	Process Orders	112	
3.6.3	Delete Old Orders	115	
3.6.4	Print Order Invoice	115	
3.7	Recursive Queries	117	
3.8	Error Handling	120	
3.8.1	Explicit Handling	121	
3.8.2	Implicit Handling	123	
3.9	Transaction Control	124	
3.10	Dynamic SQL	125	
3.10.1	The <code>execute immediate</code> Statement	125	
3.10.2	The <code>prepare</code> and <code>execute using</code> Statements	126	
3.10.3	Dynamic Select	128	
3.11	Pro*C++	135	
3.11.1	Compiling Pro*C++ programs	135	
3.11.2	A Simple Query Example	135	
3.11.3	Multiple Answer Query using Cursors	138	
3.11.4	Dynamic SQL Query	142	
	Exercises	145	

4 PL/SQL 153

4.1	What Is PL/SQL?	153	
4.2	Data Types and Variables	154	
4.3	Program Control Statements	156	
4.3.1	<code>null</code> Statement	156	
4.3.2	Assignment Statement	156	
4.3.3	Conditional Statements	157	
4.3.4	Loops	160	
4.4	Program Structure	162	
4.4.1	Anonymous Blocks	162	
4.4.2	Procedures and Functions	163	
4.4.3	Stored Procedures and Functions	168	
4.4.4	Packages	170	
4.5	Triggers	174	
4.6	Database Access Using Cursors	179	
4.6.1	Explicit Cursors	179	

- 4.6.2 Parameterized Cursors 183
- 4.6.3 Select for Update 184
- 4.6.4 Cursor Variables 185
- 4.7 Records 188
 - 4.7.1 Table-Based Records 188
 - 4.7.2 Cursor-Based Records 189
 - 4.7.3 Programmer-Defined Records 190
- 4.8 PL/SQL Tables 191
- 4.9 Built-In Packages 194
 - 4.9.1 The `dbms_output` Package 194
 - 4.9.2 The `dbms_sql` Package 196
- 4.10 Error Handling 208
- 4.11 PL/SQL Access to Oracle8 Objects 212
 - 4.11.1 Declaring and Initializing Objects 212
 - 4.11.2 Object Type Method Implementation 213
 - 4.11.3 Accessing Database Objects in PL/SQL 215
 - 4.11.4 Accessing Varying Arrays in PL/SQL 217
 - 4.11.5 Built-In Methods for Collection Objects 219
- Exercises 220

5 Oracle JDBC 225

- 5.1 What Is JDBC? 225
- 5.2 A Simple JDBC Program 226
- 5.3 Developing JDBC Applications 227
 - 5.3.1 Loading the JDBC Drivers 228
 - 5.3.2 Connecting to the Database 228
 - 5.3.3 The `Connection` Object 229
- 5.4 Nonquery SQL Statements 231
 - 5.4.1 Using the `Statement` Object 232
 - 5.4.2 Using the `PreparedStatement` Object 235
 - 5.4.3 Using the `CallableStatement` Object 237
- 5.5 Executing SQL Queries 241
 - 5.5.1 The `ResultSet` Class 242
 - 5.5.2 `ResultSet` Methods 242
 - 5.5.3 An SQL Query Example 244
 - 5.5.4 `ResultSet` Metadata 248
 - 5.5.5 Oracle `REFCURSOR` Type 254
 - 5.5.6 Processing Multiple `ResultSets` 256
- 5.6 Grade Book Application 259
 - 5.6.1 Function `select_course` 260

5.6.2	Function <code>add_enrolls</code>	262
5.6.3	Function <code>add_scores</code>	263
5.6.4	Function <code>modify_score</code>	265
5.7	Database Metadata	266
5.8	Errors and Warnings	268
5.8.1	The <code>SQLException</code> Class	268
5.8.2	The <code>SQLWarning</code> Class	269
5.8.3	The <code>DataTruncation</code> Class	270
	Exercises	271
<hr/>		
6	SQLJ: Embedded SQL in Java	277
6.1	What is SQLJ?	277
6.2	Simple Example	278
6.3	Compiling SQLJ Programs	280
6.4	Multiple Connections	281
6.5	Host Variables and Expressions	284
6.6	SQLJ Iterators	285
6.6.1	Named Iterators	285
6.6.2	Positional Iterators	290
6.7	Dynamic SQL using JDBC	292
6.8	Calling PL/SQL from within SQLJ	294
6.9	Investment Portfolio Database Application	298
	Exercises	310
<hr/>		
7	Projects	313
7.1	Airline Flight Information System	314
7.2	Library Database Application	315
7.3	University Student Database	317
7.4	Video Chain Database	318
7.5	Banking Database	320
7.6	BiBTeX Database	321
7.7	Music Store Database	323
7.8	Online Auctions Database	324
7.9	Oracle Data Dictionary Browser	325
	Suggested Readings	327
	Index	329

Oracle Programming/Database

ORACLE⁸™ PROGRAMMING

A PRIMER

Rajshekhar Sunderraman, Georgia State University

This programming companion provides a streamlined approach to Oracle SQL, the most prevalent database language used in industry and on campus today. This book focuses on the most up-to-date aspects of Oracle8 and is designed as a detailed guide for new users of this application. Readers of this primer will be able to complete projects in a number of different programming environments (PRO*C/C++, PL/SQL, JDBC, and SQLJ). This book is suitable for use as a supplement in a database course that uses Oracle, as well as a reference for those in a nonacademic environment interested in learning about Oracle.

HIGHLIGHTS

- Covers the basics of programming with Oracle
- Presents new material on Pro*C++
- Includes a new chapter on SQLJ
- Devotes a complete chapter to JDBC
- Introduces Oracle8 objects
- Suggests an extensive list of problems and projects that reflect Oracle8

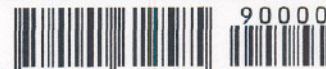
ABOUT THE AUTHOR

Rajshekhar Sunderraman is an associate professor of computer science at Georgia State University in Atlanta, Georgia. Professor Sunderraman received his Ph.D. in computer science from Iowa State University and has been teaching computer science for more than 10 years. He has published numerous articles on a wide range of topics, including inconsistencies in relational databases, negation in deductive databases, declarative specification of objects in object-oriented databases, and database querying of Web data.

For more information about
Addison-Wesley Computer Science books, visit us at
www.awlonline.com/cs

ADDISON-WESLEY

Addison-Wesley is an imprint
of Addison Wesley Longman, Inc.



9 780201 612585

ISBN 0-201-61258-5