Sams Teach Yourself SQL in 10 Minutes, Third Edition @Team DDU

Table of Contents

[1. Sams Teach Yourself SQL in 10 Minutes, Third Edition 6](#_Toc352165144)

[2. Table of Contents 6](#_Toc352165145)

[3. Copyright 6](#_Toc352165146)

[4. About the Author 8](#_Toc352165147)

[5. Acknowledgments 9](#_Toc352165148)

[6. We Want to Hear from You! 9](#_Toc352165149)

[7. Introduction 10](#_Toc352165150)

[7.1 Who is the Teach Yourself SQL Book For? 11](#_Toc352165151)

[7.2 DBMSs Covered in This Book 11](#_Toc352165152)

[7.3 Conventions Used in This Book 11](#_Toc352165153)

[8. Lesson 1. Understanding SQL 12](#_Toc352165154)

[8.1 Database Basics 12](#_Toc352165155)

[8.2 What Is SQL? 17](#_Toc352165156)

[8.3 Try It Yourself 17](#_Toc352165157)

[8.4 Summary 18](#_Toc352165158)

[9. Lesson 2. Retrieving Data 18](#_Toc352165159)

[9.1 The SELECT Statement 18](#_Toc352165160)

[9.2 Retrieving Individual Columns 19](#_Toc352165161)

[9.3 Retrieving Multiple Columns 21](#_Toc352165162)

[9.4 Retrieving All Columns 22](#_Toc352165163)

[9.5 Summary 23](#_Toc352165164)

[10. Lesson 3. Sorting Retrieved Data 23](#_Toc352165165)

[10.1 Sorting Data 23](#_Toc352165166)

[10.2 Sorting by Multiple Columns 26](#_Toc352165167)

[10.3 Sorting by Column Position 27](#_Toc352165168)

[10.4 Specifying Sort Direction 29](#_Toc352165169)

[10.5 Summary 31](#_Toc352165170)

[11. Lesson 4. Filtering Data 31](#_Toc352165171)

[11.1 Using the WHERE Clause 32](#_Toc352165172)

[11.2 The WHERE Clause Operators 33](#_Toc352165173)

[11.3 Summary 39](#_Toc352165174)

[12. Lesson 5. Advanced Data Filtering 39](#_Toc352165175)

[12.1 Combining WHERE Clauses 39](#_Toc352165176)

[12.2 Using the IN Operator 44](#_Toc352165177)

[12.3 Using the NOT Operator 46](#_Toc352165178)

[12.4 Summary 48](#_Toc352165179)

[13. Lesson 6. Using Wildcard Filtering 48](#_Toc352165180)

[13.1 Using the LIKE Operator 48](#_Toc352165181)

[13.2 Tips for Using Wildcards 55](#_Toc352165182)

[13.3 Summary 56](#_Toc352165183)

[14. Lesson 7. Creating Calculated Fields 56](#_Toc352165184)

[14.1 Understanding Calculated Fields 56](#_Toc352165185)

[14.2 Concatenating Fields 57](#_Toc352165186)

[14.3 Performing Mathematical Calculations 64](#_Toc352165187)

[14.4 Summary 66](#_Toc352165188)

[15. Lesson 8. Using Data Manipulation Functions 67](#_Toc352165189)

[15.1 Understanding Functions 67](#_Toc352165190)

[15.2 Using Functions 68](#_Toc352165191)

[15.3 Summary 75](#_Toc352165192)

[16. Lesson 9. Summarizing Data 76](#_Toc352165193)

[16.1 Using Aggregate Functions 76](#_Toc352165194)

[16.2 Aggregates on Distinct Values 83](#_Toc352165195)

[16.3 Combining Aggregate Functions 85](#_Toc352165196)

[16.4 Summary 86](#_Toc352165197)

[17. Lesson 10. Grouping Data 86](#_Toc352165198)

[17.1 Understanding Data Grouping 86](#_Toc352165199)

[17.2 Creating Groups 87](#_Toc352165200)

[17.3 Filtering Groups 89](#_Toc352165201)

[17.4 Grouping and Sorting 92](#_Toc352165202)

[17.5 SELECT Clause Ordering 95](#_Toc352165203)

[17.6 Summary 95](#_Toc352165204)

[18. Lesson 11. Working with Subqueries 96](#_Toc352165205)

[18.1 Understanding Subqueries 96](#_Toc352165206)

[18.2 Filtering by Subquery 96](#_Toc352165207)

[18.3 Using Subqueries As Calculated Fields 101](#_Toc352165208)

[18.4 Summary 104](#_Toc352165209)

[19. Lesson 12. Joining Tables 105](#_Toc352165210)

[19.1 Understanding Joins 105](#_Toc352165211)

[19.2 Creating a Join 107](#_Toc352165212)

[19.3 Summary 116](#_Toc352165213)

[20. Lesson 13. Creating Advanced Joins 116](#_Toc352165214)

[20.1 Using Table Aliases 116](#_Toc352165215)

[20.2 Using Different Join Types 117](#_Toc352165216)

[20.3 Using Joins with Aggregate Functions 125](#_Toc352165217)

[20.4 Using Joins and Join Conditions 127](#_Toc352165218)

[20.5 Summary 127](#_Toc352165219)

[21. Lesson 14. Combining Queries 128](#_Toc352165220)

[21.1 Understanding Combined Queries 128](#_Toc352165221)

[21.2 Creating Combined Queries 128](#_Toc352165222)

[21.3 Summary 135](#_Toc352165223)

[22. Lesson 15. Inserting Data 135](#_Toc352165224)

[22.1 Understanding Data Insertion 135](#_Toc352165225)

[22.2 Copying from One Table to Another 143](#_Toc352165226)

[22.3 Summary 144](#_Toc352165227)

[23. Lesson 16. Updating and Deleting Data 144](#_Toc352165228)

[23.1 Updating Data 144](#_Toc352165229)

[23.2 Deleting Data 147](#_Toc352165230)

[23.3 Guidelines for Updating and Deleting Data 148](#_Toc352165231)

[23.4 Summary 149](#_Toc352165232)

[24. Lesson 17. Creating and Manipulating Tables 149](#_Toc352165233)

[24.1 Creating Tables 149](#_Toc352165234)

[24.2 Updating Tables 155](#_Toc352165235)

[24.3 Deleting Tables 156](#_Toc352165236)

[24.4 Renaming Tables 157](#_Toc352165237)

[24.5 Summary 157](#_Toc352165238)

[25. Lesson 18. Using Views 158](#_Toc352165239)

[25.1 Understanding Views 158](#_Toc352165240)

[25.2 Creating Views 161](#_Toc352165241)

[25.3 Summary 169](#_Toc352165242)

[26. Lesson 19. Working with Stored Procedures 169](#_Toc352165243)

[26.1 Understanding Stored Procedures 169](#_Toc352165244)

[26.2 Why to Use Stored Procedures 170](#_Toc352165245)

[26.3 Executing Stored Procedures 172](#_Toc352165246)

[26.4 Creating Stored Procedures 173](#_Toc352165247)

[26.5 Summary 177](#_Toc352165248)

[27. Lesson 20. Managing Transaction Processing 177](#_Toc352165249)

[27.1 Understanding Transaction Processing 177](#_Toc352165250)

[27.2 Controlling Transactions 179](#_Toc352165251)

[27.3 Summary 184](#_Toc352165252)

[28. Lesson 21. Using Cursors 184](#_Toc352165253)

[28.1 Understanding Cursors 184](#_Toc352165254)

[28.2 Working with Cursors 185](#_Toc352165255)

[28.3 Summary 191](#_Toc352165256)

[29. Lesson 22. Understanding Advanced SQL Features 191](#_Toc352165257)

[29.1 Understanding Constraints 191](#_Toc352165258)

[29.2 Understanding Indexes 197](#_Toc352165259)

[29.3 Understanding Triggers 199](#_Toc352165260)

[29.4 Database Security 201](#_Toc352165261)

[29.5 Summary 201](#_Toc352165262)

[30. Appendix A. Sample Table Scripts 202](#_Toc352165263)

[30.1 Understanding the Sample Tables 202](#_Toc352165264)

[30.2 Obtaining the Sample Tables 205](#_Toc352165265)

[31. Appendix B. Working in Popular Applications 207](#_Toc352165266)

[31.1 Using Aqua Data Studio 207](#_Toc352165267)

[31.2 Using DB2 208](#_Toc352165268)

[31.3 Using Macromedia ColdFusion 208](#_Toc352165269)

[31.4 Using Microsoft Access 209](#_Toc352165270)

[31.5 Using Microsoft ASP 210](#_Toc352165271)

[31.6 Using Microsoft ASP.NET 210](#_Toc352165272)

[31.7 Using Microsoft Query 211](#_Toc352165273)

[31.8 Using Microsoft SQL Server 211](#_Toc352165274)

[31.9 Using MySQL 212](#_Toc352165275)

[31.10 Using Oracle 212](#_Toc352165276)

[31.11 Using PHP 213](#_Toc352165277)

[31.12 Using PostgreSQL 213](#_Toc352165278)

[31.13 Using Query Tool 213](#_Toc352165279)

[31.14 Using Sybase 214](#_Toc352165280)

[31.15 Configuring ODBC Data Sources 214](#_Toc352165281)

[32. Appendix C. SQL Statement Syntax 215](#_Toc352165282)

[32.1 ALTER TABLE 216](#_Toc352165283)

[32.2 COMMIT 216](#_Toc352165284)

[32.3 CREATE INDEX 216](#_Toc352165285)

[32.4 CREATE PROCEDURE 217](#_Toc352165286)

[32.5 CREATE TABLE 217](#_Toc352165287)

[32.6 CREATE VIEW 218](#_Toc352165288)

[32.7 DELETE 218](#_Toc352165289)

[32.8 DROP 219](#_Toc352165290)

[32.9 INSERT 219](#_Toc352165291)

[32.10 INSERT SELECT 219](#_Toc352165292)

[32.11 ROLLBACK 220](#_Toc352165293)

[32.12 SELECT 220](#_Toc352165294)

[32.13 UPDATE 221](#_Toc352165295)

[33. Appendix D. Using SQL Datatypes 221](#_Toc352165296)

[33.1 String Datatypes 222](#_Toc352165297)

[33.2 Numeric Datatypes 223](#_Toc352165298)

[33.3 Date and Time Datatypes 224](#_Toc352165299)

[33.4 Binary Datatypes 225](#_Toc352165300)

[34. Appendix E. SQL Reserved Words 226](#_Toc352165301)

[35. Index 231](#_Toc352165302)

[35.1 index\_SYMBOL 231](#_Toc352165303)

[35.2 index\_A 231](#_Toc352165304)

[35.3 index\_B 233](#_Toc352165305)

[35.4 index\_C 234](#_Toc352165306)

[35.5 index\_D 238](#_Toc352165307)

[35.6 index\_E 241](#_Toc352165308)

[35.7 index\_F 242](#_Toc352165309)

[35.8 index\_G 244](#_Toc352165310)

[35.9 index\_H 245](#_Toc352165311)

[35.10 index\_I 245](#_Toc352165312)

[35.11 index\_J 246](#_Toc352165313)

[35.12 index\_K 247](#_Toc352165314)

[35.13 index\_L 247](#_Toc352165315)

[35.14 index\_M 248](#_Toc352165316)

[35.15 index\_N 249](#_Toc352165317)

[35.16 index\_O 250](#_Toc352165318)

[35.17 index\_P 251](#_Toc352165319)

[35.18 index\_Q 253](#_Toc352165320)

[35.19 index\_R 254](#_Toc352165321)

[35.20 index\_S 256](#_Toc352165322)

[35.21 index\_T 262](#_Toc352165323)

[35.22 index\_U 265](#_Toc352165324)

[35.23 index\_V 266](#_Toc352165325)

[35.24 index\_W 267](#_Toc352165326)

[35.25 index\_Y 268](#_Toc352165327)

# 1. Sams Teach Yourself SQL in 10 Minutes, Third Edition

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Sams Teach Yourself SQL in 10 Minutes has established itself as the gold standard for introductory SQL books, offering a fast-paced accessible tutorial to the major themes and techniques involved in applying the SQL language. Forta's examples are clear and his writing style is crisp and concise. As with earlier editions, this revision includes coverage of current versions of all major commercial SQL platforms. New this time around is coverage of MySQL, and PostgreSQL. All examples have been tested against each SQL platform, with incompatibilities or platform distinctives called out and explained.

# 2. Table of Contents

|  |  |  |
| --- | --- | --- |
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# 5. Acknowledgments

Thanks to the team at Sams for all these years of support, dedication, and encouragement. A special thank you to Mike Stephens and Mark Renfrow for shepherding this new edition from concept to reality (a process that required them to occasionally shepherd me, too).

Thanks to the many hundreds of you who provided feedback on the first two editions of this book. Fortunately, most of it was positive, and all of it was appreciated. The enhancements and changes in this edition are a direct response to your feedback.

And finally, thanks to the many thousands of you who bought the previous editions of this book (in English, and in any of the many translations), making it not just my best-selling title, but also one of the best-selling books on the subject. Your continued support is the highest compliment an author can ever be paid.

# 6. We Want to Hear from You!

As the reader of this book, you are our most important critic and commentator. We value your opinion and want to know what we're doing right, what we could do better, what areas you'd like to see us publish in, and any other words of wisdom you're willing to pass our way.

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# 7. Introduction

SQL is the most widely used database language. Whether you are an application developer, database administrator, Web application designer, or Microsoft Office user, a good working knowledge of SQL is an important part of interacting with databases.

This book was born out of necessity. I had been teaching Web application development for several years, and students were constantly asking for SQL book recommendations. There are lots of SQL books out there. Some are actually very good. But they all have one thing in common: for most users they teach just too much information. Instead of teaching SQL itself most books teach everything from database design and normalization to relational database theory and administrative concerns. And while those are all important topics, they are not of interest to most of us who just need to learn SQL.

And so, not finding a single book that I felt comfortable recommending, I turned that classroom experience into the book you are holding. Sams Teach Yourself SQL in 10 Minutes will teach you SQL you need to know, starting with simple data retrieval and working on to more complex topics including the use of joins, subqueries, stored procedures, cursors, triggers, and table constraints. You'll learn methodically, systematically, and simply-in lessons that will each take 10 minutes or less to complete.

Now in its third edition, this book has taught SQL to hundreds of thousands of users, and now it is your turn. So turn to [Lesson 1](#Bookmark10)(See 8.), and get to work. You'll be writing world class SQL in no time at all.

## 7.1 Who is the Teach Yourself SQL Book For?

* You are new to SQL.
* You want to quickly learn how to get the most out of SQL.
* You want to learn how to use SQL in your own application development.
* You want to be productive quickly and easily in SQL without having to call someone for help.

## 7.2 DBMSs Covered in This Book

For the most part, the SQL taught in this book will apply to any Database Management System (DBMS). However, as all SQL implementations are not created equal, the following DBMSs are explicitly covered (and specific instructions or notes are included where needed):

* IBM DB2
* Microsoft Access
* Microsoft SQL Server
* MySQL
* Oracle
* PostgreSQL
* Sybase Adaptive Server

Example databases and SQL scripts are also available for all of these DBMSs.

## 7.3 Conventions Used in This Book

This book uses different typefaces to differentiate between code and regular English, and also to help you identify important concepts.

Text that you type and text that should appear on your screen is presented in monospace type.

It will look like this to mimic the way text looks on your screen.

Placeholders for variables and expressions appear in *monospace italic* font. You should replace the placeholder with the specific value it represents.

This arrow (说明: graphics/ccc.gif) at the beginning of a line of code means that a single line of code is too long to fit on the printed page. Continue typing all the characters after the 说明: graphics/ccc.gifas though they were part of the preceding line.

|  |  |
| --- | --- |
| 说明: graphics/note_icon.gif | A Note presents interesting pieces of information related to the surrounding discussion. |

|  |  |
| --- | --- |
| 说明: graphics/tip_icon.gif | A Tip offers advice or teaches an easier way to do something. |

|  |  |
| --- | --- |
| 说明: graphics/caution_icon.gif | A Caution advises you about potential problems and helps you steer clear of disaster. |

|  |  |
| --- | --- |
| 说明: graphics/newterm_icon.gif | New Term icons provide clear definitions of new, essential terms. |

|  |  |
| --- | --- |
| 说明: graphics/input_icon.jpg | The Input icon identifies code that you can type in yourself. |

|  |  |
| --- | --- |
| 说明: graphics/output_icon.jpg | The Output icon highlights the output produced by running a program. |

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | The Analysis icon alerts you to the author's line-by-line analysis of a program. |

# 8. Lesson 1. Understanding SQL

|  |
| --- |
| In this lesson, you'll learn exactly what SQL is and what it will do for you. |

## 8.1 Database Basics

The fact that you are reading a book on SQL indicates that you, somehow, need to interact with databases. SQL is a language used to do just this, so before looking at SQL itself, it is important that you understand some basic concepts about databases and database technologies.

Whether you are aware of it or not, you use databases all the time. Each time you select a name from your email address book, you are using a database. If you conduct a search on an Internet search site, you are using a database. When you log into your network at work, you are validating your name and password against a database. Even when you use your ATM card at a cash machine, you are using databases for PIN number verification and balance checking.

But even though we all use databases all the time, there remains much confusion over what exactly a database is. This is especially true because different people use the same database terms to mean different things. Therefore, a good place to start our study is with a list and explanation of the most important database terms.

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| 说明: graphics/caution_icon.gif | Reviewing Basic Concepts What follows is a very brief overview of some basic database concepts. It is intended to either jolt your memory if you already have some database experience, or to provide you with the absolute basics, if you are new to databases. Understanding databases is an important part of mastering SQL, and you might want to find a good book on database fundamentals to brush up on the subject if needed. |

**What Is a Database?**

The term database is used in many different ways, but for our purposes (and indeed, from SQL's perspective) a database is a collection of data stored in some organized fashion. The simplest way to think of it is to imagine a database as a filing cabinet. The filing cabinet is simply a physical location to store data, regardless of what that data is or how it is organized.

|  |  |
| --- | --- |
| 说明: graphics/newterm_icon.gif | Database A container (usually a file or set of files) to store organized data. |

|  |  |
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| 说明: graphics/caution_icon.gif | Misuse Causes Confusion People often use the term database to refer to the database software they are running. This is incorrect, and it is a source of much confusion. Database software is actually called the Database Management System (or DBMS). The database is the container created and manipulated via the DBMS. A database might be a file stored on a hard drive, but it might not. And for the most part this is not even significant as you never access a database directly anyway; you always use the DBMS and it accesses the database for you. |

**Tables**

When you store information in your filing cabinet you don't just toss it in a drawer. Rather, you create files within the filing cabinet, and then you file related data in specific files.

In the database world, that file is called a table. A table is a structured file that can store data of a specific type. A table might contain a list of customers, a product catalog, or any other list of information.

|  |  |
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| 说明: graphics/newterm_icon.gif | Table A structured list of data of a specific type. |

The key here is that the data stored in the table is one type of data or one list. You would never store a list of customers and a list of orders in the same database table. Doing so would make subsequent retrieval and access difficult. Rather, you'd create two tables, one for each list.

Every table in a database has a name that identifies it. That name is always unique-meaning no other table in that database can have the same name.

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| 说明: graphics/note_icon.gif | Table Names What makes a table name unique is actually a combination of several things including the database name and table name. Some databases also use the name of the database owner as part of the unique name. This means that while you cannot use the same table name twice in the same database, you definitely can reuse table names in different databases. |

Tables have characteristics and properties that define how data is stored in them. These include information about what data may be stored, how it is broken up, how individual pieces of information are named, and much more. This set of information that describes a table is known as a schema, and schema are used to describe specific tables within a database, as well as entire databases (and the relationship between tables in them, if any).

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| --- | --- |
| 说明: graphics/newterm_icon.gif | Schema Information about database and table layout and properties. |

**Columns and Datatypes**

Tables are made up of columns. A column contains a particular piece of information within a table.

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| 说明: graphics/newterm_icon.gif | Column A single field in a table. All tables are made up of one or more columns. |

The best way to understand this is to envision database tables as grids, somewhat like spreadsheets. Each column in the grid contains a particular piece of information. In a customer table, for example, one column contains the customer number, another contains the customer name, and the address, city, state, and zip are all stored in their own columns.

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| 说明: graphics/tip_icon.gif | Breaking Up Data It is extremely important to break data into multiple columns correctly. For example, city, state, and zip should always be separate columns. By breaking these out, it becomes possible to sort or filter data by specific columns (for example, to find all customers in a particular state or in a particular city). If city and state are combined into one column, it would be extremely difficult to sort or filter by state. |

Each column in a database has an associated datatype. A datatype defines what type of data the column can contain. For example, if the column is to contain a number (perhaps the number of items in an order), the datatype would be a numeric datatype. If the column were to contain dates, text, notes, currency amounts, and so on, the appropriate datatype would be used to specify this.

|  |  |
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| 说明: graphics/newterm_icon.gif | Datatype A type of allowed data. Every table column has an associated datatype that restricts (or allows) specific data in that column. |

Datatypes restrict the type of data that can be stored in a column (for example, preventing the entry of alphabetical characters into a numeric field). Datatypes also help sort data correctly, and play an important role in optimizing disk usage. As such, special attention must be given to picking the right datatype when tables are created.

|  |  |
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| 说明: graphics/caution_icon.gif | Datatype Compatibility Datatypes and their names are one of the primary sources of SQL incompatibility. While most basic datatypes are supported consistently, many more advanced datatypes are not. And worse, occasionally you'll find that the same datatype is referred to by different names in different DBMSs. There is not much you can do about this, but it is important to keep in mind when you create table schemas. |

**Rows**

Data in a table is stored in rows; each record saved is stored in its own row. Again, envisioning a table as a spreadsheet style grid, the vertical columns in the grid are the table columns, and the horizontal rows are the table rows.

For example, a customers table might store one customer per row. The number of rows in the table is the number of records in it.

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| 说明: graphics/newterm_icon.gif | Row A record in a table. |

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| --- | --- |
| 说明: graphics/note_icon.gif | Records or Rows? You may hear users refer to database records when referring to rows. For the most part, the two terms are used interchangeably, but row is technically the correct term. |

**Primary Keys**

Every row in a table should have some column (or set of columns) that uniquely identifies it. A table containing customers might use a customer number column for this purpose, whereas a table containing orders might use the order ID. An employee list table might use an employee ID or the employee social security number column.

|  |  |
| --- | --- |
| 说明: graphics/newterm_icon.gif | Primary Key A column (or set of columns) whose values uniquely identify every row in a table. |

This column (or set of columns) that uniquely identifies each row in a table is called a primary key. The primary key is used to refer to a specific row. Without a primary key, updating or deleting specific rows in a table becomes extremely difficult as there is no guaranteed safe way to refer to just the rows to be affected.

|  |  |
| --- | --- |
| 说明: graphics/tip_icon.gif | Always Define Primary Keys Although primary keys are not actually required, most database designers ensure that every table they create has a primary key so that future data manipulation is possible and manageable. |

Any column in a table can be established as the primary key, as long as it meets the following conditions:

* No two rows can have the same primary key value.
* Every row must have a primary key value (primary key columns may not allow NULL values).
* Values in primary key columns can never be modified or updated.
* Primary key values can never be reused. (If a row is deleted from the table, its primary key may not be assigned to any new rows in the future.)

Primary keys are usually defined on a single column within a table. But this is not required, and multiple columns may be used together as a primary key. When multiple columns are used, the rules listed above must apply to all columns that make up the primary key, and the values of all columns together must be unique (individual columns need not have unique values).

There is another very important type of key called a foreign key, but I'll get to that later on in [Lesson 12](#Bookmark66)(See 19.), "Joining Tables."

## 8.2 What Is SQL?

SQL (pronounced as the letters S-Q-L or as sequel) is an abbreviation for Structured Query Language. SQL is a language designed specifically for communicating with databases.

Unlike other languages (spoken languages like English, or programming languages like Java or Visual Basic), SQL is made up of very few words. This is deliberate. SQL is designed to do one thing and do it well-provide you with a simple and efficient way to read and write data from a database.

What are the advantages of SQL?

* SQL is not a proprietary language used by specific database vendors. Almost every major DBMS supports SQL, so learning this one language will enable you to interact with just about every database you'll run into.
* SQL is easy to learn. The statements are all made up of descriptive English words, and there aren't that many of them.
* Despite its apparent simplicity, SQL is actually a very powerful language, and by cleverly using its language elements you can perform very complex and sophisticated database operations.

And with that, let's learn SQL.

|  |  |
| --- | --- |
| 说明: graphics/note_icon.gif | SQL Extensions Many DBMS vendors have extended their support for SQL by adding statements or instructions to the language. The purpose of these extensions is to provide additional functionality or simplified ways to perform specific operations. And while often extremely useful, these extensions tend to be very DBMS specific, and they are rarely supported by more than a single vendor.  Standard SQL is governed by the ANSI standards committee, and is thus called ANSI SQL. All major DBMSs, even those with their own extensions, support ANSI SQL. Individual implementations have their own names (PL-SQL, Transact-SQL, and so forth).  For the most part, the SQL taught in this book is ANSI SQL. On the odd occasion where DBMS specific SQL is used it is so noted. |

## 8.3 Try It Yourself

Like any language, the best way to learn SQL is to try it for yourself. To do this you'll need a database and an application with which to test your SQL statements.

All of the lessons in this book use real SQL statements and real database tables. [Appendix A](#Bookmark119)(See 30.), "Sample Table Scripts," explains what the example tables are, and provides details on how to obtain (or create) them so that you may follow along with the instructions in each lesson. [Appendix B](#Bookmark122)(See 31.), "Working in Popular Applications," describes the steps needed to execute your SQL in a variety of applications. Before proceeding to the next lesson, I'd strongly suggest that you turn to these two appendixes so that you'll be ready to follow along.

## 8.4 Summary

In this first lesson, you learned what SQL is and why it is useful. Because SQL is used to interact with databases, you also reviewed some basic database terminology.

# 9. Lesson 2. Retrieving Data

|  |
| --- |
| In this lesson, you'll learn how to use the *SELECT* statement to retrieve one or more columns of data from a table. |

## 9.1 The SELECT Statement

As explained in [Lesson 1](#Bookmark10)(See 8.), "Understanding SQL," SQL statements are made up of plain English terms. These terms are called keywords, and every SQL statement is made up of one or more keywords. The SQL statement that you'll probably use most frequently is the SELECT statement. Its purpose is to retrieve information from one or more tables.

|  |  |
| --- | --- |
| 说明: graphics/newterm_icon.gif | Keyword A reserved word that is part of the SQL language. Never name a table or column using a keyword. [Appendix E](#Bookmark157)(See 34.), "SQL Reserved Words," lists some of the more common reserved words. |

To use SELECT to retrieve table data you must, at a minimum, specify two pieces of information-what you want to select, and from where you want to select it.

|  |
| --- |
| Following Along with the Examples The sample SQL statements (and sample output) throughout the lessons in this book use a set of data files that are described in [Appendix A](#Bookmark119)(See 30.), "Sample Table Scripts." If you'd like to follow along and try the examples yourself (I strongly recommend that you do so), refer to [Appendix A](#Bookmark119)(See 30.) which contains instructions on how to download or create these data files.  It is important to understand that SQL is a language, not an application. The way that you specify SQL statements and display statement output varies from one application to the next. To assist you in adapting the examples to your own environment, [Appendix B](#Bookmark122)(See 31.), "Working in Popular Applications," explains how to issue the statements taught throughout this book using many popular applications and development environments. And if you need an application with which to follow along, [Appendix B](#Bookmark122)(See 31.) has recommendations for you too. |

## 9.2 Retrieving Individual Columns

We'll start with a simple SQL SELECT statement, as follows:

说明: graphics/input_icon.jpg

SELECT prod\_name

FROM Products;

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | The statement above uses the SELECT statement to retrieve a single column called prod\_name from the Products table. The desired column name is specified right after the SELECT keyword, and the FROM keyword specifies the name of the table from which to retrieve the data. The output from this statement is shown in the following: |

说明: graphics/output_icon.jpg

prod\_name

--------------------

Fish bean bag toy

Bird bean bag toy

Rabbit bean bag toy

8 inch teddy bear

12 inch teddy bear

18 inch teddy bear

Raggedy Ann

King doll

Queen doll

|  |  |
| --- | --- |
| 说明: graphics/note_icon.gif | Unsorted Data If you tried this query yourself you might have discovered that the data was displayed in a different order than shown here. If this is the case, don't worry-it is working exactly as it is supposed to. If query results are not explicitly sorted (we'll get to that in the next lesson) then data will be returned in no order of any significance. It may be the order in which the data was added to the table, but it may not. As long as your query returned the same number of rows then it is working. |

A simple SELECT statement like the one used above returns all the rows in a table. Data is not filtered (so as to retrieve a subset of the results), nor is it sorted. We'll discuss these topics in the next few lessons.

|  |  |
| --- | --- |
| 说明: graphics/tip_icon.gif | Use of White Space All extra white space within a SQL statement is ignored when that statement is processed. SQL statements can be specified on one long line or broken up over many lines. Most SQL developers find that breaking up statements over multiple lines makes them easier to read and debug. |

|  |  |
| --- | --- |
| 说明: graphics/note_icon.gif | Terminating Statements Multiple SQL statements must be separated by semicolons (the ; character). Most DBMSs do not require that a semicolon be specified after single statements. But if your particular DBMS complains, you might have to add it there. Of course, you can always add a semicolon if you wish. It'll do no harm, even if it is, in fact, not needed. The exception to this rule is Sybase Adaptive Server which does not like SQL statements ending with ;.  SQL Statement and Case It is important to note that SQL statements are case-insensitive, so SELECT is the same as select, which is the same as Select. Many SQL developers find that using uppercase for all SQL keywords and lowercase for column and table names makes code easier to read and debug. However, be aware that while the SQL language is case-insensitive, the names of tables, columns, and values may not be (that depends on your DBMS and how it is configured). |

## 9.3 Retrieving Multiple Columns

To retrieve multiple columns from a table, the same SELECT statement is used. The only difference is that multiple column names must be specified after the SELECT keyword, and each column must be separated by a comma.

|  |  |
| --- | --- |
| 说明: graphics/tip_icon.gif | Take Care with Commas When selecting multiple columns be sure to specify a comma between each column name, but not after the last column name. Doing so will generate an error. |

The following SELECT statement retrieves three columns from the products table:

说明: graphics/input_icon.jpg

SELECT prod\_id, prod\_name, prod\_price

FROM Products;

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | Just as in the prior example, this statement uses the SELECT statement to retrieve data from the Products table. In this example, three column names are specified, each separated by a comma. The output from this statement is shown below: |

说明: graphics/output_icon.jpg

prod\_id prod\_name prod\_price

--------- -------------------- ----------

BNBG01 Fish bean bag toy 3.4900

BNBG02 Bird bean bag toy 3.4900

BNBG03 Rabbit bean bag toy 3.4900

BR01 8 inch teddy bear 5.9900

BR02 12 inch teddy bear 8.9900

BR03 18 inch teddy bear 11.9900

RGAN01 Raggedy Ann 4.9900

RYL01 King doll 9.4900

RYL02 Queen dool 9.4900

|  |  |
| --- | --- |
| 说明: graphics/note_icon.gif | Presentation of Data As you will notice in the above output, SQL statements typically return raw, unformatted data. Data formatting is a presentation issue, not a retrieval issue. Therefore, presentation (for example, displaying the above price values as currency amounts with the correct number of decimal places) is typically specified in the application that displays the data. Actual retrieved data (without application-provided formatting) is rarely used. |

## 9.4 Retrieving All Columns

In addition to being able to specify desired columns (one or more, as seen above), SELECT statements can also request all columns without having to list them individually. This is done using the asterisk (\*) wildcard character in lieu of actual column names, as follows:

说明: graphics/input_icon.jpg

SELECT \*

FROM Products;

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | When a wildcard (\*) is specified, all the columns in the table are returned. The column order will typically, but not always, be the physical order in which the columns appear in the table definition. However, SQL data is seldom displayed as is. (Usually, it is returned to an application that formats or presents the data as needed.) As such, this should not pose a problem. |

|  |  |
| --- | --- |
| 说明: graphics/caution_icon.gif | Using Wildcards As a rule, you are better off not using the \* wildcard unless you really do need every column in the table. Even though use of wildcards may save you the time and effort needed to list the desired columns explicitly, retrieving unnecessary columns usually slows down the performance of your retrieval and your application. |

|  |  |
| --- | --- |
| 说明: graphics/tip_icon.gif | Retrieving Unknown Columns There is one big advantage to using wildcards. As you do not explicitly specify column names (because the asterisk retrieves every column), it is possible to retrieve columns whose names are unknown. |

## 9.5 Summary

In this lesson, you learned how to use the SQL SELECT statement to retrieve a single table column, multiple table columns, and all table columns. Next you'll learn how to sort the retrieved data.

# 10. Lesson 3. Sorting Retrieved Data

|  |
| --- |
| In this lesson, you will learn how to use the *SELECT* statement's *ORDER BY* clause to sort retrieved data as needed. |

## 10.1 Sorting Data

As you learned in the last lesson, the following SQL statement returns a single column from a database table. But look at the output. The data appears to be displayed in no particular order at all.

说明: graphics/input_icon.jpg

SELECT prod\_name

FROM Products;

说明: graphics/output_icon.jpg

prod\_name

--------------------

Fish bean bag toy

Bird bean bag toy

Rabbit bean bag toy

8 inch teddy bear

12 inch teddy bear

18 inch teddy bear

Raggedy Ann

King doll

Queen doll

Actually, the retrieved data is not displayed in a mere random order. If unsorted, data will typically be displayed in the order in which it appears in the underlying tables. This could be the order in which the data was added to the tables initially. However, if data was subsequently updated or deleted, the order will be affected by how the DBMS reuses reclaimed storage space. The end result is that you cannot (and should not) rely on the sort order if you do not explicitly control it. Relational database design theory states that the sequence of retrieved data cannot be assumed to have significance if ordering was not explicitly specified.

|  |  |
| --- | --- |
| 说明: graphics/newterm_icon.gif | Clause SQL statements are made up of clauses, some required and some optional. A clause usually consists of a keyword and supplied data. An example of this is the SELECT statement's FROM clause, which you saw in the last lesson. |

To explicitly sort data retrieved using a SELECT statement, the ORDER BY clause is used. ORDER BY takes the name of one or more columns by which to sort the output. Look at the following example:

说明: graphics/input_icon.jpg

SELECT prod\_name

FROM Products

ORDER BY prod\_name;

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | This statement is identical to the earlier statement, except it also specifies an ORDER BY clause instructing the Database Management System software to sort the data alphabetically by the prod\_name column. The results are as follows: |

说明: graphics/output_icon.jpg

prod\_name

--------------------

12 inch teddy bear

18 inch teddy bear

8 inch teddy bear

Bird bean bag toy

Fish bean bag toy

King doll

Queen doll

Rabbit bean bag toy

Raggedy Ann

|  |  |
| --- | --- |
| 说明: graphics/caution_icon.gif | Position of **ORDER BY** Clause When specifying an ORDER BY clause, be sure that it is the last clause in your SELECT statement. Using clauses out of order will generate an error message. |

|  |  |
| --- | --- |
| 说明: graphics/tip_icon.gif | Sorting by Nonselected Columns More often than not, the columns used in an ORDER BY clause will be ones that were selected for display. However, this is actually not required, and it is perfectly legal to sort data by a column that is not retrieved. |

## 10.2 Sorting by Multiple Columns

It is often necessary to sort data by more than one column. For example, if you are displaying an employee list, you might want to display it sorted by last name and first name (first by last name, and then within each last name sort by first name). This would be useful if there are multiple employees with the same last name.

To sort by multiple columns, simply specify the column names separated by commas (just as you do when you are selecting multiple columns).

The following code retrieves three columns and sorts the results by two of them-first by price and then by name.

说明: graphics/input_icon.jpg

SELECT prod\_id, prod\_price, prod\_name

FROM Products

ORDER BY prod\_price, prod\_name;

说明: graphics/output_icon.jpg

prod\_id prod\_price prod\_name

------- ---------- --------------------

BNBG02 3.4900 Bird bean bag toy

BNBG01 3.4900 Fish bean bag toy

BNBG03 3.4900 Rabbit bean bag toy

RGAN01 4.9900 Raggedy Ann

BR01 5.9900 8 inch teddy bear

BR02 8.9900 12 inch teddy bear

RYL01 9.4900 King doll

RYL02 9.4900 Queen doll

BR03 11.9900 18 inch teddy bear

It is important to understand that when you are sorting by multiple columns, the sort sequence is exactly as specified. In other words, using the output in the example above, the products are sorted by the prod\_name column only when multiple rows have the same prod\_price value. If all the values in the prod\_price column had been unique, no data would have been sorted by prod\_name.

## 10.3 Sorting by Column Position

In addition to being able to specify sort order using column names, ORDER BY also supports ordering specified by relative column position. The best way to understand this is to look at an example:

说明: graphics/input_icon.jpg

SELECT prod\_id, prod\_price, prod\_name

FROM Products

ORDER BY 2, 3;

说明: graphics/output_icon.jpg

prod\_id prod\_price prod\_name

------- ---------- --------------------

BNBG02 3.4900 Bird bean bag toy

BNBG01 3.4900 Fish bean bag toy

BNBG03 3.4900 Rabbit bean bag toy

RGAN01 4.9900 Raggedy Ann

BR01 5.9900 8 inch teddy bear

BR02 8.9900 12 inch teddy bear

RYL01 9.4900 King doll

RYL02 9.4900 Queen doll

BR03 11.9900 18 inch teddy bear

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | As you can see, the output is identical to that of the query above. The difference here is in the ORDER BY clause. Instead of specifying column names, the relative positions of selected columns in the SELECT list are specified. ORDER BY 2 means sort by the second column in the SELECT list, the prod\_price column. ORDER BY 2, 3 means sort by prod\_price and then by prod\_name. |

The primary advantage of this technique is that it saves retyping the column names. But there are some downsides too. First, not explicitly listing column names increases the likelihood of you mistakenly specifying the wrong column. Second, it is all too easy to mistakenly reorder data when making changes to the SELECT list (forgetting to make the corresponding changes to the ORDER BY clause). And finally, obviously you cannot use this technique when sorting by columns that are not in the SELECT list.

|  |  |
| --- | --- |
| 说明: graphics/tip_icon.gif | Sorting by Nonselected Columns Obviously, this technique cannot be used when sorting by columns that do not appear in the SELECT list. However, you can mix and match actual column names and relative column positions in a single statement if needed. |

## 10.4 Specifying Sort Direction

Data sorting is not limited to ascending sort orders (from A to Z). Although this is the default sort order, the ORDER BY clause can also be used to sort in descending order (from Z to A). To sort by descending order, the keyword DESC must be specified.

The following example sorts the products by price in descending order (most expensive first):

说明: graphics/input_icon.jpg

SELECT prod\_id, prod\_price, prod\_name

FROM Products

ORDER BY prod\_price DESC;

说明: graphics/output_icon.jpg

prod\_id prod\_price prod\_name

------- ---------- --------------------

BR03 11.9900 18 inch teddy bear

RYL01 9.4900 King doll

RYL02 9.4900 Queen doll

BR02 8.9900 12 inch teddy bear

BR01 5.9900 8 inch teddy bear

RGAN01 4.9900 Raggedy Ann

BNBG01 3.4900 Fish bean bag toy

BNBG02 3.4900 Bird bean bag toy

BNBG03 3.4900 Rabbit bean bag toy

But what if you were to sort by multiple columns? The following example sorts the products in descending order (most expensive first), plus product name:

说明: graphics/input_icon.jpg

SELECT prod\_id, prod\_price, prod\_name

FROM Products

ORDER BY prod\_price DESC, prod\_name;

说明: graphics/output_icon.jpg

prod\_id prod\_price prod\_name

------- ---------- --------------------

BR03 11.9900 18 inch teddy bear

RYL01 9.4900 King doll

RYL02 9.4900 Queen doll

BR02 8.9900 12 inch teddy bear

BR01 5.9900 8 inch teddy bear

RGAN01 4.9900 Raggedy Ann

BNBG02 3.4900 Bird bean bag toy

BNBG01 3.4900 Fish bean bag toy

BNBG03 3.4900 Rabbit bean bag toy

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | The DESC keyword only applies to the column name that directly precedes it. In the example above, DESC was specified for the prod\_price column, but not for the prod\_name column. Therefore, the prod\_price column is sorted in descending order, but the prod\_name column (within each price) is still sorted in standard ascending order. |

|  |  |
| --- | --- |
| 说明: graphics/tip_icon.gif | Sorting Descending on Multiple Columns If you want to sort descending on multiple columns, be sure each column has its own DESC keyword. |

It is worth noting that DESC is short for DESCENDING, and both keywords may be used. The opposite of DESC is ASC (or ASCENDING), which may be specified to sort in ascending order. In practice, however, ASC is not usually used because ascending order is the default sequence (and is assumed if neither ASC nor DESC are specified).

|  |  |
| --- | --- |
| 说明: graphics/tip_icon.gif | Case Sensitivity and Sort Orders When you are sorting textual data, is A the same as a? And does a come before B or after Z? These are not theoretical questions, and the answers depend on how the database is set up.  In dictionary sort order, A is treated the same as a, and that is the default behavior for most Database Management Systems. However, most good DBMSs enable database administrators to change this behavior if needed. (If your database contains lots of foreign language characters, this might become necessary.)  The key here is that if you do need an alternate sort order, you cannot accomplish it with a simple ORDER BY clause. You must contact your database administrator. |

## 10.5 Summary

In this lesson, you learned how to sort retrieved data using the SELECT statement's ORDER BY clause. This clause, which must be the last in the SELECT statement, can be used to sort data on one or more columns as needed.

# 11. Lesson 4. Filtering Data

|  |
| --- |
| In this lesson, you will learn how to use the *SELECT* statement's *WHERE* clause to specify search conditions. |

## 11.1 Using the WHERE Clause

Database tables usually contain large amounts of data, and you seldom need to retrieve all the rows in a table. More often than not you'll want to extract a subset of the table's data as needed for specific operations or reports. Retrieving just the data you want involves specifying search criteria, also known as a filter condition.

Within a SELECT statement, data is filtered by specifying search criteria in the WHERE clause. The WHERE clause is specified right after the table name (the FROM clause) as follows:

说明: graphics/input_icon.jpg

SELECT prod\_name, prod\_price

FROM Products

WHERE prod\_price = 3.49;

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | This statement retrieves two columns from the products table, but instead of returning all rows, only rows with a prod\_price value of 3.49 are returned, as follows: |

说明: graphics/output_icon.jpg

prod\_name prod\_price

------------------- ----------

Fish bean bag toy 3.4900

Bird bean bag toy 3.4900

Rabbit bean bag toy 3.4900

This example uses a simple equality test: It checks to see if a column has a specified value, and it filters the data accordingly. But SQL lets you do more than just test for equality.

|  |  |
| --- | --- |
| 说明: graphics/caution_icon.gif | Picky PostgreSQL PostgreSQL has very strict rules governing the values passed to SQL statements, especially pertaining to numbers used with decimal columns. As such, the previous example may not work as is on PostgreSQL. To get this example to work you may need to explicitly tell PostgreSQL that 3.49 is a valid number by including the type in the WHERE clause. To do this, replace = 3.49 with = decimal '3.49'. |

|  |  |
| --- | --- |
| 说明: graphics/tip_icon.gif | SQL Versus Application Filtering Data can also be filtered at the application level. To do this, the SQL SELECT statement retrieves more data than is actually required for the client application, and the client code loops through the returned data to extract just the needed rows.  As a rule, this practice is strongly discouraged. Databases are optimized to perform filtering quickly and efficiently. Making the client application (or development language) do the databases job will dramatically impact application performance and will create applications that cannot scale properly. In addition, if data is filtered at the client, the server has to send unneeded data across the network connections, resulting in a waste of network bandwidth usage. |

|  |  |
| --- | --- |
| 说明: graphics/caution_icon.gif | **WHERE** Clause Position When using both ORDER BY and WHERE clauses, make sure that ORDER BY comes after the WHERE, otherwise an error will be generated. (See [Lesson 3](#Bookmark21)(See 10.), "Sorting Retrieved Data," for more information on using ORDER BY.) |

## 11.2 The WHERE Clause Operators

The first WHERE clause we looked at tests for equality-determining if a column contains a specific value. SQL supports a whole range of conditional operators as listed in [Table 4.1](#Bookmark29_ch04table01).

| **Table 4.1. WHERE Clause Operators** | |
| --- | --- |
| Operator | Description |
| = | Equality |
| <> | Nonequality |
| != | Nonequality |
| < | Less than |
| <= | Less than or equal to |
| !< | Not less than |
| > | Greater than |
| >= | Greater than or equal to |
| !> | Not greater than |
| BETWEEN | Between two specified values |
| IS NULL | Is a NULL value |

|  |  |
| --- | --- |
| 说明: graphics/caution_icon.gif | Operator Compatibility Some of the operators listed in [Table 4.1](#Bookmark29_ch04table01) are redundant (for example, <> is the same as !=. !< (not less than) accomplishes the same effect as >= (greater than or equal to). Not all of these operators are supported by all DBMSs. Refer to your DBMS documentation to determine exactly what it supports. |

**Checking against a Single Value**

We have already seen an example of testing for equality. Let's take a look at a few examples to demonstrate the use of other operators.

This first example lists all products that cost less than $10:

说明: graphics/input_icon.jpg

SELECT prod\_name, prod\_price

FROM Products

WHERE prod\_price < 10;

说明: graphics/output_icon.jpg

prod\_name prod\_price

------------------- ----------

Fish bean bag toy 3.4900

Bird bean bag toy 3.4900

Rabbit bean bag toy 3.4900

8 inch teddy bear 5.9900

12 inch teddy bear 8.9900

Raggedy Ann 4.9900

King doll 9.4900

Queen doll 9.4900

This next statement retrieves all products costing $10 or less (although the result will be the same as in the previous example because there are no items with a price of exactly $10):

说明: graphics/input_icon.jpg

SELECT prod\_name, prod\_price

FROM Products

WHERE prod\_price <= 10;

**Checking for Nonmatches**

This next example lists all products not made by vendor DLL01:

说明: graphics/input_icon.jpg

SELECT vend\_id, prod\_name

FROM Products

WHERE vend\_id <> 'DLL01';

说明: graphics/output_icon.jpg

vend\_id prod\_name

---------- ------------------

BRS01 8 inch teddy bear

BRS01 12 inch teddy bear

BRS01 18 inch teddy bear

FNG01 King doll

FNG01 Queen doll

|  |  |
| --- | --- |
| 说明: graphics/tip_icon.gif | When to Use Quotes If you look closely at the conditions used in the above WHERE clauses, you will notice that some values are enclosed within single quotes, and others are not. The single quotes are used to delimit a string. If you are comparing a value against a column that is a string datatype, the delimiting quotes are required. Quotes are not used to delimit values used with numeric columns. |

The following is the same example, except this one uses the != operator instead of <>:

说明: graphics/input_icon.jpg

SELECT vend\_id, prod\_name

FROM Products

WHERE vend\_id != 'DLL01';

|  |  |
| --- | --- |
| 说明: graphics/caution_icon.gif | **!=** Or **<>**? != and <> can usually be used interchangeably. However, not all DBMSs support both forms of the nonequality operator. Microsoft Access, for example, supports <> but does not support !=. If in doubt, consult your DBMSs documentation. |

**Checking for a Range of Values**

To check for a range of values, you can use the BETWEEN operator. Its syntax is a little different from other WHERE clause operators because it requires two values: the beginning and end of the range. The BETWEEN operator can be used, for example, to check for all products that cost between $5 and $10 or for all dates that fall between specified start and end dates.

The following example demonstrates the use of the BETWEEN operator by retrieving all products with a price between $5 and $10:

说明: graphics/input_icon.jpg

SELECT prod\_name, prod\_price

FROM Products

WHERE prod\_price BETWEEN 5 AND 10;

说明: graphics/output_icon.jpg

prod\_name prod\_price

------------------- ----------

8 inch teddy bear 5.9900

12 inch teddy bear 8.9900

King doll 9.4900

Queen doll 9.4900

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | As seen in this example, when BETWEEN is used, two values must be specified-the low end and high end of the desired range. The two values must also be separated by the AND keyword. BETWEEN matches all the values in the range, including the specified start and end values. |

**Checking for No Value**

When a table is created, the table designer can specify whether or not individual columns can contain no value. When a column contains no value, it is said to contain a NULL value.

|  |  |
| --- | --- |
| 说明: graphics/newterm_icon.gif | NULL No value, as opposed to a field containing 0, or an empty string, or just spaces. |

The SELECT statement has a special WHERE clause that can be used to check for columns with NULL values-the IS NULL clause. The syntax looks like this:

说明: graphics/input_icon.jpg

SELECT prod\_name

FROM Products

WHERE prod\_price IS NULL;

This statement returns a list of all products that have no price (an empty prod\_price field, not a price of 0), and because there are none, no data is returned. The Vendors table, however, does contain columns with NULL values-the vend\_state column will contain NULL if there is no state (as would be the case with non-U.S. addresses):

说明: graphics/input_icon.jpg

SELECT vend\_id

FROM Vendors

WHERE vend\_state IS NULL;

说明: graphics/output_icon.jpg

vend\_id

--------------

FNG01

JTS01

|  |  |
| --- | --- |
| 说明: graphics/tip_icon.gif | DBMS Specific Operators Many DBMSs extend the standard set of operators, providing advanced filtering options. Refer to your DBMS documentation for more information. |

## 11.3 Summary

In this lesson, you learned how to filter returned data using the SELECT statement's WHERE clause. You learned how to test for equality, nonequality, greater than and less than, value ranges, as well as for NULL values.

# 12. Lesson 5. Advanced Data Filtering

In this lesson, you'll learn how to combine *WHERE* clauses to create powerful and sophisticated search conditions. You'll also learn how to use the *NOT* and *IN* operators.

## 12.1 Combining WHERE Clauses

All the WHERE clauses introduced in [Lesson 4](#Bookmark27)(See 11.), "Filtering Data," filter data using a single criteria. For a greater degree of filter control, SQL lets you specify multiple WHERE clauses. These clauses may be used in two ways: as AND clauses or as OR clauses.

|  |  |
| --- | --- |
| 说明: graphics/newterm_icon.gif | Operator A special keyword used to join or change clauses within a WHERE clause. Also known as logical operators. |

**Using the AND Operator**

To filter by more than one column, you use the AND operator to append conditions to your WHERE clause. The following code demonstrates this:

说明: graphics/input_icon.jpg

SELECT prod\_id, prod\_price, prod\_name

FROM Products

WHERE vend\_id = 'DLL01' AND prod\_price <= 4;

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | The above SQL statement retrieves the product name and price for all products made by vendor DLL01 as long as the price is $4 or less. The WHERE clause in this SELECT statement is made up of two conditions, and the keyword AND is used to join them. AND instructs the database management system software to return only rows that meet all the conditions specified. If a product is made by vendor DLL01, but it costs more than $4, it is not retrieved. Similarly, products that cost less than $4 that are made by a vendor other than the one specified are not to be retrieved. The output generated by this SQL statement is as follows: |

说明: graphics/output_icon.jpg

prod\_id prod\_price prod\_name

------- ---------- --------------------

BNBG02 3.4900 Bird bean bag toy

BNBG01 3.4900 Fish bean bag toy

BNBG03 3.4900 Rabbit bean bag toy

|  |  |
| --- | --- |
| 说明: graphics/newterm_icon.gif | **AND** A keyword used in a WHERE clause to specify that only rows matching all the specified conditions should be retrieved. |

**Using the OR Operator**

The OR operator is exactly the opposite of AND. The OR operator instructs the database management system software to retrieve rows that match either condition. In fact, most of the better DBMSs will not even evaluate the second condition in an OR WHERE clause if the first condition has already been met. (If the first condition was met, the row would be retrieved regardless of the second condition.)

Look at the following SELECT statement:

说明: graphics/input_icon.jpg

SELECT prod\_name, prod\_price

FROM Products

WHERE vend\_id = 'DLL01' OR vend\_id = 'BRS01';

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | The above SQL statement retrieves the product name and price for any products made by either of the two specified vendors. The OR operator tells the DBMS to match either condition, not both. If an AND operator is used here, no data is returned. The output generated by this SQL statement is as follows: |

说明: graphics/output_icon.jpg

prod\_name prod\_price

------------------- ----------

Fish bean bag toy 3.4900

Bird bean bag toy 3.4900

Rabbit bean bag toy 3.4900

8 inch teddy bear 5.9900

12 inch teddy bear 8.9900

18 inch teddy bear 11.9900

Raggedy Ann 4.9900

|  |  |
| --- | --- |
| 说明: graphics/newterm_icon.gif | **OR** A keyword used in a WHERE clause to specify that any rows matching either of the specified conditions should be retrieved. |

**Understanding Order of Evaluation**

WHERE clauses can contain any number of AND and OR operators. Combining the two enables you to perform sophisticated and complex filtering.

But combining AND and OR operators presents an interesting problem. To demonstrate this, look at an example. You need a list of all products costing $10 or more made by vendors DLL01 and BRS01. The following SELECT statement uses a combination of AND and OR operators to build a WHERE clause:

说明: graphics/input_icon.jpg

SELECT prod\_name, prod\_price

FROM Products

WHERE vend\_id = 'DLL01' OR vend\_id = 'BRS01'

AND prod\_price >= 10;

说明: graphics/output_icon.jpg

prod\_name prod\_price

------------------- ----------

Fish bean bag toy 3.4900

Bird bean bag toy 3.4900

Rabbit bean bag toy 3.4900

18 inch teddy bear 11.9900

Raggedy Ann 4.9900

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | Look at the results above. Four of the rows returned have prices less than $10-so, obviously, the rows were not filtered as intended. Why did this happen? The answer is the order of evaluation. SQL (like most languages) processes AND operators before OR operators. When SQL sees the above WHERE clause, it reads any products costing $10 or more made by vendor BRS01, and any products made by vendor DLL01 regardless of price. In other words, because AND ranks higher in the order of evaluation, the wrong operators were joined together. |

The solution to this problem is to use parentheses to explicitly group related operators. Take a look at the following SELECT statement and output:

说明: graphics/input_icon.jpg

SELECT prod\_name, prod\_price

FROM Products

WHERE (vend\_id = 'DLL01' OR vend\_id = 'BRS01')

AND prod\_price >= 10;

说明: graphics/output_icon.jpg

prod\_name prod\_price

------------------- ----------

18 inch teddy bear 11.9900

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | The only difference between this SELECT statement and the earlier one is that, in this statement, the first two WHERE clause conditions are enclosed within parentheses. As parentheses have a higher order of evaluation than either AND or OR operators, the DBMS first filters the OR condition within those parentheses. The SQL statement then becomes any products made by either vendor DLL01 or vendor BRS01 costing $10 or greater, which is exactly what we want. |

|  |  |
| --- | --- |
| 说明: graphics/tip_icon.gif | Using Parentheses in **WHERE** Clauses Whenever you write WHERE clauses that use both AND and OR operators, use parentheses to explicitly group operators. Don't ever rely on the default evaluation order, even if it is exactly what you want. There is no downside to using parentheses, and you are always better off eliminating any ambiguity. |

## 12.2 Using the IN Operator

The IN operator is used to specify a range of conditions, any of which can be matched. IN takes a comma-delimited list of valid values, all enclosed within parentheses. The following example demonstrates this:

说明: graphics/input_icon.jpg

SELECT prod\_name, prod\_price

FROM Products

WHERE vend\_id IN ('DLL01','BRS01')

ORDER BY prod\_name;

说明: graphics/output_icon.jpg

prod\_name prod\_price

------------------- ----------

12 inch teddy bear 8.9900

18 inch teddy bear 11.9900

8 inch teddy bear 5.9900

Bird bean bag toy 3.4900

Fish bean bag toy 3.4900

Rabbit bean bag toy 3.4900

Raggedy Ann 4.9900

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | The SELECT statement retrieves all products made by vendor DLL01 and vendor BRS01. The IN operator is followed by a comma-delimited list of valid values, and the entire list must be enclosed within parentheses. |

If you are thinking that the IN operator accomplishes the same goal as OR, you are right. The following SQL statement accomplishes the exact same thing as the example above:

说明: graphics/input_icon.jpg

SELECT prod\_name, prod\_price

FROM Products

WHERE vend\_id = 'DLL01' OR vend\_id = 'BRS01'

ORDER BY prod\_name;

说明: graphics/output_icon.jpg

prod\_name prod\_price

------------------- ----------

12 inch teddy bear 8.9900

18 inch teddy bear 11.9900

8 inch teddy bear 5.9900

Bird bean bag toy 3.4900

Fish bean bag toy 3.4900

Rabbit bean bag toy 3.4900

Raggedy Ann 4.9900

Why use the IN operator? The advantages are

* When you are working with long lists of valid options, the IN operator syntax is far cleaner and easier to read.
* The order of evaluation is easier to manage when IN is used (as there will be fewer operators used).
* IN operators almost always execute more quickly than lists of OR operators.
* The biggest advantage of IN is that the IN operator can contain another SELECT statement, enabling you to build highly dynamic WHERE clauses. You'll look at this in detail in [Lesson 11](#Bookmark61)(See 18.), "Working with Subqueries."

|  |  |
| --- | --- |
| 说明: graphics/newterm_icon.gif | **IN** A keyword used in a WHERE clause to specify a list of values to be matched using an OR comparison. |

## 12.3 Using the NOT Operator

The WHERE clause's NOT operator has one function and one function only-NOT negates whatever condition comes next. Because NOT is never used by itself (it is always used in conjunction with some other operator), its syntax is a little different from all other operators. Unlike other operators, NOT can be used before the column to filter on, not just after it.

|  |  |
| --- | --- |
| 说明: graphics/newterm_icon.gif | **NOT** A keyword used in a WHERE clause to negate a condition. |

The following example demonstrates the use of NOT. To list the products made by all vendors except vendor DLL01, you can write the following:

说明: graphics/input_icon.jpg

SELECT prod\_name

FROM Products

WHERE NOT vend\_id = 'DLL01'

ORDER BY prod\_name;

说明: graphics/output_icon.jpg

prod\_name

------------------

12 inch teddy bear

18 inch teddy bear

8 inch teddy bear

King doll

Queen doll

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | The NOT here negates the condition that follows it; so instead of matching vend\_id to DLL01, the DBMS matches vend\_id to anything that is not DLL01. |

The preceding example could have also been accomplished using the <> operator, as follows:

说明: graphics/input_icon.jpg

SELECT prod\_name

FROM Products

WHERE vend\_id <> 'DLL01'

ORDER BY prod\_name;

说明: graphics/output_icon.jpg

prod\_name

------------------

12 inch teddy bear

18 inch teddy bear

8 inch teddy bear

King doll

Queen doll

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | Why use NOT? Well, for simple WHERE clauses such as the ones shown here, there really is no advantage to using NOT. NOT is useful in more complex clauses. For example, using NOT in conjunction with an IN operator makes it simple to find all rows that do not match a list of criteria. |

|  |  |
| --- | --- |
| 说明: graphics/note_icon.gif | **NOT** in MySQL The form of NOT described here is not supported by MySQL. In MySQL NOT is only used to negate EXISTS (as in NOT EXISTS). |

## 12.4 Summary

This lesson picked up where the last lesson left off and taught you how to combine WHERE clauses with the AND and OR operators. You also learned how to explicitly manage the order of evaluation and how to use the IN and NOT operators.

# 13. Lesson 6. Using Wildcard Filtering

In this lesson, you'll learn what wildcards are, how they are used, and how to perform wildcard searches using the *LIKE* operator for sophisticated filtering of retrieved data.

## 13.1 Using the LIKE Operator

All the previous operators we studied filter against known values. Be it matching one or more values, testing for greater-than or less-than known values, or checking a range of values, the common denominator is that the values used in the filtering are known. But filtering data that way does not always work. For example, how could you search for all products that contained the text bean bag within the product name? That cannot be done with simple comparison operators; that's a job for wildcard searching. Using wildcards, you can create search patterns that can be compared against your data. In this example, if you want to find all products that contain the words bean bag, you can construct a wildcard search pattern enabling you to find that bean bag text anywhere within a product name.

|  |  |
| --- | --- |
| 说明: graphics/newterm_icon.gif | Wildcards Special characters used to match parts of a value. |

|  |  |
| --- | --- |
| 说明: graphics/newterm_icon.gif | Search pattern A search condition made up of literal text, wildcard characters, or any combination of the two. |

The wildcards themselves are actually characters that have special meanings within SQL WHERE clauses, and SQL supports several wildcard types.

To use wildcards in search clauses, the LIKE operator must be used. LIKE instructs the DBMS that the following search pattern is to be compared using a wildcard match rather than a straight equality match.

|  |  |
| --- | --- |
| 说明: graphics/note_icon.gif | Predicates When is an operator not an operator? When it is a predicate. Technically, LIKE is a predicate, not an operator. The end result is the same; just be aware of this term in case you run across it in SQL documentation or manuals. |

Wildcard searching can be used only with text fields (strings); you can't use wildcards to search fields of nontext datatypes.

**The Percent Sign (%) Wildcard**

The most frequently used wildcard is the percent sign (%). Within a search string, % means match any number of occurrences of any character. For example, to find all products that start with the word Fish, you can issue the following SELECT statement:

说明: graphics/input_icon.jpg

SELECT prod\_id, prod\_name

FROM Products

WHERE prod\_name LIKE 'Fish%';

说明: graphics/output_icon.jpg

prod\_id prod\_name

------- ------------------

BNBG01 Fish bean bag toy

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | This example uses a search pattern of 'Fish%'. When this clause is evaluated, any value that starts with Fish is retrieved. The % tells the DBMS to accept any characters after the word Fish, regardless of how many characters there are. |

|  |  |
| --- | --- |
| 说明: graphics/note_icon.gif | Microsoft Access Wildcards If you are using Microsoft Access, you might need to use \* instead of %. |

|  |  |
| --- | --- |
| 说明: graphics/note_icon.gif | Case-Sensitivity Depending on your DBMS and how it is configured, searches might be case-sensitive, in which case 'fish%' would not match Fish bean bag toy. |

Wildcards can be used anywhere within the search pattern, and multiple wildcards can be used as well. The following example uses two wildcards, one at either end of the pattern:

说明: graphics/input_icon.jpg

SELECT prod\_id, prod\_name

FROM Products

WHERE prod\_name LIKE '%bean bag%';

说明: graphics/output_icon.jpg

prod\_id prod\_name

-------- --------------------

BNBG01 Fish bean bag toy

BNBG02 Bird bean bag toy

BNBG03 Rabbit bean bag toy

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | The search pattern '%bean bag%' means match any value that contains the text bean bag anywhere within it, regardless of any characters before or after that text. |

Wildcards can also be used in the middle of a search pattern, although that is rarely useful. The following example finds all products that begin with an F and end with a y:

说明: graphics/input_icon.jpg

SELECT prod\_name

FROM Products

WHERE prod\_name LIKE 'F%y';

It is important to note that, in addition to matching one or more characters, % also matches zero characters. % represents zero, one, or more characters at the specified location in the search pattern.

|  |  |
| --- | --- |
| 说明: graphics/note_icon.gif | Watch for Trailing Spaces Many DBMSs, including Microsoft Access, pad field contents with spaces. For example, if a column expects 50 characters and the text stored is Fish bean bag toy (17 characters), 33 spaces might be appended to the text to fully fill the column. This usually has no real impact on data and how it is used, but it could negatively affect the previous SQL statement. The clause WHERE prod\_name LIKE 'F%y' matches only prod\_name if it starts with F and ends with y. If the value is padded with spaces, it does not end with y, so Fish bean bag toy is not retrieved. One simple solution to this problem is to append a second % to the search pattern: 'F%y%' also matches characters (or spaces) after the y. A better solution is to trim the spaces using functions, as is discussed in [Lesson 8](#Bookmark45)(See 15.), "Using Data Manipulation Functions." |

**The Underscore (\_) Wildcard**

Another useful wildcard is the underscore (\_). The underscore is used just like %, but instead of matching multiple characters, the underscore matches just a single character.

|  |  |
| --- | --- |
| 说明: graphics/note_icon.gif | Microsoft Access Wildcards If you are using Microsoft Access, you might need to use ? instead of \_. |

Take a look at this example:

说明: graphics/input_icon.jpg

SELECT prod\_id, prod\_name

FROM Products

WHERE prod\_name LIKE '\_\_ inch teddy bear';

|  |  |
| --- | --- |
| 说明: graphics/note_icon.gif | Watch for Trailing Spaces As in the previous example, you might have to append a wildcard to the pattern for this example to work. |

说明: graphics/output_icon.jpg

prod\_id prod\_name

-------- --------------------

BNBG02 12 inch teddy bear

BNBG03 18 inch teddy bear

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | The search pattern used in this WHERE clause specifies two wildcards followed by literal text. The results shown are the only rows that match the search pattern: The underscore matches 12 in the first row and 18 in the second row. The 8 inch teddy bear product did not match because the search pattern requires two wildcard matches, not one. By contrast, the following SELECT statement uses the % wildcard and returns three matching products: |

说明: graphics/input_icon.jpg

SELECT prod\_id, prod\_name

FROM Products

WHERE prod\_name LIKE '% inch teddy bear';

说明: graphics/output_icon.jpg

prod\_id prod\_name

-------- --------------------

BNBG01 8 inch teddy bear

BNBG02 12 inch teddy bear

BNBG03 18 inch teddy bear

Unlike %, which can match zero characters, \_ always matches one character-no more and no less.

**The Brackets ([]) Wildcard**

The brackets ([]) wildcard is used to specify a set of characters, any one of which must match a character in the specified position (the location of the wildcard).

|  |  |
| --- | --- |
| 说明: graphics/note_icon.gif | Sets Are Not Always Supported Unlike the wildcards described thus far, the use of [] to create sets is not supported by all DBMSs. Sets are supported by Microsoft Access, Microsoft SQL Server, and Sybase Adaptive Server. Consult your DBMS documentation to determine whether sets are supported. |

For example, to find all contacts whose names begin with the letter J or the letter M, you can do the following:

说明: graphics/input_icon.jpg

SELECT cust\_contact

FROM Customers

WHERE cust\_contact LIKE '[JM]%'

ORDER BY cust\_contact;

说明: graphics/output_icon.jpg

cust\_contact

-----------------

Jim Jones

John Smith

Michelle Green

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | The WHERE clause in this statement is '[JM]%'. This search pattern uses two different wildcards. The [JM] matches any contact name that begins with either of the letters within the brackets, and it also matches only a single character. Therefore, any names longer than one character do not match. The % wildcard after the [JM] matches any number of characters after the first character, returning the desired results. |

This wildcard can be negated by prefixing the characters with ^ (the carat character). For example, the following matches any contact name that does not begin with the letter J or the letter M (the opposite of the previous example):

说明: graphics/input_icon.jpg

SELECT cust\_contact

FROM Customers

WHERE cust\_contact LIKE '[^JM]%'

ORDER BY cust\_contact;

|  |  |
| --- | --- |
| 说明: graphics/note_icon.gif | Negating Sets in Microsoft Access If you are using Microsoft Access, you might need to use ! instead of ^ to negate a set-so use [!JM] instead of [^JM]. |

Of course, you can accomplish the same result using the NOT operator. The only advantage of ^ is that it can simplify the syntax if you are using multiple WHERE clauses:

说明: graphics/input_icon.jpg

SELECT cust\_contact

FROM Customers

WHERE NOT cust\_contact LIKE '[JM]%'

ORDER BY cust\_contact;

|  |  |
| --- | --- |
| 说明: graphics/caution_icon.gif | Caution The brackets ([]) wildcard is not supported by all DBMSs. Consult your DBMS documentation to find out whether this particular wildcard is supported. |

## 13.2 Tips for Using Wildcards

As you can see, SQL's wildcards are extremely powerful. But that power comes with a price: Wildcard searches typically take far longer to process than any other search types discussed previously. Here are some tips to keep in mind when using wildcards:

* Don't overuse wildcards. If another search operator will do, use it instead.
* When you do use wildcards, try to not use them at the beginning of the search pattern unless absolutely necessary. Search patterns that begin with wildcards are the slowest to process.
* Pay careful attention to the placement of the wildcard symbols. If they are misplaced, you might not return the data you intended.

Having said that, wildcards are an important and useful search tool, and one that you will use frequently.

## 13.3 Summary

In this lesson, you learned what wildcards are and how to use SQL wildcards within your WHERE clauses. You also learned that wildcards should be used carefully and never overused.

# 14. Lesson 7. Creating Calculated Fields

In this lesson, you will learn what calculated fields are, how to create them, and how to use aliases to refer to them from within your application.

## 14.1 Understanding Calculated Fields

Data stored within a database's tables is often not available in the exact format needed by your applications. Here are some examples:

* You need to display a field containing the name of a company along with the company's location, but that information is stored in separated table columns.
* City, state, and ZIP Code are stored in separate columns (as they should be), but your mailing label printing program needs them retrieved as one correctly formatted field.
* Column data is in mixed upper- and lowercase, and your report needs all data presented in uppercase.
* An Order Items table stores item price and quantity but not the expanded price (price multiplied by quantity) of each item. To print invoices, you need that expanded price.
* You need total, averages, or other calculations based on table data.

In each of these examples, the data stored in the table is not exactly what your application needs. Rather than retrieve the data as it is and then reformat it within your client application or report, what you really want is to retrieve converted, calculated, or reformatted data directly from the database.

This is where calculated fields come in. Unlike all the columns we retrieved in the lessons thus far, calculated fields don't actually exist in database tables. Rather, a calculated field is created on-the-fly within a SQL SELECT statement.

|  |  |
| --- | --- |
| 说明: graphics/newterm_icon.gif | Field Essentially means the same thing as column and often is used interchangeably, although database columns are typically called columns and the term fields is normally used in conjunction with calculated fields. |

It is important to note that only the database knows which columns in a SELECT statement are actual table columns and which are calculated fields. From the perspective of a client (for example, your application), a calculated field's data is returned in the same way as data from any other column.

|  |  |
| --- | --- |
| 说明: graphics/tip_icon.gif | Client Versus Server Formatting Many of the conversions and reformatting that can be performed within SQL statements can also be performed directly in your client application. However, as a rule, it is far quicker to perform these operations on the database server than it is to perform them within the client because DBMSs are built to perform this type of processing quickly and efficiently. |

## 14.2 Concatenating Fields

To demonstrate working with calculated fields, let's start with a simple example-creating a title made up of two columns.

The Vendors table contains vendor name and address information. Imagine that you are generating a vendor report and need to list the vendor location as part of the vendor name in the format name (location).

The report wants a single value, and the data in the table is stored in two columns: vend\_name and vend\_country. In addition, you need to surround vend\_country with parenthesis, and those are definitely not stored in the database table. The SELECT statement that returns the vendor names and locations is simple enough, but how would you create this combined value?

|  |  |
| --- | --- |
| 说明: graphics/newterm_icon.gif | Concatenate Joining values together (by appending them to each other) to form a single long value. |

The solution is to concatenate the two columns. In SQL SELECT statements, you can concatenate columns using a special operator. Depending on which DBMS you are using, this can be a plus sign (+) or two pipes (||).

|  |  |
| --- | --- |
| 说明: graphics/note_icon.gif | **+** or **||**? Access, SQL Server, and Sybase support + for concatenation. DB2, Oracle, PostgreSQL, and Sybase support ||. Refer to your DBMS documentation for more details.  || is actually the preferred syntax, so more and more DBMSs are implementing support for it. |

Here's an example using the plus sign (the syntax used by most DBMSs):

说明: graphics/input_icon.jpg

SELECT vend\_name + ' (' + vend\_country + ')'

FROM Vendors

ORDER BY vend\_name;

说明: graphics/output_icon.jpg

----------------------------------------------------

Bear Emporium (USA )

Bears R Us (USA )

Doll House Inc. (USA )

Fun and Games (England )

Furball Inc. (USA )

Jouets et ours (France )

The following is the same statement, but using the || syntax:

说明: graphics/input_icon.jpg

SELECT vend\_name || ' (' || vend\_country || ')'

FROM Vendors

ORDER BY vend\_name;

说明: graphics/output_icon.jpg

----------------------------------------------------

Bear Emporium (USA )

Bears R Us (USA )

Doll House Inc. (USA )

Fun and Games (England )

Furball Inc. (USA )

Jouets et ours (France )

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | The previous SELECT statements concatenate the following elements: |

* The name stored in the vend\_name column
* A string containing a space and an open parenthesis
* The state stored in the vend\_country column
* A string containing the close parenthesis

As you can see in the output shown previously, the SELECT statement returns a single column (a calculated field) containing all four of these elements as one unit.

|  |  |
| --- | --- |
| 说明: graphics/note_icon.gif | Concatenation in MySQL MySQL does not support concatenation using + or ||. Rather, it requires the use of a CONCAT() function that takes a list of items to be concatenated. Using CONCAT(), the first line of the example would be as follows:  SELECT CONCAT(vend\_name, ' (', vend\_country, ')'  MySQL does support the use of ||, but not for concatenation. In MySQL || is equivalent to the operator OR, and && is equivalent to the operator AND. |

Look again at the output returned by the SELECT statement. The two columns incorporated into the calculated field are padded with spaces. Many databases (although not all) save text values padded to the column width. To return the data formatted properly, you must trim those padded spaces. This can be done using the SQL RTRIM() function, as follows:

说明: graphics/input_icon.jpg

SELECT RTRIM(vend\_name) + ' (' + RTRIM(vend\_country) + ')'

FROM Vendors

ORDER BY vend\_name;

说明: graphics/output_icon.jpg

----------------------------------------------------

Bear Emporium (USA)

Bears R Us (USA)

Doll House Inc. (USA)

Fun and Games (England)

Furball Inc. (USA)

Jouets et ours (France)

The following is the same statement, but using the || syntax:

说明: graphics/input_icon.jpg

SELECT RTRIM(vend\_name) || ' (' || RTRIM(vend\_country) || ')'

FROM Vendors

ORDER BY vend\_name;

说明: graphics/output_icon.jpg

----------------------------------------------------

Bear Emporium (USA)

Bears R Us (USA)

Doll House Inc. (USA)

Fun and Games (England)

Furball Inc. (USA)

Jouets et ours (France)

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | The RTRIM() function trims all space from the right of a value. By using RTRIM(), the individual columns are all trimmed properly. A comma and space separate the city and state, and a space separates the state and ZIP Code. |

|  |  |
| --- | --- |
| 说明: graphics/note_icon.gif | The **TRIM** Functions Most DBMSs support RTRIM() (which, as just seen, trims the right side of a string), as well as LTRIM() (which trims the left side of a string), and TRIM() (which trims both the right and left). |

**Using Aliases**

The SELECT statement used to concatenate the address field works well, as seen in the previous output. But what is the name of this new calculated column? Well, the truth is, it has no name; it is simply a value. Although this can be fine if you are just looking at the results in a SQL query tool, an unnamed column cannot be used within a client application because the client has no way to refer to that column.

To solve this problem, SQL supports column aliases. An alias is just that, an alternative name for a field or value. Aliases are assigned with the AS keyword. Take a look at the following SELECT statement:

说明: graphics/input_icon.jpg

SELECT RTRIM(vend\_name) + ' (' + RTRIM(vend\_country) + ')' AS vend\_title

FROM Vendors

ORDER BY vend\_name;

说明: graphics/output_icon.jpg

vend\_title

----------------------------------------------------

Bear Emporium (USA)

Bears R Us (USA)

Doll House Inc. (USA)

Fun and Games (England)

Furball Inc. (USA)

Jouets et ours (France)

The following is the same statement, but using the || syntax:

说明: graphics/input_icon.jpg

SELECT RTRIM(vend\_name) || ' (' || RTRIM(vend\_country) || ')' AS vend\_title

FROM Vendors

ORDER BY vend\_name;

说明: graphics/output_icon.jpg

vend\_title

----------------------------------------------------

Bear Emporium (USA)

Bears R Us (USA)

Doll House Inc. (USA)

Fun and Games (England)

Furball Inc. (USA)

Jouets et ours (France)

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | The SELECT statement itself is the same as the one used in the previous code snippet, except that here the calculated field is followed by the text AS vend\_title. This instructs SQL to create a calculated field named vend\_title containing the calculation specified. As you can see in the output, the results are the same as before, but the column is now named vend\_title and any client application can refer to this column by name, just as it would to any actual table column. |

|  |  |
| --- | --- |
| 说明: graphics/tip_icon.gif | Other Uses for Aliases Aliases have other uses, too. Some common uses include renaming a column if the real table column name contains illegal characters (for example, spaces) and expanding column names if the original names are either ambiguous or easily misread. |

|  |  |
| --- | --- |
| 说明: graphics/caution_icon.gif | Alias Names Aliases can be single words or complete strings. If the latter is used, the string should be enclosed within quotes. This practice is legal but is strongly discouraged. Although multiword names are indeed highly readable, they create all sorts of problems for many client applications. So much so that one of the most common uses of aliases is to rename multiword column names to single-word names (as explained previously). |

|  |  |
| --- | --- |
| 说明: graphics/note_icon.gif | Derived Columns Aliases are also sometimes referred to as derived columns, so regardless of the term you run across, they mean the same thing. |

## 14.3 Performing Mathematical Calculations

Another frequent use for calculated fields is performing mathematical calculations on retrieved data. Let's take a look at an example. The Orders table contains all orders received, and the OrderItems table contains the individual items within each order. The following SQL statement retrieves all the items in order number 20008:

说明: graphics/input_icon.jpg

SELECT prod\_id, quantity, item\_price

FROM OrderItems

WHERE order\_num = 20008;

说明: graphics/output_icon.jpg

prod\_id quantity item\_price

---------- ----------- ---------------------

RGAN01 5 4.9900

BR03 5 11.9900

BNBG01 10 3.4900

BNBG02 10 3.4900

BNBG03 10 3.4900

The item\_price column contains the per unit price for each item in an order. To expand the item price (item price multiplied by quantity ordered), you simply do the following:

说明: graphics/input_icon.jpg

SELECT prod\_id,

quantity,

item\_price,

quantity\*item\_price AS expanded\_price

FROM OrderItems

WHERE order\_num = 20008;

说明: graphics/output_icon.jpg

prod\_id quantity item\_price expanded\_price

------- -------- ---------- --------------

RGAN01 5 4.9900 24.9500

BR03 5 11.9900 59.9500

BNBG01 10 3.4900 34.9000

BNBG02 10 3.4900 34.9000

BNBG03 10 3.4900 34.9000

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | The expanded\_price column shown in the previous output is a calculated field; the calculation is simply quantity\*item\_price. The client application can now use this new calculated column just as it would any other column. |

SQL supports the basic mathematical operators listed in [Table 7.1](#Bookmark43_ch07table01). In addition, parentheses can be used to establish order of precedence. Refer to [Lesson 5](#Bookmark31)(See 12.), "Advanced Data Filtering," for an explanation of precedence.

| **Table 7.1. SQL Mathematical Operators** | |
| --- | --- |
| Operator | Description |
| + | Addition |
| - | Subtraction |
| \* | Multiplication |
| / | Division |

## 14.4 Summary

In this lesson, you learned what calculated fields are and how to create them. We used examples demonstrating the use of calculated fields for both string concatenation and mathematical operations. In addition, you learned how to create and use aliases so your application can refer to calculated fields.

# 15. Lesson 8. Using Data Manipulation Functions

In this lesson, you'll learn what functions are, what types of functions DBMSs support, and how to use these functions. You'll also learn why

## 15.1 Understanding Functions

Like almost any other computer language, SQL supports the use of functions to manipulate data. Functions are operations that are usually performed on data, usually to facilitate conversion and manipulation.

An example of a function is the RTRIM() that we used in the last lesson to trim any spaces from the end of a string.

**The Problem with Functions**

Before you work through this lesson and try the examples, you should be aware that using SQL functions can be highly problematic.

Unlike SQL statements (for example, SELECT), which for the most part are supported by all DBMSs equally, functions tend to be very DBMS specific. In fact, very few functions are supported identically by all major DBMSs. Although all types of functionality are usually available in each DBMS, the implementation of that functionality can differ greatly. To demonstrate just how problematic this can be, [Table 8.1](#Bookmark46_ch08table01) lists three commonly needed functions and their syntax as employed by various DBMSs:

| **Table 8.1. DBMS Function Differences** | |
| --- | --- |
| Function | Syntax |
| Extract part of a string | Access uses MID(). DB2, Oracle, and PostgreSQL use SUBSTR(). MySQL, SQL Server, and Sybase use SUBSTRING(). |
| Datatype conversion | Access and Oracle use multiple functions, one for each conversion type. DB2 and PostgreSQL use CAST(). MySQL, SQL Server, and Sybase use CONVERT(). |
| Get current date | Access uses NOW(). DB2 and PostgreSQL use CURRENT\_DATE. MySQL uses CURDATE(). Oracle uses SYSDATE. SQL Server and Sybase use GETDATE(). |

As you can see, unlike SQL statements, SQL functions are not portable. This means that code you write for a specific SQL implementation might not work on another implementation.

|  |  |
| --- | --- |
| 说明: graphics/newterm_icon.gif | Portable Code that is written so that it will run on multiple systems. |

With code portability in mind, many SQL programmers opt not to use any implementation-specific features. Although this is a somewhat noble and idealistic view, it is not always in the best interests of application performance. If you opt not to use these functions, you make your application code work harder. It must use other methods to do what the DBMS could have done more efficiently.

|  |  |
| --- | --- |
| 说明: graphics/tip_icon.gif | Should You Use Functions? So now you are trying to decide whether you should or shouldn't use functions. Well, that decision is yours, and there is no right or wrong choice. If you do decide to use functions, make sure you comment your code well, so that at a later date you (or another developer) will know exactly what SQL implementation you were writing to. |

## 15.2 Using Functions

Most SQL implementations support the following types of functions:

* Text functions are used to manipulate strings of text (for example, trimming or padding values and converting values to upper and lowercase).
* Numeric functions are used to perform mathematical operations on numeric data (for example, returning absolute numbers and performing algebraic calculations).
* Date and time functions are used to manipulate date and time values and to extract specific components from these values (for example, returning differences between dates, and checking date validity).
* System functions return information specific to the DBMS being used (for example, returning user login information).

In the last lesson, you saw a function used as part of a column list in a SELECT statement, but that's not all functions can do. You can use functions in other parts of the SELECT statement (for instance in the WHERE clause), as well as in other SQL statements (more on that in later lessons).

**Text Manipulation Functions**

You've already seen an example of text-manipulation functions in the last lesson-the RTRIM() function was used to trim white space from the end of a column value. Here is another example, this time using the UPPER() function:

说明: graphics/input_icon.jpg

SELECT vend\_name, UPPER(vend\_name)

AS vend\_name\_upcase

FROM Vendors

ORDER BY vend\_name;

说明: graphics/output_icon.jpg

vend\_name vend\_name\_upcase

----------------------------- -------------------

Bear Emporium BEAR EMPORIUM

Bears R Us BEARS R US

Doll House Inc. DOLL HOUSE INC.

Fun and Games FUN AND GAMES

Furball Inc. FURBALL INC.

Jouets et ours JOUETS ET OURS

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | As you can see, UPPER() converts text to upper-case and so in this example each vendor is listed twice, first exactly as stored in the Vendors table, and then converted to upper case as column vend\_name\_upcase. |

[Table 8.2](#Bookmark47_ch08table02) lists some commonly used text-manipulation functions.

| **Table 8.2. Commonly Used Text-Manipulation Functions** | |
| --- | --- |
| Function | Description |
| LEFT() (or use substring function) | Returns characters from left of string |
| LENGTH() (also DATALENGTH() or LEN()) | Returns the length of a string |
| LOWER() | Converts string to lowercase |
| LTRIM() (LCASE() if using Access) | Trims white space from left of string |
| RIGHT() (or use substring function) | Returns characters from right of string |
| RTRIM() | Trims white space from right of string |
| SOUNDEX() | Returns a string's SOUNDEX value |
| UPPER() (UCASE() if using Access) | Converts string to uppercase |

One item in [Table 8.2](#Bookmark47_ch08table02) requires further explanation. SOUNDEX is an algorithm that converts any string of text into an alphanumeric pattern describing the phonetic representation of that text. SOUNDEX takes into account similar sounding characters and syllables, enabling strings to be compared by how they sound rather than how they have been typed. Although SOUNDEX is not a SQL concept, most DBMSs do offer SOUNDEX support.

|  |  |
| --- | --- |
| 说明: graphics/note_icon.gif | **SOUNDEX** Support SOUNDEX() is not supported by Microsoft Access or PostgreSQL, and so the following example will not work on those DBMSs. |

Here's an example using the SOUNDEX() function. Customer Kids Place is in the Customers table and has a contact named Michelle Green. But what if that were a typo, and the contact actually was supposed to have been Michael Green? Obviously, searching by the correct contact name would return no data, as shown here:

说明: graphics/input_icon.jpg

SELECT cust\_name, cust\_contact

FROM Customers

WHERE cust\_contact = 'Michael Green';

说明: graphics/output_icon.jpg

cust\_name cust\_contact

-------------------------- ---------------------

Now try the same search using the SOUNDEX() function to match all contact names that sound similar to Michael Green:

说明: graphics/input_icon.jpg

SELECT cust\_name, cust\_contact

FROM Customers

WHERE SOUNDEX(cust\_contact) = SOUNDEX('Michael Green');

说明: graphics/output_icon.jpg

cust\_name cust\_contact

-------------------------- ---------------------

Kids Place Michelle Green

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | In this example, the WHERE clause uses the SOUNDEX() function to convert both the cust\_contact column value and the search string to their SOUNDEX values. Because Michael Green and Michelle Green sound alike, their SOUNDEX values match, and so the WHERE clause correctly filtered the desired data. |

**Date and Time Manipulation Functions**

Date and times are stored in tables using datatypes, and each DBMS uses its own special varieties. Date and time values are stored in special formats so that they may be sorted or filtered quickly and efficiently, as well as to save physical storage space.

The format used to store dates and times is usually of no use to your applications, and so date and time functions are almost always used to read, expand, and manipulate these values. Because of this, date and time manipulation functions are some of the most important functions in the SQL language. Unfortunately, they also tend to be the least consistent and least portable.

To demonstrate the use of date manipulation function, here is a simple example. The Orders table contains all orders along with an order date. To retrieve a list of all orders made in 2004 in SQL Server and Sybase, do the following:

说明: graphics/input_icon.jpg

SELECT order\_num

FROM Orders

WHERE DATEPART(yy, order\_date) = 2004;

说明: graphics/output_icon.jpg

order\_num

-----------

20005

20006

20007

20008

20009

In Access use this version:

说明: graphics/input_icon.jpg

SELECT order\_num

FROM Orders

WHERE DATEPART('yyyy', order\_date) = 2004;

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | This example (both the SQL Server and Sybase version, and the Access version) uses the DATEPART() function which, as its name suggests, returns a part of a date. DATEPART() takes two parameters, the part to return, and the date to return it from. In our example DATEPART() returns just the year from the order\_date column. By comparing that to 2004, the WHERE clause can filter just the orders for that year. |

Here is the PostgreSQL version that uses a similar function named DATE\_PART():

说明: graphics/input_icon.jpg

SELECT order\_num

FROM Orders

WHERE DATE\_PART('year', order\_date) = 2004;

MySQL has all sorts of date manipulation functions, but not DATEPART(). MySQL users can use a function named YEAR() to extract the year from a date:

说明: graphics/input_icon.jpg

SELECT order\_num

FROM Orders

WHERE YEAR(order\_date) = 2004;

Oracle has no DATEPART() function either, but there are several other date manipulation functions that can be used to accomplish the same retrieval. Here is an example:

说明: graphics/input_icon.jpg

SELECT order\_num

FROM Orders

WHERE to\_number(to\_char(order\_date, 'YY')) = 2004;

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | In this example, the to\_char() function is used to extract part of the date, and to\_number() is used to convert it to a numeric value so that it can be compared to 2004. |

Another way to accomplish this same task is to use the BETWEEN operator:

说明: graphics/input_icon.jpg

SELECT order\_num

FROM Orders

WHERE order\_date BETWEEN to\_date('01-JAN-2004')

AND to\_date('31-DEC-2004');

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | In this example, Oracle's to\_date() function is used to convert two strings to dates. One contains the date January 1, 2004, and the other contains the date December 31, 2004. A standard BETWEEN operator is used to find all orders between those two dates. It is worth noting that this same code would not work with SQL Server because it does not support the to\_date() function. However, if you replaced to\_date() with DATEPART(), you could indeed use this type of statement. |

|  |  |
| --- | --- |
| 说明: graphics/tip_icon.gif | Oracle Dates Dates in the format of DD-MMM-YYYY (as in the example shown above) are usually processed by Oracle correctly even if not explicitly cast as dates using to\_date(); however, to be safe, that function should always be used. |

The example shown here extracted and used part of a date (the year). To filter by a specific month, the same process could be used, specifying an AND operator and both year and month comparisons.

DBMSs typically offer far more than simple date part extraction. Most have functions for comparing dates, performing date based arithmetic, options for formatting dates, and more. But, as you have seen, date-time manipulation functions are particularly DBMS specific. Refer to your DBMS documentation for the list of the date-time manipulation functions it supports.

**Numeric Manipulation Functions**

Numeric manipulation functions do just that-manipulate numeric data. These functions tend to be used primarily for algebraic, trigonometric, or geometric calculations and, therefore, are not as frequently used as string or date and time manipulation functions.

The ironic thing is that of all the functions found in the major DBMSs, the numeric functions are the ones that are most uniform and consistent. [Table 8.3](#Bookmark47_ch08table03) lists some of the more commonly used numeric manipulation functions.

| **Table 8.3. Commonly Used Numeric Manipulation Functions** | |
| --- | --- |
| Function | Description |
| ABS() | Returns a number's absolute value |
| COS() | Returns the trigonometric cosine of a specified angle |
| EXP() | Returns the exponential value of a specific number |
| PI() | Returns the value of PI |
| SIN() | Returns the trigonometric sine of a specified angle |
| SQRT() | Returns the square root of a specified number |
| TAN() | Returns the trigonometric tangent of a specified angle |

Refer to your DBMS documentation for a list of the supported mathematical manipulation functions.

## 15.3 Summary

In this lesson, you learned how to use SQL's data manipulation functions. You also learned that although these functions can be extremely useful in formatting, manipulating, and filtering data, the function details are very inconsistent from one SQL implementation to the next.

# 16. Lesson 9. Summarizing Data

|  |
| --- |
| In this lesson, you will learn what the SQL aggregate functions are and how to use them to summarize table data. |

## 16.1 Using Aggregate Functions

It is often necessary to summarize data without actually retrieving it all, and SQL provides special functions for this purpose. Using these functions, SQL queries are often used to retrieve data for analysis and reporting purposes. Examples of this type of retrieval are

* Determining the number of rows in a table (or the number of rows that meet some condition or contain a specific value).
* Obtaining the sum of a set of rows in a table.
* Finding the highest, lowest, and average values in a table column (either for all rows or for specific rows).

In each of these examples, you want a summary of the data in a table, not the actual data itself. Therefore, returning the actual table data would be a waste of time and processing resources (not to mention bandwidth). To repeat, all you really want is the summary information.

To facilitate this type of retrieval, SQL features a set of five aggregate functions, which are listed in [Table 9.1](#Bookmark50_ch09table01). These functions enable you to perform all the types of retrieval just enumerated. You'll be relieved to know that unlike the data manipulation functions in the last lesson, SQL's aggregate functions are supported pretty consistently by the major SQL implementations.

|  |  |
| --- | --- |
| 说明: graphics/newterm_icon.gif | Aggregate Functions Functions that operate on a set of rows to calculate and return a single value. |

| **Table 9.1. SQL Aggregate Functions** | |
| --- | --- |
| Function | Description |
| AVG() | Returns a column's average value |
| COUNT() | Returns the number of rows in a column |
| MAX() | Returns a column's highest value |
| MIN() | Returns a column's lowest value |
| SUM() | Returns the sum of a column's values |

The use of each of these functions is explained in the following sections.

**The AVG() Function**

AVG() is used to return the average value of a specific column by counting both the number of rows in the table and the sum of their values. AVG() can be used to return the average value of all columns or of specific columns or rows.

This first example uses AVG() to return the average price of all the products in the Products table:

说明: graphics/input_icon.jpg

SELECT AVG(prod\_price) AS avg\_price

FROM Products;

说明: graphics/output_icon.jpg

avg\_price

-------------

6.823333

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | The SELECT statement above returns a single value, avg\_price that contains the average price of all products in the Products table. avg\_price is an alias as explained in [Lesson 7](#Bookmark40)(See 14.), "Creating Calculated Fields." |

AVG() can also be used to determine the average value of specific columns or rows. The following example returns the average price of products offered by a specific vendor:

说明: graphics/input_icon.jpg

SELECT AVG(prod\_price) AS avg\_price

FROM Products

WHERE vend\_id = 'DLL01';

说明: graphics/output_icon.jpg

avg\_price

-----------

3.8650

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | This SELECT statement differs from the previous one only in that this one contains a WHERE clause. The WHERE clause filters only products with a vendor\_id of DLL01, and, therefore, the value returned in avg\_price is the average of just that vendor's products. |

|  |  |
| --- | --- |
| 说明: graphics/caution_icon.gif | Individual Columns Only AVG() may only be used to determine the average of a specific numeric column, and that column name must be specified as the function parameter. To obtain the average value of multiple columns, multiple AVG() functions must be used. |

|  |  |
| --- | --- |
| 说明: graphics/note_icon.gif | **NULL** Values Column rows containing NULL values are ignored by the AVG() function. |

**The COUNT() Function**

COUNT() does just that: It counts. Using COUNT(), you can determine the number of rows in a table or the number of rows that match a specific criterion.

COUNT() can be used two ways:

* Use COUNT(\*) to count the number of rows in a table, whether columns contain values or NULL values.
* Use COUNT(column) to count the number of rows that have values in a specific column, ignoring NULL values.

This first example returns the total number of customers in the Customers table:

说明: graphics/input_icon.jpg

SELECT COUNT(\*) AS num\_cust

FROM Customers;

说明: graphics/output_icon.jpg

num\_cust

--------

5

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | In this example, COUNT(\*) is used to count all rows, regardless of values. The count is returned in num\_cust. |

The following example counts just the customers with an email address:

说明: graphics/input_icon.jpg

SELECT COUNT(cust\_email) AS num\_cust

FROM Customers;

说明: graphics/output_icon.jpg

num\_cust

--------

3

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | This SELECT statement uses COUNT(cust\_email) to count only rows with a value in the cust\_email column. In this example, cust\_email is 3 (meaning that only 3 of the 5 customers have email addresses). |

|  |  |
| --- | --- |
| 说明: graphics/note_icon.gif | **NULL** Values Column rows with NULL values in them are ignored by the COUNT() function if a column name is specified, but not if the asterisk (\*) is used. |

**The MAX() Function**

MAX() returns the highest value in a specified column. MAX() requires that the column name be specified, as seen here:

说明: graphics/input_icon.jpg

SELECT MAX(prod\_price) AS max\_price

FROM Products;

说明: graphics/output_icon.jpg

max\_price

----------

11.9900

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | Here MAX() returns the price of the most expensive item in Products table. |

|  |  |
| --- | --- |
| 说明: graphics/tip_icon.gif | Using **MAX()** with Non-Numeric Data Although MAX() is usually used to find the highest numeric or date values, many (but not all) DBMSs allow it to be used to return the highest value in any columns including textual columns. When used with textual data, MAX() returns the row that would be the last if the data were sorted by that column. |

|  |  |
| --- | --- |
| 说明: graphics/note_icon.gif | **NULL** Values Column rows with NULL values in them are ignored by the MAX() function. |

**The MIN() Function**

MIN() does the exact opposite of MAX(); it returns the lowest value in a specified column. Like MAX(), MIN() requires that the column name be specified, as seen here:

说明: graphics/input_icon.jpg

SELECT MIN(prod\_price) AS min\_price

FROM Products;

说明: graphics/output_icon.jpg

min\_price

----------

3.4900

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | Here MIN() returns the price of the least expensive item in Products table. |

|  |  |
| --- | --- |
| 说明: graphics/tip_icon.gif | Using **MIN()** with Non-Numeric Data Although MIN() is usually used to find the lowest numeric or date values, many (but not all) DBMSs allow it to be used to return the lowest value in any columns including textual columns. When used with textual data, MIN() will return the row that would be first if the data were sorted by that column. |

|  |  |
| --- | --- |
| 说明: graphics/note_icon.gif | **NULL** Values Column rows with NULL values in them are ignored by the MIN() function. |

**The SUM() Function**

SUM() is used to return the sum (total) of the values in a specific column.

Here is an example to demonstrate this. The OrderItems table contains the actual items in an order, and each item has an associated quantity. The total number of items ordered (the sum of all the quantity values) can be retrieved as follows:

说明: graphics/input_icon.jpg

SELECT SUM(quantity) AS items\_ordered

FROM OrderItems

WHERE order\_num = 20005;

说明: graphics/output_icon.jpg

items\_ordered

----------

200

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | The function SUM(quantity) returns the sum of all the item quantities in an order, and the WHERE clause ensures that just the right order items are included. |

SUM() can also be used to total calculated values. In this next example the total order amount is retrieved by totaling item\_price\*quantity for each item:

说明: graphics/input_icon.jpg

SELECT SUM(item\_price\*quantity) AS total\_price

FROM OrderItems

WHERE order\_num = 20005;

说明: graphics/output_icon.jpg

total\_price

----------

1648.0000

The function SUM(item\_price\*quantity) returns the sum of all the expanded prices in an order, and again the WHERE clause ensures that just the right order items are included.

|  |  |
| --- | --- |
| 说明: graphics/tip_icon.gif | Performing Calculations on Multiple Columns All the aggregate functions can be used to perform calculations on multiple columns using the standard mathematical operators, as shown in the example. |

|  |  |
| --- | --- |
| 说明: graphics/note_icon.gif | **NULL** Values Column rows with NULL values in them are ignored by the SUM() function. |

## 16.2 Aggregates on Distinct Values

The five aggregate functions can all be used in two ways:

* To perform calculations on all rows, specify the ALL argument or specify no argument at all (because ALL is the default behavior).
* To only include unique values, specify the DISTINCT argument.

|  |  |
| --- | --- |
| 说明: graphics/tip_icon.gif | **ALL** Is Default The ALL argument need not be specified because it is the default behavior. If DISTINCT is not specified, ALL is assumed. |

|  |  |
| --- | --- |
| 说明: graphics/note_icon.gif | Not in Access Microsoft Access does not support the use of DISTINCT within aggregate functions, and so the following example will not work with Access. |

The following example uses the AVG() function to return the average product price offered by a specific vendor. It is the same SELECT statement used above, but here the DISTINCT argument is used so that the average only takes into account unique prices:

说明: graphics/input_icon.jpg

SELECT AVG(DISTINCT prod\_price) AS avg\_price

FROM Products

WHERE vend\_id = 'DLL01';

说明: graphics/output_icon.jpg

avg\_price

-----------

4.2400

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | As you can see, in this example avg\_price is higher when DISTINCT is used because there are multiple items with the same lower price. Excluding them raises the average price. |

|  |  |
| --- | --- |
| 说明: graphics/caution_icon.gif | Caution DISTINCT may only be used with COUNT() if a column name is specified. DISTINCT may not be used with COUNT(\*). Similarly, DISTINCT must be used with a column name and not with a calculation or expression. |

|  |  |
| --- | --- |
| 说明: graphics/tip_icon.gif | Using DISTINCT with **MIN()** and **MAX()** Although DISTINCT can technically be used with MIN() and MAX(), there is actually no value in doing so. The minimum and maximum values in a column will be the same whether or not only distinct values are included. |

|  |  |
| --- | --- |
| 说明: graphics/note_icon.gif | Additional Aggregate Arguments In addition to the DISTINCT and ALL arguments shown here, some DBMSs support additional arguments such as TOP and TOP PERCENT that let you perform calculations on subsets of query results. Refer to your DBMS documentation to determine exactly what arguments are available to you. |

## 16.3 Combining Aggregate Functions

All the examples of aggregate function used thus far have involved a single function. But actually, SELECT statements may contain as few or as many aggregate functions as needed. Look at this example:

说明: graphics/input_icon.jpg

SELECT COUNT(\*) AS num\_items,

MIN(prod\_price) AS price\_min,

MAX(prod\_price) AS price\_max,

AVG(prod\_price) AS price\_avg

FROM Products;

说明: graphics/output_icon.jpg

num\_items price\_min price\_max price\_avg

--------- --------- --------- ---------

9 3.4900 11.9900 6.823333

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | Here a single SELECT statement performs four aggregate calculations in one step and returns four values (the number of items in the Products table, and the highest, lowest, and average product prices). |

|  |  |
| --- | --- |
| 说明: graphics/caution_icon.gif | Naming Aliases When specifying alias names to contain the results of an aggregate function, try to not use the name of an actual column in the table. Although there is nothing actually illegal about doing so, many SQL implementations do not support this and will generate obscure error messages if you do so. |

## 16.4 Summary

Aggregate functions are used to summarize data. SQL supports five aggregate functions, all of which can be used in multiple ways to return just the results you need. These functions are designed to be highly efficient, and they usually return results far more quickly than you could calculate them yourself within your own client application.

# 17. Lesson 10. Grouping Data

In this lesson, you'll learn how to group data so that you can summarize subsets of table contents. This involves two new *SELECT* statement clauses: the *GROUP BY* clause and the *HAVING* clause.

## 17.1 Understanding Data Grouping

In the last lesson, you learned that the SQL aggregate functions can be used to summarize data. This enables you to count rows, calculate sums and averages, and obtain high and low values without having to retrieve all the data.

All the calculations thus far were performed on all the data in a table or on data that matched a specific WHERE clause. As a reminder, the following example returns the number of products offered by vendor DLL01:

说明: graphics/input_icon.jpg

SELECT COUNT(\*) AS num\_prods

FROM Products

WHERE vend\_id = 'DLL01';

说明: graphics/output_icon.jpg

num\_prods

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4

But what if you wanted to return the number of products offered by each vendor? Or products offered by vendors who offer a single product, or only those who offer more than ten products?

This is where groups come into play. Grouping lets you divide data into logical sets so that you can perform aggregate calculations on each group.

## 17.2 Creating Groups

Groups are created using the GROUP BY clause in your SELECT statement. The best way to understand this is to look at an example:

说明: graphics/input_icon.jpg

SELECT vend\_id, COUNT(\*) AS num\_prods

FROM Products

GROUP BY vend\_id;

说明: graphics/output_icon.jpg

vend\_id num\_prods

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BRS01 3

DLL01 4

FNG01 2

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | The above SELECT statement specifies two columns, vend\_id, which contains the ID of a product's vendor, and num\_prods, which is a calculated field (created using the COUNT(\*) function). The GROUP BY clause instructs the DBMS to sort the data and group it by vend\_id. This causes num\_prods to be calculated once per vend\_id rather than once for the entire table. As you can see in the output, vendor BRS01 has 3 products listed, vendor DLL01 has 4 products listed, and vendor FNG01 has 2 products listed. |

Because you used GROUP BY, you did not have to specify each group to be evaluated and calculated. That was done automatically. The GROUP BY clause instructs the DBMS to group the data and then perform the aggregate on each group rather than on the entire result set.

Before you use GROUP BY, here are some important rules about its use that you need to know:

* GROUP BY clauses can contain as many columns as you want. This enables you to nest groups, providing you with more granular control over how data is grouped.
* If you have nested groups in your GROUP BY clause, data is summarized at the last specified group. In other words, all the columns specified are evaluated together when grouping is established (so you won't get data back for each individual column level).
* Every column listed in GROUP BY must be a retrieved column or a valid expression (but not an aggregate function). If an expression is used in the SELECT, that same expression must be specified in GROUP BY. Aliases cannot be used.
* Most SQL implementations do not allow GROUP BY columns with variable length datatypes (such as text or memo fields).
* Aside from the aggregate calculations statements, every column in your SELECT statement must be present in the GROUP BY clause.
* If the grouping column contains a row with a NULL value, NULL will be returned as a group. If there are multiple rows with NULL values, they'll all be grouped together.
* The GROUP BY clause must come after any WHERE clause and before any ORDER BY clause.

|  |  |
| --- | --- |
| 说明: graphics/tip_icon.gif | The **ALL** Clause Some SQL implementations (such as Microsoft SQL Server) support an optional ALL clause within GROUP BY. This clause can be used to return all groups, even those that have no matching rows (in which case the aggregate would return NULL). Refer to your DBMS documentation to see if it supports ALL. |

|  |  |
| --- | --- |
| 说明: graphics/caution_icon.gif | Specifying Columns by Relative Position Some SQL implementations allow you to specify GROUP BY columns by the position in the SELECT list. For example, GROUP BY 2,1 can mean group by the second column selected and then by the first. Although this shorthand syntax is convenient, it is not supported by all SQL implementations. It's use is also risky in that it is highly susceptible to the introduction of errors when editing SQL statements. |

## 17.3 Filtering Groups

In addition to being able to group data using GROUP BY, SQL also allows you to filter which groups to include and which to exclude. For example, you might want a list of all customers who have made at least two orders. To obtain this data you must filter based on the complete group, not on individual rows.

You've already seen the WHERE clause in action (that was introduced back in [Lesson 4](#Bookmark27)(See 11.), "Filtering Data." But WHERE does not work here because WHERE filters specific rows, not groups. As a matter of fact, WHERE has no idea what a group is.

So what do you use instead of WHERE? SQL provides yet another clause for this purpose: the HAVING clause. HAVING is very similar to WHERE. In fact, all types of WHERE clauses you learned about thus far can also be used with HAVING. The only difference is that WHERE filters rows and HAVING filters groups.

|  |  |
| --- | --- |
| 说明: graphics/tip_icon.gif | **HAVING** Supports All of **WHERE**'s Operators In [Lesson 4](#Bookmark27)(See 11.) and [Lesson 5](#Bookmark31)(See 12.), "Advanced Data Filtering," you learned about WHERE clause conditions (including wildcard conditions and clauses with multiple operators). All the techniques and options that you learned about WHERE can be applied to HAVING. The syntax is identical; just the keyword is different. |

So how do you filter rows? Look at the following example:

说明: graphics/input_icon.jpg

SELECT cust\_id, COUNT(\*) AS orders

FROM Orders

GROUP BY cust\_id

HAVING COUNT(\*) >= 2;

说明: graphics/output_icon.jpg

cust\_id orders

---------- -----------

1000000001 2

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | The first three lines of this SELECT statement are similar to the statements seen above. The final line adds a HAVING clause that filters on those groups with a COUNT(\*) >= 2-two or more orders. |

As you can see, a WHERE clause does not work here because the filtering is based on the group aggregate value, not on the values of specific rows.

|  |  |
| --- | --- |
| 说明: graphics/note_icon.gif | The difference between **HAVING** and **WHERE** Here's another way to look it: WHERE filters before data is grouped, and HAVING filters after data is grouped. This is an important distinction; rows that are eliminated by a WHERE clause will not be included in the group. This could change the calculated values which in turn could affect which groups are filtered based on the use of those values in the HAVING clause. |

So is there ever a need to use both WHERE and HAVING clauses in one statement? Actually, yes, there is. Suppose you want to further filter the above statement so that it returns any customers who placed two or more orders in the past 12 months. To do that, you can add a WHERE clause that filters out just the orders placed in the past 12 months. You then add a HAVING clause to filter just the groups with two or more rows in them.

To better demonstrate this, look at the following example that lists all vendors who have two or more products priced at 4 or more:

说明: graphics/input_icon.jpg

SELECT vend\_id, COUNT(\*) AS num\_prods

FROM Products

WHERE prod\_price >= 4

GROUP BY vend\_id

HAVING COUNT(\*) >= 2;

说明: graphics/output_icon.jpg

vend\_id num\_prods

---------- -----------

BRS01 3

FNG01 2

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | This statement warrants an explanation. The first line is a basic SELECT using an aggregate function-much like the examples thus far. The WHERE clause filters all rows with a prod\_price of at least 4. Data is then grouped by vend\_id, and then a HAVING clause filters just those groups with a count of 2 or more. Without the WHERE clause an extra row would have been retrieved (vendor DLL01 who sells four products all priced under 4) as seen here: |

说明: graphics/input_icon.jpg

SELECT vend\_id, COUNT(\*) AS num\_prods

FROM Products

GROUP BY vend\_id

HAVING COUNT(\*) >= 2;

说明: graphics/output_icon.jpg

vend\_id num\_prods

---------- -----------

BRS01 3

DLL01 4

FNG01 2

|  |  |
| --- | --- |
| 说明: graphics/note_icon.gif | Using **HAVING** and **WHERE** HAVING is so similar to WHERE that most DBMSs treat them as the same thing if no GROUP BY is specified. Nevertheless, you should make that distinction yourself. Use HAVING only in conjunction with GROUP BY clauses. Use WHERE for standard row-level filtering. |

## 17.4 Grouping and Sorting

It is important to understand that GROUP BY and ORDER BY are very different, even though they often accomplish the same thing. [Table 10.1](#Bookmark58_ch10table01) summarizes the differences between them.

| **Table 10.1. ORDER BY Versus GROUP BY** | |
| --- | --- |
| **ORDER BY** | **GROUP BY** |
| Sorts generated output. | Groups rows. The output might not be in group order, however. |
| Any columns (even columns not selected) may be used. | Only selected columns or expressions columns may be used, and every selected column expression must be used. |
| Never required. | Required if using columns (or expressions) with aggregate functions. |

The first difference listed in [Table 10.1](#Bookmark58_ch10table01) is extremely important. More often than not, you will find that data grouped using GROUP BY will indeed be output in group order. But that is not always the case, and it is not actually required by the SQL specifications. Furthermore, even if your particular DBMS does, in fact, always sort the data by the specified GROUP BY clause, you might actually want it sorted differently. Just because you group data one way (to obtain group specific aggregate values) does not mean that you want the output sorted that same way. You should always provide an explicit ORDER BY clause as well, even if it is identical to the GROUP BY clause.

|  |  |
| --- | --- |
| 说明: graphics/tip_icon.gif | Don't Forget **ORDER BY** As a rule, anytime you use a GROUP BY clause, you should also specify an ORDER BY clause. That is the only way to ensure that data will be sorted properly. Never rely on GROUP BY to sort your data. |

To demonstrate the use of both GROUP BY and ORDER BY, let's look at an example. The following SELECT statement is similar to the ones seen previously. It retrieves the order number and number of items ordered for all orders containing three or more items:

说明: graphics/input_icon.jpg

SELECT order\_num, COUNT(\*) AS items

FROM OrderItems

GROUP BY order\_num

HAVING COUNT(\*) >= 3;

说明: graphics/output_icon.jpg

order\_num items

---------- -----

20006 3

20007 5

20008 5

20009 3

To sort the output by number of items ordered, all you need to do is add an ORDER BY clause, as follows:

说明: graphics/input_icon.jpg

SELECT order\_num, COUNT(\*) AS items

FROM OrderItems

GROUP BY order\_num

HAVING COUNT(\*) >= 3

ORDER BY items, order\_num;

|  |  |
| --- | --- |
| 说明: graphics/caution_icon.gif | Access Incompatibility Microsoft Access does not allow sorting by alias, and so this example will fail. The solution is to replace items (in the ORDER BY clause) with the actual calculation or with the field position. As such, ORDER BY COUNT(\*), order\_num or ORDER BY 1, order\_num will both work. |

说明: graphics/output_icon.jpg

order\_num items

---------- -----

20006 3

20009 3

20007 5

20008 5

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | In this example, the GROUP BY clause is used to group the data by order number (the order\_num column) so that the COUNT(\*) function can return the number of items in each order. The HAVING clause filters the data so that only orders with three or more items are returned. Finally, the output is sorted using the ORDER BY clause. |

## 17.5 SELECT Clause Ordering

This is probably a good time to review the order in which SELECT statement clauses are to be specified. [Table 10.2](#Bookmark59_ch10table02) lists all the clauses we have learned thus far, in the order they must be used.

| **Table 10.2. SELECT Clauses and Their Sequence** | | |
| --- | --- | --- |
| Clause | Description | Required |
| SELECT | Columns or expressions to be returned | Yes |
| FROM | Table to retrieve data from | Only if selecting data from a table |
| WHERE | Row-level filtering | No |
| GROUP BY | Group specification | Only if calculating aggregates by group |
| HAVING | Group-level filtering | No |
| ORDER BY | Output sort order | No |

## 17.6 Summary

In [Lesson 9](#Bookmark49)(See 16.), "Summarizing Data," you learned how to use the SQL aggregate functions to perform summary calculations on your data. In this lesson, you learned how to use the GROUP BY clause to perform these calculations on groups of data, returning results for each group. You saw how to use the HAVING clause to filter specific groups. You also learned the difference between ORDER BY and GROUP BY and between WHERE and HAVING.

# 18. Lesson 11. Working with Subqueries

|  |
| --- |
| In this lesson, you'll learn what subqueries are and how to use them. |

## 18.1 Understanding Subqueries

SELECT statements are SQL queries. All the SELECT statements we have seen thus far are simple queries: single statements retrieving data from individual database tables.

|  |  |
| --- | --- |
| 说明: graphics/newterm_icon.gif | Query Any SQL statement. However, the term is usually used to refer to SELECT statements. |

SQL also enables you to create subqueries: queries that are embedded into other queries. Why would you want to do this? The best way to understand this concept is to look at a couple of examples.

|  |  |
| --- | --- |
| 说明: graphics/note_icon.gif | MySQL Support If you are using MySQL, be aware that support for subqueries was introduced in version 4.1. Earlier versions of MySQL do not support subqueries. |

## 18.2 Filtering by Subquery

The database tables used in all the lessons in this book are relational tables. (See [Appendix A](#Bookmark119)(See 30.), "Sample Data Scripts," for a description of each of the tables and their relationships.) Orders are stored in two tables. The Orders table stores a single row for each order containing order number, customer ID, and order date. The individual order items are stored in the related OrderItems table. The Orders table does not store customer information. It only stores a customer ID. The actual customer information is stored in the Customers table.

Now suppose you wanted a list of all the customers who ordered item RGAN01. What would you have to do to retrieve this information? Here are the steps:

1. Retrieve the order numbers of all orders containing item RGAN01.
2. Retrieve the customer ID of all the customers who have orders listed in the order numbers returned in the previous step.
3. Retrieve the customer information for all the customer IDs returned in the previous step.

Each of these steps can be executed as a separate query. By doing so, you use the results returned by one SELECT statement to populate the WHERE clause of the next SELECT statement.

You can also use subqueries to combine all three queries into one single statement.

The first SELECT statement should be self-explanatory by now. It retrieves the order\_num column for all order items with a prod\_id of RGAN01. The output lists the two orders containing this item:

说明: graphics/input_icon.jpg

SELECT order\_num

FROM OrderItems

WHERE prod\_id = 'RGAN01';

说明: graphics/output_icon.jpg

order\_num

-----------

20007

20008

The next step is to retrieve the customer IDs associated with orders 20007 and 20008. Using the IN clause described in [Lesson 5](#Bookmark31)(See 12.), "Advanced Data Filtering," you can create a SELECT statement as follows:

说明: graphics/input_icon.jpg

SELECT cust\_id

FROM Orders

WHERE order\_num IN (20007,20008);

说明: graphics/output_icon.jpg

cust\_id

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1000000004

1000000005

Now, combine the two queries by turning the first (the one that returned the order numbers) into a subquery. Look at the following SELECT statement:

说明: graphics/input_icon.jpg

SELECT cust\_id

FROM Orders

WHERE order\_num IN (SELECT order\_num

FROM OrderItems

WHERE prod\_id = 'RGAN01');

说明: graphics/output_icon.jpg

cust\_id

----------

1000000004

1000000005

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | Subqueries are always processed starting with the innermost SELECT statement and working outward. When the preceding SELECT statement is processed, the DBMS actually performs two operations. |

First it runs the subquery:

SELECT order\_num FROM orderitems WHERE prod\_id='RGAN01'

That query returns the two order numbers 20007 and 20008. Those two values are then passed to the WHERE clause of the outer query in the comma-delimited format required by the IN operator. The outer query now becomes

SELECT cust\_id FROM orders WHERE order\_num IN (20007,20008)

As you can see, the output is correct and exactly the same as the output returned by the hard-coded WHERE clause above.

|  |  |
| --- | --- |
| 说明: graphics/tip_icon.gif | Formatting Your SQL SELECT statements containing subqueries can be difficult to read and debug, especially as they grow in complexity. Breaking up the queries over multiple lines and indenting the lines appropriately as shown here can greatly simplify working with subqueries. |

You now have the IDs of all the customers who ordered item RGAN01. The next step is to retrieve the customer information for each of those customer IDs. The SQL statement to retrieve the two columns is

说明: graphics/input_icon.jpg

SELECT cust\_name, cust\_contact

FROM Customers

WHERE cust\_id IN ('1000000004','1000000005');

Instead of hard-coding those customer IDs, you can turn this WHERE clause into a subquery:

说明: graphics/input_icon.jpg

SELECT cust\_name, cust\_contact

FROM Customers

WHERE cust\_id IN (SELECT cust\_id

FROM Orders

WHERE order\_num IN (SELECT order\_num

FROM OrderItems

WHERE prod\_id = 'RGAN01'));

说明: graphics/output_icon.jpg

cust\_name cust\_contact

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Fun4All Denise L. Stephens

The Toy Store Kim Howard

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | To execute the above SELECT statement, the DBMS had to actually perform three SELECT statements. The innermost subquery returned a list of order numbers that were then used as the WHERE clause for the subquery above it. That subquery returned a list of customer IDs that were used as the WHERE clause for the top-level query. The top-level query actually returned the desired data. |

As you can see, using subqueries in a WHERE clause enables you to write extremely powerful and flexible SQL statements. There is no limit imposed on the number of subqueries that can be nested, although in practice you will find that performance will tell you when you are nesting too deeply.

|  |  |
| --- | --- |
| 说明: graphics/caution_icon.gif | Single Column Only Subquery SELECT statements can only retrieve a single column. Attempting to retrieve multiple columns will return an error. |

|  |  |
| --- | --- |
| 说明: graphics/caution_icon.gif | Subqueries and Performance The code shown here works, and it achieves the desired result. However, using subqueries is not always the most efficient way to perform this type of data retrieval. More on this in [Lesson 12](#Bookmark66)(See 19.), "Joining Tables," where you will revisit this same example. |

## 18.3 Using Subqueries As Calculated Fields

Another way to use subqueries is in creating calculated fields. Suppose you want to display the total number of orders placed by every customer in your Customers table. Orders are stored in the Orders table along with the appropriate customer ID.

To perform this operation, follow these steps:

1. Retrieve the list of customers from the Customers table.
2. For each customer retrieved, count the number of associated orders in the Orders table.

As you learned in the previous two lessons, you can use SELECT COUNT(\*) to count rows in a table, and by providing a WHERE clause to filter a specific customer ID, you can count just that customer's orders. For example, the following code counts the number of orders placed by customer 1000000001:

说明: graphics/input_icon.jpg

SELECT COUNT(\*) AS orders

FROM Orders

WHERE cust\_id = '1000000001';

To perform that COUNT(\*) calculation for each customer, use COUNT\* as a subquery. Look at the following code:

说明: graphics/input_icon.jpg

SELECT cust\_name,

cust\_state,

(SELECT COUNT(\*)

FROM Orders

WHERE Orders.cust\_id = Customers.cust\_id) AS

orders

FROM Customers

ORDER BY cust\_name;

说明: graphics/output_icon.jpg

cust\_name cust\_state orders

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Fun4All IN 1

Fun4All AZ 1

Kids Place OH 0

The Toy Store IL 1

Village Toys MI 2

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | This SELECT statement returns three columns for every customer in the Customers table: cust\_name, cust\_state, and orders. Orders is a calculated field that is set by a subquery that is provided in parentheses. That subquery is executed once for every customer retrieved. In the example above, the subquery is executed five times because five customers were retrieved. |

The WHERE clause in the subquery is a little different from the WHERE clauses used previously because it uses fully qualified column names. The following clause tells SQL to compare the cust\_id in the Orders table to the one currently being retrieved from the Customers table:

WHERE Orders.cust\_id = Customers.cust\_id

This syntax-the table name and the column name separated by a period-must be used whenever there is possible ambiguity about column names. In this example, there are two cust\_id columns, one in Customers and one in Orders. Without fully qualifying the column names, the DBMS assumes you are comparing the cust\_id in the Orders table to itself. Because

SELECT COUNT(\*) FROM Orders WHERE cust\_id = cust\_id

will always return the total number of orders in the Orders table, the results will not be what you expected:

说明: graphics/input_icon.jpg

SELECT cust\_name,

cust\_state,

(SELECT COUNT(\*)

FROM Orders

WHERE cust\_id = cust\_id) AS orders

FROM Customers

ORDER BY cust\_name;

说明: graphics/output_icon.jpg

cust\_name cust\_state orders

------------------------- ---------- ------

Fun4All IN 5

Fun4All AZ 5

Kids Place OH 5

The Toy Store IL 5

Village Toys MI 5

Although subqueries are extremely useful in constructing this type of SELECT statement, care must be taken to properly qualify ambiguous column names.

|  |  |
| --- | --- |
| 说明: graphics/note_icon.gif | Always More Than One Solution As explained earlier in this lesson, although the sample code shown here works, it is often not the most efficient way to perform this type of data retrieval. You will revisit this example in a later lesson. |

## 18.4 Summary

In this lesson, you learned what subqueries are and how to use them. The most common uses for subqueries are in WHERE clause IN operators and for populating calculated columns. You saw examples of both of these types of operations.

# 19. Lesson 12. Joining Tables

|  |
| --- |
| In this lesson, you'll learn what joins are, why they are used, and how to create *SELECT* statements using them. |

## 19.1 Understanding Joins

One of SQL's most powerful features is the capability to join tables on-the-fly within data retrieval queries. Joins are one of the most important operations that you can perform using SQL SELECT, and a good understanding of joins and join syntax is an extremely important part of learning SQL.

Before you can effectively use joins, you must understand relational tables and the basics of relational database design. What follows is by no means complete coverage of the subject, but it should be enough to get you up and running.

**Understanding Relational Tables**

The best way to understand relational tables is to look at a real-world example.

Suppose you had a database table containing a product catalog, with each catalog item in its own row. The kind of information you would store with each item would include a product description and price, along with vendor information about the company that creates the product.

Now suppose that you had multiple catalog items created by the same vendor. Where would you store the vendor information (things like vendor name, address, and contact information)? You wouldn't want to store that data along with the products for several reasons:

* Because the vendor information is the same for each product that vendor produces, repeating the information for each product is a waste of time and storage space.
* If vendor information changes (for example, if the vendor moves or his area code changes), you would need to update every occurrence of the vendor information.
* When data is repeated (that is, the vendor information is used with each product), there is a high likelihood that the data will not be entered exactly the same way each time. Inconsistent data is extremely difficult to use in reporting.

The key here is that having multiple occurrences of the same data is never a good thing, and that principle is the basis for relational database design. Relational tables are designed so that information is split into multiple tables, one for each data type. The tables are related to each other through common values (and thus the relational in relational design).

In our example, you can create two tables, one for vendor information and one for product information. The Vendors table contains all the vendor information, one table row per vendor, along with a unique identifier for each vendor. This value, called a primary key, can be a vendor ID, or any other unique value.

The Products table stores only product information, and no vendor specific information other than the vendor ID (the Vendors table's primary key). This key relates the Vendors table to the Products table, and using this vendor ID enables you to use the Vendors table to find the details about the appropriate vendor.

What does this do for you? Well, consider the following:

* Vendor information is never repeated, and so time and space are not wasted.
* If vendor information changes, you can update a single record, the one in the Vendors table. Data in related tables does not change.
* As no data is repeated, the data used is obviously consistent, making data reporting and manipulation much simpler.

The bottom line is that relational data can be stored efficiently and manipulated easily. Because of this, relational databases scale far better than nonrelational databases.

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| --- | --- |
| 说明: graphics/newterm_icon.gif | Scale Able to handle an increasing load without failing. A well-designed database or application is said to scale well. |

**Why Use Joins?**

As just explained, breaking data into multiple tables enables more efficient storage, easier manipulation, and greater scalability. But these benefits come with a price.

If data is stored in multiple tables, how can you retrieve that data with a single SELECT statement?

The answer is to use a join. Simply put, a join is a mechanism used to associate tables within a SELECT statement (and thus the name join). Using a special syntax, multiple tables can be joined so that a single set of output is returned, and the join associates the correct rows in each table on-the-fly.

|  |  |
| --- | --- |
| 说明: graphics/note_icon.gif | Using Interactive DBMS Tools It is important to understand that a join is not a physical entity-in other words, it does not exist in the actual database tables. A join is created by the DBMS as needed, and it persists for the duration of the query execution.  Many DBMSs provide graphical interfaces that can be used to define table relationships interactively. These tools can be invaluable in helping to maintain referential integrity. When using relational tables, it is important that only valid data is inserted into relational columns. Going back to the example, if an invalid vendor ID is stored in the Products table, those products would be inaccessible because they would not be related to any vendor. To prevent this from occurring, the database can be instructed to only allow valid values (ones present in the Vendors table) in the vendor ID column in the Products table. Referential integrity means that the DBMS enforces data integrity rules. And these rules are often managed through DBMS provided interfaces. |

## 19.2 Creating a Join

Creating a join is very simple. You must specify all the tables to be included and how they are related to each other. Look at the following example:

说明: graphics/input_icon.jpg

SELECT vend\_name, prod\_name, prod\_price

FROM Vendors, Products

WHERE Vendors.vend\_id = Products.vend\_id;

说明: graphics/output_icon.jpg

vend\_name prod\_name prod\_price

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Doll House Inc. Fish bean bag toy 3.4900

Doll House Inc. Bird bean bag toy 3.4900

Doll House Inc. Rabbit bean bag toy 3.4900

Bears R Us 8 inch teddy bear 5.9900

Bears R Us 12 inch teddy bear 8.9900

Bears R Us 18 inch teddy bear 11.9900

Doll House Inc. Raggedy Ann 4.9900

Fun and Games King doll 9.4900

Fun and Games Queen doll 9.4900

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | Let's take a look at the preceding code. The SELECT statement starts in the same way as all the statements you've looked at thus far, by specifying the columns to be retrieved. The big difference here is that two of the specified columns (prod\_name and prod\_price) are in one table, whereas the other (vend\_name) is in another table. |

Now look at the FROM clause. Unlike all the prior SELECT statements, this one has two tables listed in the FROM clause, Vendors and Products. These are the names of the two tables that are being joined in this SELECT statement. The tables are correctly joined with a WHERE clause that instructs the DBMS to match vend\_id in the Vendors table with vend\_id in the Products table.

You'll notice that the columns are specified as Vendors.vend\_id and Products.vend\_id. This fully qualified column name is required here because if you just specified vend\_id, the DBMS cannot tell which vend\_id columns you are referring to. (There are two of them, one in each table.) As you can see in the preceding output, a single SELECT statement returns data from two different tables.

|  |  |
| --- | --- |
| 说明: graphics/caution_icon.gif | Fully Qualifying Column Names You must use the fully qualified column name (table and column separated by a period) whenever there is a possible ambiguity about which column you are referring to. Most DBMSs will return an error message if you refer to an ambiguous column name without fully qualifying it with a table name. |

**The Importance of the WHERE Clause**

It might seem strange to use a WHERE clause to set the join relationship, but actually, there is a very good reason for this. Remember, when tables are joined in a SELECT statement, that relationship is constructed on-the-fly. There is nothing in the database table definitions that can instruct the DBMS how to join the tables. You have to do that yourself. When you join two tables, what you are actually doing is pairing every row in the first table with every row in the second table. The WHERE clause acts as a filter to only include rows that match the specified filter condition-the join condition, in this case. Without the WHERE clause, every row in the first table will be paired with every row in the second table, regardless of if they logically go together or not.

|  |  |
| --- | --- |
| 说明: graphics/newterm_icon.gif | Cartesian Product The results returned by a table relationship without a join condition. The number of rows retrieved will be the number of rows in the first table multiplied by the number of rows in the second table. |

To understand this, look at the following SELECT statement and output:

说明: graphics/input_icon.jpg

SELECT vend\_name, prod\_name, prod\_price

FROM Vendors, Products;

说明: graphics/output_icon.jpg

vend\_name prod\_name prod\_price

----------- --------- ----------

Bears R Us 8 inch teddy bear 5.99

Bears R Us 12 inch teddy bear 8.99

Bears R Us 18 inch teddy bear 11.99

Bears R Us Fish bean bag toy 3.49

Bears R Us Bird bean bag toy 3.49

Bears R Us Rabbit bean bag toy 3.49

Bears R Us Raggedy Ann 4.99

Bears R Us King doll 9.49

Bears R Us Queen doll 9.49

Bear Emporium 8 inch teddy bear 5.99

Bear Emporium 12 inch teddy bear 8.99

Bear Emporium 18 inch teddy bear 11.99

Bear Emporium Fish bean bag toy 3.49

Bear Emporium Bird bean bag toy 3.49

Bear Emporium Rabbit bean bag toy 3.49

Bear Emporium Raggedy Ann 4.99

Bear Emporium King doll 9.49

Bear Emporium Queen doll 9.49

Doll House Inc. 8 inch teddy bear 5.99

Doll House Inc. 12 inch teddy bear 8.99

Doll House Inc. 18 inch teddy bear 11.99

Doll House Inc. Fish bean bag toy 3.49

Doll House Inc. Bird bean bag toy 3.49

Doll House Inc. Rabbit bean bag toy 3.49

Doll House Inc. Raggedy Ann 4.99

Doll House Inc. King doll 9.49

Doll House Inc. Queen doll 9.49

Furball Inc. 8 inch teddy bear 5.99

Furball Inc. 12 inch teddy bear 8.99

Furball Inc. 18 inch teddy bear 11.99

Furball Inc. Fish bean bag toy 3.49

Furball Inc. Bird bean bag toy 3.49

Furball Inc. Rabbit bean bag toy 3.49

Furball Inc. Raggedy Ann 4.99

Furball Inc. King doll 9.49

Furball Inc. Queen doll 9.49

Fun and Games 8 inch teddy bear 5.99

Fun and Games 12 inch teddy bear 8.99

Fun and Games 18 inch teddy bear 11.99

Fun and Games Fish bean bag toy 3.49

Fun and Games Bird bean bag toy 3.49

Fun and Games Rabbit bean bag toy 3.49

Fun and Games Raggedy Ann 4.99

Fun and Games King doll 9.49

Fun and Games Queen doll 9.49

Jouets et ours 8 inch teddy bear 5.99

Jouets et ours 12 inch teddy bear 8.99

Jouets et ours 18 inch teddy bear 11.99

Jouets et ours Fish bean bag toy 3.49

Jouets et ours Bird bean bag toy 3.49

Jouets et ours Rabbit bean bag toy 3.49

Jouets et ours Raggedy Ann 4.99

Jouets et ours King doll 9.49

Jouets et ours Queen doll 9.49

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | As you can see in the preceding output, the Cartesian product is seldom what you want. The data returned here has matched every product with every vendor, including products with the incorrect vendor (and even vendors with no products at all). |

|  |  |
| --- | --- |
| 说明: graphics/caution_icon.gif | Don't Forget the **WHERE** Clause Make sure all your joins have WHERE clauses, or the DBMS will return far more data than you want. Similarly, make sure your WHERE clauses are correct. An incorrect filter condition will cause the DBMS to return incorrect data. |

|  |  |
| --- | --- |
| 说明: graphics/tip_icon.gif | Cross Joins Sometimes you'll hear the type of join that returns a Cartesian Product referred to as a cross join. |

**Inner Joins**

The join you have been using so far is called an equijoin-a join based on the testing of equality between two tables. This kind of join is also called an inner join. In fact, you may use a slightly different syntax for these joins, specifying the type of join explicitly. The following SELECT statement returns the exact same data as the preceding example:

说明: graphics/input_icon.jpg

SELECT vend\_name, prod\_name, prod\_price

FROM Vendors INNER JOIN Products

ON Vendors.vend\_id = Products.vend\_id;

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | The SELECT in the statement is the same as the preceding SELECT statement, but the FROM clause is different. Here the relationship between the two tables is part of the FROM clause specified as INNER JOIN. When using this syntax the join condition is specified using the special ON clause instead of a WHERE clause. The actual condition passed to ON is the same as would be passed to WHERE. |

Refer to your DBMS documentation to see which syntax is preferred.

|  |  |
| --- | --- |
| 说明: graphics/note_icon.gif | The "Right" Syntax Per the ANSI SQL specification, use of the INNER JOIN syntax is preferable. |

**Joining Multiple Tables**

SQL imposes no limit to the number of tables that may be joined in a SELECT statement. The basic rules for creating the join remain the same. First list all the tables, and then define the relationship between each. Here is an example:

说明: graphics/input_icon.jpg

SELECT prod\_name, vend\_name, prod\_price, quantity

FROM OrderItems, Products, Vendors

WHERE Products.vend\_id = Vendors.vend\_id

AND OrderItems.prod\_id = Products.prod\_id

AND order\_num = 20007;

说明: graphics/output_icon.jpg

prod\_name vend\_name prod\_price quantity

--------- --------- ---------- --------

18 inch teddy bear Bears R Us 11.9900 50

Fish bean bag toy Doll House Inc. 3.4900 100

Bird bean bag toy Doll House Inc. 3.4900 100

Rabbit bean bag toy Doll House Inc. 3.4900 100

Raggedy Ann Doll House Inc. 4.9900 50

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | This example displays the items in order number 20007. Order items are stored in the OrderItems table. Each product is stored by its product ID, which refers to a product in the Products table. The products are linked to the appropriate vendor in the Vendors table by the vendor ID, which is stored with each product record. The FROM clause here lists the three tables, and the WHERE clause defines both of those join conditions. An additional WHERE condition is then used to filter just the items for order 20007. |

|  |  |
| --- | --- |
| 说明: graphics/caution_icon.gif | Performance Considerations DBMSs process joins at run-time relating each table as specified. This process can become very resource intensive so be careful not to join tables unnecessarily. The more tables you join the more performance will degrade. |

|  |  |
| --- | --- |
| 说明: graphics/caution_icon.gif | Maximum Number of Tables in a Join While it is true that SQL itself has no maximum number of tables per join restriction, many DBMSs do indeed have restrictions. Refer to your DBMS documentation to determine what restrictions there are, if any. |

Now would be a good time to revisit the following example from [Lesson 11](#Bookmark61)(See 18.), "Working with Subqueries." As you will recall, this SELECT statement returns a list of customers who ordered product RGAN01:

说明: graphics/input_icon.jpg

SELECT cust\_name, cust\_contact

FROM Customers

WHERE cust\_id IN (SELECT cust\_id

FROM Orders

WHERE order\_num IN (SELECT order\_num

FROM OrderItems

WHERE prod\_id = 'RGAN01'));

As I mentioned in [Lesson 11](#Bookmark61)(See 18.), subqueries are not always the most efficient way to perform complex SELECT operations, and so as promised, here is the same query using joins:

说明: graphics/input_icon.jpg

SELECT cust\_name, cust\_contact

FROM Customers, Orders, OrderItems

WHERE Customers.cust\_id = Orders.cust\_id

AND OrderItems.order\_num = Orders.order\_num

AND prod\_id = 'RGAN01';

说明: graphics/output_icon.jpg

cust\_name cust\_contact

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Fun4All Denise L. Stephens

The Toy Store Kim Howard

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | As explained in [Lesson 11](#Bookmark61)(See 18.), returning the data needed in this query requires the use of three tables. But instead of using them within nested subqueries, here two joins are used to connect the tables. There are three WHERE clause conditions here. The first two connect the tables in the join, and the last one filters the data for product RGAN01. |

|  |  |
| --- | --- |
| 说明: graphics/tip_icon.gif | It Pays to Experiment As you can see, there is often more than one way to perform any given SQL operation. And there is rarely a definitive right or wrong way. Performance can be affected by the type of operation, the DBMS being used, the amount of data in the tables, whether or not indexes and keys are present, and a whole slew of other criteria. Therefore, it is often worth experimenting with different selection mechanisms to find the one that works best for you. |

## 19.3 Summary

Joins are one of the most important and powerful features in SQL, and using them effectively requires a basic understanding of relational database design. In this lesson, you learned some of the basics of relational database design as an introduction to learning about joins. You also learned how to create an equijoin (also known as an inner join), which is the most commonly used form of join. In the next, lesson, you'll learn how to create other types of joins.

# 20. Lesson 13. Creating Advanced Joins

In this lesson, you'll learn all about additional join types-what they are, and how to use them. You'll also learn how to use table aliases and how to use aggregate functions with joined tables.

## 20.1 Using Table Aliases

Back in [Lesson 7](#Bookmark40)(See 14.), "Creating Calculated Fields," you learned how to use aliases to refer to retrieved table columns. The syntax to alias a column looks like this:

说明: graphics/input_icon.jpg

SELECT RTRIM(vend\_name) + ' (' + RTRIM(vend\_country) + ')' AS vend\_title

FROM Vendors

ORDER BY vend\_name;

In addition to using aliases for column names and calculated fields, SQL also enables you to alias table names. There are two primary reasons to do this:

* To shorten the SQL syntax
* To enable multiple uses of the same table within a single SELECT statement

Take a look at the following SELECT statement. It is basically the same statement as an example used in the previous lesson, but it has been modified to use aliases:

说明: graphics/input_icon.jpg

SELECT cust\_name, cust\_contact

FROM Customers AS C, Orders AS O, OrderItems AS OI

WHERE C.cust\_id = O.cust\_id

AND OI.order\_num = O.order\_num

AND prod\_id = 'RGAN01';

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | You'll notice that the three tables in the FROM clauses all have aliases. Customers AS C establishes C as an alias for Customers, and so on. This enables you to use the abbreviated C instead of the full text Customers. In this example, the table aliases were used only in the WHERE clause, but aliases are not limited to just WHERE. You can use aliases in the SELECT list, the ORDER BY clause, and in any other part of the statement as well. |

|  |  |
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| 说明: graphics/caution_icon.gif | No **AS** in Oracle Oracle does not support the AS keyword. To use aliases in Oracle, simply specify the alias without AS (so Customers C instead of Customers AS C). |

It is also worth noting that table aliases are only used during query execution. Unlike column aliases, table aliases are never returned to the client.

## 20.2 Using Different Join Types

So far, you have used only simple joins known as inner joins or equijoins. You'll now take a look at three additional join types: the self join, the natural join, and the outer join.

**Self Joins**

As I mentioned earlier, one of the primary reasons to use table aliases is to be able to refer to the same table more than once in a single SELECT statement. An example will demonstrate this.

Suppose you wanted to send a mailing to all the customer contacts who work for the same company for which Jim Jones works. This query requires that you first find out which company Jim Jones works for, and next which customers work for that company. The following is one way to approach this problem:

说明: graphics/input_icon.jpg

SELECT cust\_id, cust\_name, cust\_contact

FROM Customers

WHERE cust\_name = (SELECT cust\_name

FROM Customers

WHERE cust\_contact = 'Jim Jones');

说明: graphics/output_icon.jpg

cust\_id cust\_name cust\_contact

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1000000003 Fun4All Jim Jones

1000000004 Fun4All Denise L. Stephens

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | This first solution uses subqueries. The inner SELECT statement does a simple retrieval to return the cust\_name of the company that Jim Jones works for. That name is the one used in the WHERE clause of the outer query so that all employees who work for that company are retrieved. (You learned all about subqueries in [Lesson 11](#Bookmark61)(See 18.), "Working with Subqeries." Refer to that lesson for more information.) |

Now look at the same query using a join:

说明: graphics/input_icon.jpg

SELECT c1.cust\_id, c1.cust\_name, c1.cust\_contact

FROM Customers AS c1, Customers AS c2

WHERE c1.cust\_name = c2.cust\_name

AND c2.cust\_contact = 'Jim Jones';

说明: graphics/output_icon.jpg

cust\_id cust\_name cust\_contact

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1000000003 Fun4All Jim Jones

1000000004 Fun4All Denise L. Stephens

|  |  |
| --- | --- |
| 说明: graphics/tip_icon.gif | No **AS** in Oracle Oracle users, remember to drop the AS. |

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | The two tables needed in this query are actually the same table, and so the Customers table appears in the FROM clause twice. Although this is perfectly legal, any references to table Customers would be ambiguous because the DBMS does not know which Customers table you are referring to. |

To resolve this problem table aliases are used. The first occurrence of Customers has an alias of C1, and the second has an alias of C2. Now those aliases can be used as table names. The SELECT statement, for example, uses the C1 prefix to explicitly state the full name of the desired columns. If it did not, the DBMS would return an error because there are two columns named cust\_id, cust\_name, and cust\_contact. It cannot know which one you want (even though, in truth, they are one and the same). The WHERE clause first joins the tables, and then it filters the data by cust\_contact in the second table to return only the desired data.

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| 说明: graphics/tip_icon.gif | Self Joins Instead of Subqueries Self joins are often used to replace statements using subqueries that retrieve data from the same table as the outer statement. Although the end result is the same, many DBMSs process joins far more quickly than they do subqueries. It is usually worth experimenting with both to determine which performs better. |

**Natural Joins**

Whenever tables are joined, at least one column will appear in more than one table (the columns being joined). Standard joins (the inner joins that you learned about in the last lesson) return all data, even multiple occurrences of the same column. A natural join simply eliminates those multiple occurrences so that only one of each column is returned.

How does it do this? The answer is it doesn't-you do it. A natural join is a join in which you select only columns that are unique. This is typically done using a wildcard (SELECT \*) for one table and explicit subsets of the columns for all other tables. The following is an example:

说明: graphics/input_icon.jpg

SELECT C.\*, O.order\_num, O.order\_date, OI.prod\_id, OI.quantity, OI.item\_price

FROM Customers AS C, Orders AS O, OrderItems AS OI

WHERE C.cust\_id = O.cust\_id

AND OI.order\_num = O.order\_num

AND prod\_id = 'RGAN01';

|  |  |
| --- | --- |
| 说明: graphics/tip_icon.gif | No **AS** in Oracle Oracle users, remember to drop the AS. |

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | In this example, a wildcard is used for the first table only. All other columns are explicitly listed so that no duplicate columns are retrieved. |

The truth is, every inner join you have created thus far is actually a natural join, and you will probably never even need an inner join that is not a natural join.

**Outer Joins**

Most joins relate rows in one table with rows in another. But occasionally, you will want to include rows that have no related rows. For example, you might use joins to accomplish the following tasks:

* Count how many orders each customer, including customers who have yet to place an order, placed
* List all products with order quantities, including products not ordered by anyone
* Calculate average sale sizes, taking into account customers who have not yet placed an order

In each of these examples, the join includes table rows that have no associated rows in the related table. This type of join is called an outer join.

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| 说明: graphics/caution_icon.gif | Syntax Differences It is important to note that the syntax used to create an outer join can vary slightly among different SQL implementations. The various forms of syntax described in the following section cover most implementations, but refer to your DBMS documentation to verify its syntax before proceeding. |

The following SELECT statement is a simple inner join. It retrieves a list of all customers and their orders:

说明: graphics/input_icon.jpg

SELECT Customers.cust\_id, Orders.order\_num

FROM Customers INNER JOIN Orders

ON Customers.cust\_id = Orders.cust\_id;

Outer join syntax is similar. To retrieve a list of all customers, including those who have placed no orders, you can do the following:

说明: graphics/input_icon.jpg

SELECT Customers.cust\_id, Orders.order\_num

FROM Customers LEFT OUTER JOIN Orders

ON Customers.cust\_id = Orders.cust\_id;

说明: graphics/output_icon.jpg

cust\_id order\_num

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1000000001 20005

1000000001 20009

1000000002 NULL

1000000003 20006

1000000004 20007

1000000005 20008

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | Like the inner join seen in the last lesson, this SELECT statement uses the keywords OUTER JOIN to specify the join type (instead of specifying it in the WHERE clause). But unlike inner joins, which relate rows in both tables, outer joins also include rows with no related rows. When using OUTER JOIN syntax you must use the RIGHT or LEFT keywords to specify the table from which to include all rows (RIGHT for the one on the right of OUTER JOIN, and LEFT for the one on the left). The previous example uses LEFT OUTER JOIN to select all the rows from the table on the left in the FROM clause (the Customers table). To select all the rows from the table on the right, you use a RIGHT OUTER JOIN as seen in this next example: |

说明: graphics/input_icon.jpg

SELECT Customers.cust\_id, Orders.order\_num

FROM Customers RIGHT OUTER JOIN Orders

ON Orders.cust\_id = Customers.cust\_id;

SQL Server supports an additional simplified outer join syntax. To retrieve a list of all customers, including those who have placed no orders, you can do the following:

说明: graphics/input_icon.jpg

SELECT Customers.cust\_id, Orders.order\_num

FROM Customers, Orders

WHERE Customers.cust\_id \*= Orders.cust\_id;

说明: graphics/output_icon.jpg

cust\_id order\_num

---------- ---------

1000000001 20005

1000000001 20009

1000000002 NULL

1000000003 20006

1000000004 20007

1000000005 20008

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | Here the join condition is specified in the WHERE clause. Instead of testing for equality with a =, the \*= operator is used to specify that every row in the Customers table should be included. \*= is the left outer join operator. It retrieves all the rows from the left table. |

The opposite of this left outer join is the right outer join specified by the = operator. It can be used to return all rows from the table listed to the right of the operator, as seen in this next example:

说明: graphics/input_icon.jpg

SELECT Customers.cust\_id, Orders.order\_num

FROM Customers, Orders

WHERE Orders.cust\_id =\* Customers.cust\_id;

Yet another form of the OUTER JOIN syntax (used only by Oracle) requires the use of (+) operator after the table name as follows:

说明: graphics/input_icon.jpg

SELECT Customers.cust\_id, Orders.order\_num

FROM Customers, Orders

WHERE Customers.cust\_id (+) = Orders.cust\_id

|  |  |
| --- | --- |
| 说明: graphics/tip_icon.gif | Outer Join Types Regardless of the form of outer join used, there are always two basic forms of outer joins-the left outer join and the right outer join. The only difference between them is the order of the tables that they are relating. In other words, a left outer join can be turned into a right outer join simply by reversing the order of the tables in the FROM or WHERE clause. As such, the two types of outer join can be used interchangeably, and the decision about which one is used is based purely on convenience. |

There is one other variant of the outer join, and that is the full outer join that retrieves all rows from both tables and relates those that can be related. Unlike a left outer join or right outer join, which includes unrelated rows from a single table, the full outer join includes unrelated rows from both tables. The syntax for a full outer join is as follows:

说明: graphics/input_icon.jpg

SELECT Customers.cust\_id, Orders.order\_num

FROM Orders FULL OUTER JOIN Customers

ON Orders.cust\_id = Customers.cust\_id;

|  |  |
| --- | --- |
| 说明: graphics/caution_icon.gif | **FULL OUTER JOIN** Support The FULL OUTER JOIN syntax is not supported by Access, MySQL, SQL Server, or Sybase. |

## 20.3 Using Joins with Aggregate Functions

As you learned in [Lesson 9](#Bookmark49)(See 16.), "Summarizing Data," aggregate functions are used to summarize data. Although all the examples of aggregate functions thus far only summarized data from a single table, these functions can also be used with joins.

To demonstrate this, let's look at an example. You want to retrieve a list of all customers and the number of orders that each has placed. The following code uses the COUNT() function to achieve this:

说明: graphics/input_icon.jpg

SELECT Customers.cust\_id, COUNT(Orders.order\_num) AS num\_ord

FROM Customers INNER JOIN Orders

ON Customers.cust\_id = Orders.cust\_id

GROUP BY Customers.cust\_id;

说明: graphics/output_icon.jpg

cust\_id num\_ord

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1000000001 2

1000000003 1

1000000004 1

1000000005 1

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | This SELECT statement uses INNER JOIN to relate the Customers and Orders tables to each other. The GROUP BY clause groups the data by customer, and so the function call COUNT(Orders.order\_num) counts the number of orders for each customer and returns it as num\_ord. |

Aggregate functions can be used just as easily with other join types. See the following example:

说明: graphics/input_icon.jpg

SELECT Customers.cust\_id, COUNT(Orders.order\_num) AS num\_ord

FROM Customers LEFT OUTER JOIN Orders

ON Customers.cust\_id = Orders.cust\_id

GROUP BY Customers.cust\_id;

|  |  |
| --- | --- |
| 说明: graphics/tip_icon.gif | No **AS** in Oracle Again, Oracle users, remember to drop the AS. |

说明: graphics/output_icon.jpg

cust\_id num\_ord

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1000000001 2

1000000002 0

1000000003 1

1000000004 1

1000000005 1

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | This example uses a left outer join to include all customers, even those who have not placed any orders. The results show that customer 1000000002 is also included, this time with 0 orders. |

## 20.4 Using Joins and Join Conditions

Before I wrap up our two lesson discussion on joins, I think it is worthwhile to summarize some key points regarding joins and their use:

* Pay careful attention to the type of join being used. More often than not, you'll want an inner join, but there are often valid uses for outer joins, too.
* Check your DBMSs documentation for the exact join syntax it supports. (Most DBMSs use one of the forms of syntax described in these two lessons.)
* Make sure you use the correct join condition (regardless of the syntax being used), or you'll return incorrect data.
* Make sure you always provide a join condition, or you'll end up with the Cartesian product.
* You may include multiple tables in a join and even have different join types for each. Although this is legal and often useful, make sure you test each join separately before testing them together. This will make troubleshooting far simpler.

## 20.5 Summary

This lesson was a continuation of the last lesson on joins. This lesson started by teaching you how and why to use aliases, and then continued with a discussion on different join types and various forms of syntax used with each. You also learned how to use aggregate functions with joins, and some important do's and don'ts to keep in mind when working with joins.

# 21. Lesson 14. Combining Queries

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| In this lesson, you'll learn how to use the *UNION* operator to combine multiple *SELECT* statements into one result set. |

## 21.1 Understanding Combined Queries

Most SQL queries contain a single SELECT statement that returns data from one or more tables. SQL also enables you to perform multiple queries (multiple SELECT statements) and return the results as a single query result set. These combined queries are usually known as unions or compound queries.

There are basically two scenarios in which you'd use combined queries:

* To return similarly structured data from different tables in a single query
* To perform multiple queries against a single table returning the data as one query

|  |  |
| --- | --- |
| 说明: graphics/tip_icon.gif | Combining Queries and Multiple **WHERE** Conditions For the most part, combining two queries to the same table accomplishes the same thing as a single query with multiple WHERE clause conditions. In other words, any SELECT statement with multiple WHERE clauses can also be specified as a combined query, as you'll see in the section that follows. |

## 21.2 Creating Combined Queries

SQL queries are combined using the UNION operator. Using UNION, multiple SELECT statements can be specified, and their results can be combined into a single result set.

**Using UNION**

Using UNION is simple enough. All you do is specify each SELECT statement and place the keyword UNION between each.

Let's look at an example. You need a report on all your customers in Illinois, Indiana, and Michigan. You also want to include all Fun4All locations, regardless of state. Of course, you can create a WHERE clause that will do this, but this time you'll use a UNION instead.

As I just explained, creating a UNION involves writing multiple SELECT statements. First look at the individual statements:

说明: graphics/input_icon.jpg

SELECT cust\_name, cust\_contact, cust\_email

FROM Customers

WHERE cust\_state IN ('IL','IN','MI');

说明: graphics/output_icon.jpg

cust\_name cust\_contact cust\_email

----------- ------------- ------------

Village Toys John Smith sales@villagetoys.com

Fun4All Jim Jones jjones@fun4all.com

The Toy Store Kim Howard NULL

说明: graphics/input_icon.jpg

SELECT cust\_name, cust\_contact, cust\_email

FROM Customers

WHERE cust\_name = 'Fun4All';

说明: graphics/output_icon.jpg

cust\_name cust\_contact cust\_email

--------- ------------ ----------

Fun4All Jim Jones jjones@fun4all.com

Fun4All Denise L. Stephens dstephens@fun4all.com

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | The first SELECT retrieves all rows in Illinois, Indiana, and Michigan by passing those state abbreviations to the IN clause. The second SELECT uses a simple equality test to find all Fun4All locations. |

To combine these two statements, do the following:

说明: graphics/input_icon.jpg

SELECT cust\_name, cust\_contact, cust\_email

FROM Customers

WHERE cust\_state IN ('IL','IN','MI')

UNION

SELECT cust\_name, cust\_contact, cust\_email

FROM Customers

WHERE cust\_name = 'Fun4All';

说明: graphics/output_icon.jpg

cust\_name cust\_contact cust\_email

--------- ------------ ----------

Fun4All Denise L. Stephens dstephens@fun4all.com

Fun4All Jim Jones jjones@fun4all.com

Village Toys John Smith sales@villagetoys.com

The Toy Store Kim Howard NULL

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | The preceding statements are made up of both of the previous SELECT statements separated by the UNION keyword. UNION instructs the DBMS to execute both SELECT statements and combine the output into a single query result set. |

As a point of reference, here is the same query using multiple WHERE clauses instead of a UNION:

说明: graphics/input_icon.jpg

SELECT cust\_name, cust\_contact, cust\_email

FROM Customers

WHERE cust\_state IN ('IL','IN','MI')

OR cust\_name = 'Fun4All';

In our simple example, the UNION might actually be more complicated than using a WHERE clause. But with more complex filtering conditions, or if the data is being retrieved from multiple tables (and not just a single table), the UNION could have made the process much simpler indeed.

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| --- | --- |
| 说明: graphics/tip_icon.gif | **UNION** Limits There is no standard SQL limit to the number of SELECT statements that can be combined with UNION statements. However, it is best to consult your DBMS documentation to ensure that it does not enforce any maximum statement restrictions of its own. |

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| 说明: graphics/tip_icon.gif | Performance Issues Most good DBMSs use an internal query optimizer to combine the SELECT statements before they are even processed. In theory, this means that from a performance perspective, there should be no real difference between using multiple WHERE clause conditions or a UNION. I say in theory, because, in practice, most query optimizers don't always do as good a job as they should. Your best bet is to test both methods to see which will work best for you. |

**UNION Rules**

As you can see, unions are very easy to use. But there are a few rules governing exactly which can be combined:

* A UNION must be comprised of two or more SELECT statements, each separated by the keyword UNION (so, if combining four SELECT statements there would be three UNION keywords used).
* Each query in a UNION must contain the same columns, expressions, or aggregate functions (although columns need not be listed in the same order).
* Column datatypes must be compatible: They need not be the exact same type, but they must be of a type that the DBMS can implicitly convert (for example, different numeric types or different date types).

Aside from these basic rules and restrictions, unions can be used for any data retrieval tasks.

**Including or Eliminating Duplicate Rows**

Go back to the preceding section titled "[Using UNION](#Bookmark78_ch14lev2sec1)" and look at the sample SELECT statements used. You'll notice that when executed individually, the first SELECT statement returns three rows, and the second SELECT statement returns two rows. However, when the two SELECT statements are combined with a UNION, only four rows are returned, not five.

The UNION automatically removes any duplicate rows from the query result set (in other words, it behaves just as do multiple WHERE clause conditions in a single SELECT would). Because there is a Fun4All location in Indiana, that row was returned by both SELECT statements. When the UNION was used the duplicate row was eliminated.

This is the default behavior of UNION, but you can change this if you so desire. If you would, in fact, want all occurrences of all matches returned, you can use UNION ALL instead of UNION.

Look at the following example:

说明: graphics/input_icon.jpg

SELECT cust\_name, cust\_contact, cust\_email

FROM Customers

WHERE cust\_state IN ('IL','IN','MI')

UNION ALL

SELECT cust\_name, cust\_contact, cust\_email

FROM Customers

WHERE cust\_name = 'Fun4All';

说明: graphics/output_icon.jpg

cust\_name cust\_contact cust\_email

----------- ------------ ----------

Village Toys John Smith sales@villagetoys.com

Fun4All Jim Jones jjones@fun4all.com

The Toy Store Kim Howard NULL

Fun4All Jim Jones jjones@fun4all.com

Fun4All Denise L. Stephens dstephens@fun4all.com

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | Using UNION ALL, the DBMS does not eliminate duplicates. Therefore, the preceding example returns five rows, one of them occurring twice. |

|  |  |
| --- | --- |
| 说明: graphics/tip_icon.gif | **UNION** versus **WHERE** At the beginning of this lesson, I said that UNION almost always accomplishes the same thing as multiple WHERE conditions. UNION ALL is the form of UNION that accomplishes what cannot be done with WHERE clauses. If you do, in fact, want all occurrences of matches for every condition (including duplicates), you must use UNION ALL and not WHERE. |

**Sorting Combined Query Results**

SELECT statement output is sorted using the ORDER BY clause. When combining queries with a UNION only one ORDER BY clause may be used, and it must occur after the final SELECT statement. There is very little point in sorting part of a result set one way and part another way, and so multiple ORDER BY clauses are not allowed.

The following example sorts the results returned by the previously used UNION:

说明: graphics/input_icon.jpg

SELECT cust\_name, cust\_contact, cust\_email

FROM Customers

WHERE cust\_state IN ('IL','IN','MI')

UNION

SELECT cust\_name, cust\_contact, cust\_email

FROM Customers

WHERE cust\_name = 'Fun4All'

ORDER BY cust\_name, cust\_contact;

说明: graphics/output_icon.jpg

cust\_name cust\_contact cust\_email

----------- ------------ ----------

Fun4All Denise L. Stephens dstephens@fun4all.com

Fun4All Jim Jones jjones@fun4all.com

The Toy Store Kim Howard NULL

Village Toys John Smith sales@villagetoys.com

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | This UNION takes a single ORDER BY clause after the final SELECT statement. Even though the ORDER BY appears to only be a part of that last SELECT statement, the DBMS will in fact use it to sort all the results returned by all the SELECT statements. |

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| 说明: graphics/note_icon.gif | Other **UNION** Types Some DBMSs support two additional types of UNION. EXCEPT (sometimes called MINUS) can be used to only retrieve the rows that exist in the first table but not in the second, and INTERSECT can be used to retrieve only the rows that exist in both tables. In practice, however, these UNION types are rarely used as the same results can be accomplished using joins. |

## 21.3 Summary

In this lesson, you learned how to combine SELECT statements with the UNION operator. Using UNION, you can return the results of multiple queries as one combined query, either including or excluding duplicates. The use of UNION can greatly simplify complex WHERE clauses and retrieving data from multiple tables.

# 22. Lesson 15. Inserting Data

|  |
| --- |
| In this lesson, you will learn how to insert data into tables using the SQL *INSERT* statement. |

## 22.1 Understanding Data Insertion

SELECT is undoubtedly the most frequently used SQL statement (which is why the last 14 lessons were dedicated to it). But there are three other frequently used SQL statements that you should learn. The first one is INSERT. (You'll get to the other two in the next lesson.)

As its name suggests, INSERT is used to insert (add) rows to a database table. Insert can be used in several ways:

* To insert a single complete row
* To insert a single partial row
* To insert the results of a query

You'll now look at each of these.

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| 说明: graphics/tip_icon.gif | **INSERT** and System Security Use of the INSERT statement might require special security privileges in client-server DBMSs. Before you attempt to use INSERT, make sure you have adequate security privileges to do so. |

**Inserting Complete Rows**

The simplest way to insert data into a table is to use the basic INSERT syntax, which requires that you specify the table name and the values to be inserted into the new row. Here is an example of this:

说明: graphics/input_icon.jpg

INSERT INTO Customers

VALUES('1000000006',

'Toy Land',

'123 Any Street',

'New York',

'NY',

'11111',

'USA',

NULL,

NULL);

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | The above example inserts a new customer into the Customers table. The data to be stored in each table column is specified in the VALUES clause, and a value must be provided for every column. If a column has no value (for example, the cust\_contact and cust\_email columns above), the NULL value should be used (assuming the table allows no value to be specified for that column). The columns must be populated in the order in which they appear in the table definition. |

|  |  |
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| 说明: graphics/tip_icon.gif | The **INTO** Keyword In some SQL implementations, the INTO keyword following INSERT is optional. However, it is good practice to provide this keyword even if it is not needed. Doing so will ensure that your SQL code is portable between DBMSs. |

Although this syntax is indeed simple, it is not at all safe and should generally be avoided at all costs. The above SQL statement is highly dependent on the order in which the columns are defined in the table. It also depends on information about that order being readily available. Even if it is available, there is no guarantee that the columns will be in the exact same order the next time the table is reconstructed. Therefore, writing SQL statements that depend on specific column ordering is very unsafe. If you do so, something will inevitably break at some point.

The safer (and unfortunately more cumbersome) way to write the INSERT statement is as follows:

说明: graphics/input_icon.jpg

INSERT INTO Customers(cust\_id,

cust\_name,

cust\_address,

cust\_city,

cust\_state,

cust\_zip,

cust\_country,

cust\_contact,

cust\_email)

VALUES('1000000006',

'Toy Land',

'123 Any Street',

'New York',

'NY',

'11111',

'USA',

NULL,

NULL);

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | This example does the exact same thing as the previous INSERT statement, but this time the column names are explicitly stated in parentheses after the table name. When the row is inserted the DBMS will match each item in the columns list with the appropriate value in the VALUES list. The first entry in VALUES corresponds to the first specified column name. The second value corresponds to the second column name, and so on. |

Because column names are provided, the VALUES must match the specified column names in the order in which they are specified, and not necessarily in the order that the columns appear in the actual table. The advantage of this is that, even if the table layout changes, the INSERT statement will still work correctly.

The following INSERT statement populates all the row columns (just as before), but it does so in a different order. Because the column names are specified, the insertion will work correctly:

说明: graphics/input_icon.jpg

INSERT INTO Customers(cust\_id,

cust\_contact,

cust\_email,

cust\_name,

cust\_address,

cust\_city,

cust\_state,

cust\_zip)

VALUES('1000000006',

NULL,

NULL,

'Toy Land',

'123 Any Street',

'New York',

'NY',

'11111');

|  |  |
| --- | --- |
| 说明: graphics/tip_icon.gif | Always Use a Columns List As a rule, never use INSERT without explicitly specifying the column list. This will greatly increase the probability that your SQL will continue to function in the event that table changes occur. |

|  |  |
| --- | --- |
| 说明: graphics/caution_icon.gif | Use **VALUES** Carefully Regardless of the INSERT syntax being used, the correct number of VALUES must be specified. If no column names are provided, a value must be present for every table column. If columns names are provided, a value must be present for each listed column. If none is present, an error message will be generated, and the row will not be inserted. |

**Inserting Partial Rows**

As I just explained, the recommended way to use INSERT is to explicitly specify table column names. Using this syntax, you can also omit columns. This means you only provide values for some columns, but not for others.

Look at the following example:

说明: graphics/input_icon.jpg

INSERT INTO Customers(cust\_id,

cust\_name,

cust\_address,

cust\_city,

cust\_state,

cust\_zip,

cust\_country)

VALUES('1000000006',

'Toy Land',

'123 Any Street',

'New York',

'NY',

'11111',

'USA');

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | In the examples given earlier in this lesson, values were not provided for two of the columns, cust\_contact and cust\_email. This means there is no reason to include those columns in the INSERT statement. This INSERT statement, therefore, omits the two columns and the two corresponding values. |

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| 说明: graphics/caution_icon.gif | Omitting Columns You may omit columns from an INSERT operation if the table definition so allows. One of the following conditions must exist:   * The column is defined as allowing NULL values (no value at all). * A default value is specified in the table definition. This means the default value will be used if no value is specified.   If you omit a value from a table that does not allow NULL values and does not have a default, the DBMS will generate an error message, and the row will not be inserted. |

**Inserting Retrieved Data**

INSERT is usually used to add a row to a table using specified values. There is another form of INSERT that can be used to insert the result of a SELECT statement into a table. This is known as INSERT SELECT, and, as its name suggests, it is made up of an INSERT statement and a SELECT statement.

Suppose you want to merge a list of customers from another table into your Customers table. Instead of reading one row at a time and inserting it with INSERT, you can do the following:

|  |  |
| --- | --- |
| 说明: graphics/note_icon.gif | Instructions Needed for the Next Example The following example imports data from a table named CustNew into the Customers table. To try this example, create and populate the CustNew table first. The format of the CustNew table should be the same as the Customers table described in [Appendix A](#Bookmark119)(See 30.). When populating CustNew, be sure not to use cust\_id values that were already used in Customers (the subsequent INSERT operation will fail if primary key values are duplicated). |

说明: graphics/input_icon.jpg

INSERT INTO Customers(cust\_id,

cust\_contact,

cust\_email,

cust\_name,

cust\_address,

cust\_city,

cust\_state,

cust\_zip,

cust\_country)

SELECT cust\_id,

cust\_contact,

cust\_email,

cust\_name,

cust\_address,

cust\_city,

cust\_state,

cust\_zip,

cust\_country

FROM CustNew;

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | This example uses INSERT SELECT to import all the data from CustNew into Customers. Instead of listing the VALUES to be inserted, the SELECT statement retrieves them from CustNew. Each column in the SELECT corresponds to a column in the specified columns list. How many rows will this statement insert? That depends on how many rows are in the CustNew table. If the table is empty, no rows will be inserted (and no error will be generated because the operation is still valid). If the table does, in fact, contain data, all that data is inserted into Customers. |

|  |  |
| --- | --- |
| 说明: graphics/tip_icon.gif | Column Names in **INSERT SELECT** This example uses the same column names in both the INSERT and SELECT statements for simplicity's sake. But there is no requirement that the column names match. In fact, the DBMS does not even pay attention to the column names returned by the SELECT. Rather, the column position is used, so the first column in the SELECT (regardless of its name) will be used to populate the first specified table column, and so on. |

The SELECT statement used in an INSERT SELECT can include a WHERE clause to filter the data to be inserted.

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| 说明: graphics/tip_icon.gif | Inserting Multiple Rows INSERT usually inserts only a single row. To insert multiple rows you must execute multiple INSERT statements. The exception to this rule is INSERT SELECT, which can be used to insert multiple rows with a single statement-whatever the SELECT statement returns will be inserted by the INSERT. |

## 22.2 Copying from One Table to Another

There is another form of data insertion that does not use the INSERT statement at all. To copy the contents of a table into a brand new table (one that is created on-the-fly) you can use the SELECT INTO statement.

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| 说明: graphics/note_icon.gif | Not Supported by DB2 DB2 does not support the use of SELECT INTO as described here. |

Unlike INSERT SELECT, which appends data to an existing table, SELECT INTO copies data into a new table (and depending on the DBMS being used, can overwrite the table if it already exists).

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| --- | --- |
| 说明: graphics/note_icon.gif | **INSERT SELECT** versus **SELECT INTO** One way to explain the differences between SELECT INTO and INSERT SELECT is that the former exports data while the later imports data. |

The following example demonstrates the use of SELECT INTO:

说明: graphics/input_icon.jpg

SELECT \*

INTO CustCopy

FROM Customers;

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | This SELECT statement creates a new table named CustCopy and copies the entire contents of the Customers table into it. Because SELECT \* was used, every column in the Customers table will be created (and populated) in the CustCopy table. To copy only a subset of the available columns, explicit column names can be specified instead of the \* wildcard character. |

MySQL and Oracle use a slightly different syntax:

说明: graphics/input_icon.jpg

CREATE TABLE CustCopy AS

SELECT \*

FROM Customers;

Here are some things to consider when using SELECT INTO:

* Any SELECT options and clauses may be used including WHERE and GROUP BY.
* Joins may be used to insert data from multiple tables.
* Data may only be inserted into a single table regardless of how many tables the data was retrieved from.

|  |  |
| --- | --- |
| 说明: graphics/tip_icon.gif | Making Copies of Tables SELECT INTO is a great way to make copies of tables before experimenting with new SQL statements. By making a copy first, you'll be able to test your SQL on that copy instead of on live data. |

|  |  |
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| 说明: graphics/note_icon.gif | More Examples Looking for more examples of INSERT usage? See the example table population scripts described in [Appendix A](#Bookmark119)(See 30.), "Sample Table Scripts." |

## 22.3 Summary

In this lesson, you learned how to INSERT rows into a database table. You learned several ways to use INSERT, and why explicit column specification is preferred. You also learned how to use INSERT SELECT to import rows from another table, and how to use SELECT INTO to export rows to a new table. In the next lesson, you'll learn how to use UPDATE and DELETE to further manipulate table data.

# 23. Lesson 16. Updating and Deleting Data

In this lesson, you will learn how to use the *UPDATE* and *DELETE* statements to enable you to further manipulate your table data.

## 23.1 Updating Data

To update (modify) data in a table the UPDATE statement is used. UPDATE can be used in two ways:

* To update specific rows in a table
* To update all rows in a table

Let's take a look at each of these uses.

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| --- | --- |
| 说明: graphics/caution_icon.gif | Don't Omit the **WHERE** Clause Special care must be exercised when using UPDATE, because it is all too easy to mistakenly update every row in your table. Please read this entire section on [UPDATE](#Bookmark151)(See 32.13) before using this statement. |

|  |  |
| --- | --- |
| 说明: graphics/tip_icon.gif | **UPDATE** and Security Use of the UPDATE statement might require special security privileges in client-server DBMSs. Before you attempt to use UPDATE, make sure you have adequate security privileges to do so. |

The UPDATE statement is very easy to use-some would say too easy. The basic format of an UPDATE statement is made up of three parts:

* The table to be updated
* The column names and their new values
* The filter condition that determines which rows should be updated

Let's take a look at a simple example. Customer 1000000005 now has an email address, and so his record needs updating. The following statement performs this update:

说明: graphics/input_icon.jpg

UPDATE Customers

SET cust\_email = 'kim@thetoystore.com'

WHERE cust\_id = '1000000005';

The UPDATE statement always begins with the name of the table being updated. In this example, it is the Customers table. The SET command is then used to assign the new value to a column. As used here, the SET clause sets the cust\_email column to the specified value:

SET cust\_email = 'kim@thetoystore.com'

The UPDATE statement finishes with a WHERE clause that tells the DBMS which row to update. Without a WHERE clause, the DBMS would update all the rows in the Customers table with this new email address-definitely not the desired effect.

Updating multiple columns requires a slightly different syntax:

说明: graphics/input_icon.jpg

UPDATE Customers

SET cust\_contact = 'Sam Roberts',

cust\_email = 'sam@toyland.com'

WHERE cust\_id = '1000000006';

When updating multiple columns, only a single SET command is used, and each column = value pair is separated by a comma. (No comma is specified after the last column.) In this example, columns cust\_contact and cust\_email will both be updated for customer 1000000006.

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| 说明: graphics/tip_icon.gif | Using Subqueries in an **UPDATE** Statement Subqueries may be used in UPDATE statements, enabling you to update columns with data retrieved with a SELECT statement. Refer back to [Lesson 11](#Bookmark61)(See 18.), "Working with Subqueries," for more information on subqueries and their uses. |

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| 说明: graphics/tip_icon.gif | The **FROM** Keyword Some SQL implementations support a FROM clause in the UPDATE statement that can be used to update the rows in one table with data from another table. Refer to your DBMS documentation to see if it supports this feature. |

To delete a column's value, you can set it to NULL (assuming the table is defined to allow NULL values). You can do this as follows:

说明: graphics/input_icon.jpg

UPDATE Customers

SET cust\_email = NULL

WHERE cust\_id = '1000000005';

Here the NULL keyword is used to save no value to the cust\_email column.

## 23.2 Deleting Data

To delete (remove) data from a table, the DELETE statement is used. DELETE can be used in two ways:

* To delete specific rows from a table
* To delete all rows from a table

You'll now take a look at each of these.

|  |  |
| --- | --- |
| 说明: graphics/caution_icon.gif | Don't Omit the **WHERE** Clause Special care must be exercised when using DELETE because it is all too easy to mistakenly delete every row from your table. Please read this entire section on [DELETE](#Bookmark145)(See 32.7) before using this statement. |

|  |  |
| --- | --- |
| 说明: graphics/tip_icon.gif | **DELETE** and Security Use of the DELETE statement might require special security privileges in client-server DBMSs. Before you attempt to use DELETE, make sure you have adequate security privileges to do so. |

I already stated that UPDATE is very easy to use. The good (and bad) news is that DELETE is even easier to use.

The following statement deletes a single row from the Customers table:

说明: graphics/input_icon.jpg

DELETE FROM Customers

WHERE cust\_id = '1000000006';

This statement should be self-explanatory. DELETE FROM requires that you specify the name of the table from which the data is to be deleted. The WHERE clause filters which rows are to be deleted. In this example, only customer 1000000006 will be deleted. If the WHERE clause were omitted, this statement would have deleted every customer in the table.

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| --- | --- |
| 说明: graphics/tip_icon.gif | The **FROM** Keyword In some SQL implementations, the FROM keyword following DELETE is optional. However, it is good practice to always provide this keyword, even if it is not needed. Doing this will ensure that your SQL code is portable between DBMSs |

DELETE takes no column names or wildcard characters. DELETE deletes entire rows, not columns. To delete specific columns use an UPDATE statement.

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| --- | --- |
| 说明: graphics/note_icon.gif | Table Contents, Not Tables The DELETE statement deletes rows from tables, even all rows from tables. But DELETE never deletes the table itself. |

|  |  |
| --- | --- |
| 说明: graphics/tip_icon.gif | Faster Deletes If you really do want to delete all rows from a table, don't use DELETE. Instead, use the TRUNCATE TABLE statement which accomplished the same thing but does it much quicker (because data changes are not logged). |

## 23.3 Guidelines for Updating and Deleting Data

The UPDATE and DELETE statements used in the previous section all have WHERE clauses, and there is a very good reason for this. If you omit the WHERE clause, the UPDATE or DELETE will be applied to every row in the table. In other words, if you execute an UPDATE without a WHERE clause, every row in the table will be updated with the new values. Similarly if you execute DELETE without a WHERE clause, all the contents of the table will be deleted.

Here are some best practices that many SQL programmers follow:

* Never execute an UPDATE or a DELETE without a WHERE clause unless you really do intend to update and delete every row.
* Make sure every table has a primary key (refer back to [Lesson 12](#Bookmark66)(See 19.), "Joining Tables," if you have forgotten what this is), and use it as the WHERE clause whenever possible. (You may specify individual primary keys, multiple values, or value ranges.)
* Before you use a WHERE clause with an UPDATE or a DELETE, first test it with a SELECT to make sure it is filtering the right records-it is far too easy to write incorrect WHERE clauses.
* Use database enforced referential integrity (refer back to [Lesson 12](#Bookmark66)(See 19.) for this one, too) so that the DBMS will not allow the deletion of rows that have data in other tables related to them.
* Some DBMSs allow database administrators to impose restrictions that prevent the execution of UPDATE or DELETE without a WHERE clause. If your DBMS supports this feature, consider using it.

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| --- | --- |
| 说明: graphics/caution_icon.gif | Use With Caution The bottom line is that SQL has no Undo button. Be very careful using UPDATE and DELETE, or you'll find yourself updating and deleting the wrong data. |

## 23.4 Summary

In this lesson, you learned how to use the UPDATE and DELETE statements to manipulate the data in your tables. You learned the syntax for each of these statements, as well as the inherent dangers they expose. You also learned why WHERE clauses are so important in UPDATE and DELETE statements, and you were given guidelines that should be followed to help ensure that data does not get damaged inadvertently.

# 24. Lesson 17. Creating and Manipulating Tables

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| --- |
| In this lesson you'll learn the basics of table creation, alteration, and deletion. |

## 24.1 Creating Tables

SQL is not used just for table data manipulation. Rather, SQL can be used to perform all database and table operations, including the creation and manipulation of tables themselves.

There are generally two ways to create database tables:

* Most DBMSs come with an administration tool that can be used to create and manage database tables interactively.
* Tables may also be manipulated directly with SQL statements.

To create tables programmatically, the CREATE TABLE SQL statement is used. It is worth noting that when you use interactive tools, you are actually using SQL statements. Instead of your writing these statements, however, the interface generates and executes the SQL seamlessly for you (the same is true for changes to existing tables).

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| 说明: graphics/caution_icon.gif | Syntax Differences The exact syntax of the CREATE TABLE statement can vary from one SQL implementation to another. Be sure to refer to your DBMS documentation for more information on exactly what syntax and features it supports. |

Complete coverage of all the options available when creating tables is beyond the scope of this lesson, but here are the basics. I'd recommend that you review your DBMS documentation for more information and specifics.

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| 说明: graphics/note_icon.gif | DBMS Specific Examples For examples of DBMS specific CREATE TABLE statements, see the example table creation scripts described in [Appendix A](#Bookmark119)(See 30.), "Sample Table Scripts." |

**Basic Table Creation**

To create a table using CREATE TABLE, you must specify the following information:

* The name of the new table specified after the keywords CREATE TABLE.
* The name and definition of the table columns separated by commas.
* Some DBMSs require that you also specify the table location.

The following SQL statement creates the Products table used throughout this book:

说明: graphics/input_icon.jpg

CREATE TABLE Products

(

prod\_id CHAR(10) NOT NULL,

vend\_id CHAR(10) NOT NULL,

prod\_name CHAR(254) NOT NULL,

prod\_price DECIMAL(8,2) NOT NULL,

prod\_desc VARCHAR(1000) NULL

);

|  |  |
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| 说明: graphics/analysis_icon.jpg | As you can see in the above statement, the table name is specified immediately following the CREATE TABLE keywords. The actual table definition (all the columns) is enclosed within parentheses. The columns themselves are separated by commas. This particular table is made up of five columns. Each column definition starts with the column name (which must be unique within the table), followed by the column's datatype. (Refer to [Lesson 1](#Bookmark10)(See 8.), "Understanding SQL," for an explanation of datatypes. In addition, [Appendix D](#Bookmark152)(See 33.), "Using SQL Datatypes," lists commonly used datatypes and their compatibility.) The entire statement is terminated with a semicolon after the closing parenthesis. |

I mentioned earlier that CREATE TABLE syntax varies greatly from one DBMS to another, and the simple script just seen demonstrates this. While the statement will work as is on Oracle, PostgreSQL, SQL Server, and Sybase, for MySQL the varchar must be replaced with text, and for DB2 the NULL must be removed from the final column. This is why I had to create a different SQL table creation script for each DBMS (as explained in [Appendix A](#Bookmark119)(See 30.)).

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| 说明: graphics/tip_icon.gif | Statement Formatting As you will recall, whitespace is ignored in SQL statements. Statements can be typed on one long line or broken up over many lines. It makes no difference at all. This enables you to format your SQL as best suits you. The preceding CREATE TABLE statement is a good example of SQL statement formatting-the code is specified over multiple lines, with the column definitions indented for easier reading and editing. Formatting your SQL in this way is entirely optional, but highly recommended. |

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| 说明: graphics/tip_icon.gif | Replacing Existing Tables When you create a new table, the table name specified must not exist or you'll generate an error. To prevent accidental overwriting, SQL requires that you first manually remove a table (see later sections for details) and then recreate it, rather than just overwriting it. |

**Working with NULL Values**

Back in [Lesson 4](#Bookmark27)(See 11.), "Filtering Data," you learned that NULL values are no values or the lack of a value. A column that allows NULL values also allows rows to be inserted with no value at all in that column. A column that does not allow NULL values does not accept rows with no value-in other words, that column will always be required when rows are inserted or updated.

Every table column is either a NULL column or a NOT NULL column, and that state is specified in the table definition at creation time. Take a look at the following example:

说明: graphics/input_icon.jpg

CREATE TABLE Orders

(

order\_num INTEGER NOT NULL,

order\_date DATETIME NOT NULL,

cust\_id CHAR(10) NOT NULL

);

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | This statement creates the Orders table used throughout this book. Orders contains three columns: order number, order date, and the customer ID. All three columns are required, and so each contains the keyword NOT NULL. This will prevent the insertion of columns with no value. If someone tries to insert no value, an error will be returned, and the insertion will fail. |

This next example creates a table with a mixture of NULL and NOT NULL columns:

说明: graphics/input_icon.jpg

CREATE TABLE Vendors

(

vend\_id CHAR(10) NOT NULL,

vend\_name CHAR(50) NOT NULL,

vend\_address CHAR(50) ,

vend\_city CHAR(50) ,

vend\_state CHAR(5) ,

vend\_zip CHAR(10) ,

vend\_country CHAR(50)

);

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | This statement creates the Vendors table used throughout this book. The vendor ID and vendor name columns are both required, and are, therefore, specified as NOT NULL. The five remaining columns all allow NULL values, and so NOT NULL is not specified. NULL is the default setting, so if NOT NULL is not specified NULL is assumed. |

|  |  |
| --- | --- |
| 说明: graphics/caution_icon.gif | Specifying **NULL** Most DBMSs treat the absence of NOT NULL to mean NULL. However, not all do. DB2 requires the keyword NULL and will generate an error if it is not specified. Refer to your DBMS documentation for complete syntax information. |

|  |  |
| --- | --- |
| 说明: graphics/tip_icon.gif | Primary Keys and **NULL** Values Back in [Lesson 1](#Bookmark10)(See 8.), you learned that primary keys are columns whose values uniquely identify every row in a table. Only columns that do not allow NULL values can be used in primary keys. Columns that allow no value at all cannot be used as unique identifiers. |

|  |  |
| --- | --- |
| 说明: graphics/caution_icon.gif | Understanding **NULL** Don't confuse NULL values with empty strings. A NULL value is the lack of a value; it is not an empty string. If you were to specify '' (two single quotes with nothing in between them), that would be allowed in a NOT NULL column. An empty string is a valid value; it is not no value. NULL values are specified with the keyword NULL, not with an empty string. |

**Specifying Default Values**

SQL enables you to specify default values to be used if no value is specified when a row is inserted. Default values are specified using the DEFAULT keyword in the column definitions in the CREATE TABLE statement.

Look at the following example:

说明: graphics/input_icon.jpg

CREATE TABLE OrderItems

(

order\_num INTEGER NOT NULL,

order\_item INTEGER NOT NULL,

prod\_id CHAR(10) NOT NULL,

quantity INTEGER NOT NULL DEFAULT 1,

item\_price DECIMAL(8,2) NOT NULL

);

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | This statement creates the OrderItems table that contains the individual items that make up an order. (The order itself is stored in the Orders table.) The quantity column contains the quantity for each item in an order. In this example, adding the text DEFAULT 1 to the column description instructs the DBMS to use a quantity of 1 if no quantity is specified. |

Default values are often used to store values in date or time stamp columns. For example, the system date can be used as a default date by specifying the function or variable used to refer to the system date. For example, MySQL users might specify DEFAULT CURRENT\_DATE(), while Oracle users might specify DEFAULT SYSDATE, and SQL Server users might specify DEFAULT GETDATE(). Unfortunately, the command used to obtain the system date is different in just about every DBMS. [Table 17.1](#Bookmark90_ch17table01) lists the syntax for some DBMSs. If yours is not listed here consult your DBMSs documentation.

| **Table 17.1. Obtaining The System Date** | |
| --- | --- |
| DBMS | Function/Variable |
| Access | NOW() |
| DB2 | CURRENT\_DATE |
| MySQL | CURRENT\_DATE() |
| Oracle | SYSDATE |
| PostgreSQL | CURRENT\_DATE |
| SQL Server | GETDATE() |
| Sybase | GETDATE() |

|  |  |
| --- | --- |
| 说明: graphics/tip_icon.gif | Using **DEFAULT** Instead of **NULL** Values Many database developers use DEFAULT values instead of NULL columns, especially in columns that will be used in calculations or data groupings. |

## 24.2 Updating Tables

To update table definitions, the ALTER TABLE statement is used. Although all DBMSs support ALTER TABLE, what they allow you to alter varies dramatically from one to another. Here are some points to consider when using ALTER TABLE:

* Ideally, tables should never be altered after they contain data. You should spend sufficient time anticipating future needs during the table design process so that extensive changes are not required later on.
* All DBMSs allow you to add columns to existing tables, although some restrict the datatypes that may be added (as well as NULL and DEFAULT usage).
* Many DBMSs do not allow you to remove or change columns in a table.
* Most DBMSs allow you to rename columns.
* Many DBMSs restrict the kinds of changes you can make on columns that are populated and enforce fewer restrictions on unpopulated columns.

As you can see, making changes to existing tables is neither simple nor consistent. Be sure to refer to your own DBMS documentation to determine exactly what you can alter.

To change a table using ALTER TABLE, you must specify the following information:

* The name of the table to be altered after the keywords ALTER TABLE. (The table must exist or an error will be generated.)
* The list of changes to be made.

Because adding columns to an existing table is about the only operation supported by all DBMSs, I'll use that for an example:

说明: graphics/input_icon.jpg

ALTER TABLE Vendors

ADD vend\_phone CHAR(20);

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | This statement adds a column named vend\_phone to the Vendors table. The datatype must be specified. |

Other alter operations, for example, changing or dropping columns, or adding constraints or keys, use a similar syntax. (Note that the following example will not work with all DBMSs):

说明: graphics/input_icon.jpg

ALTER TABLE Vendors

DROP COLUMN vend\_phone;

Complex table structure changes usually require a manual move process involving these steps:

* Create a new table with the new column layout.
* Use the INSERT SELECT statement (see [Lesson 15](#Bookmark80)(See 22.), "Inserting Data," for details of this statement) to copy the data from the old table to the new table. Use conversion functions and calculated fields, if needed.
* Verify that the new table contains the desired data.
* Rename the old table (or delete it, if you are really brave).
* Rename the new table with the name previously used by the old table.
* Recreate any triggers, stored procedures, indexes, and foreign keys as needed.

|  |  |
| --- | --- |
| 说明: graphics/caution_icon.gif | Use **ALTER TABLE** Carefully Use ALTER TABLE with extreme caution, and be sure you have a complete set of backups (both schema and data) before proceeding. Database table changes cannot be undone-and if you add columns you don't need, you might not be able to remove them. Similarly, if you drop a column that you do need, you might lose all the data in that column. |

## 24.3 Deleting Tables

Deleting tables (actually removing the entire table, not just the contents) is very easy-arguably too easy. Tables are deleted using the DROP TABLE statement:

说明: graphics/input_icon.jpg

DROP TABLE CustCopy;

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | This statement deletes the CustCopy table. (You created that one in [Lesson 15](#Bookmark80)(See 22.).) There is no confirmation, nor is there an undo-executing the statement will permanently remove the table. |

|  |  |
| --- | --- |
| 说明: graphics/tip_icon.gif | Using Relational Rules to Prevent Accidental Deletion Many DBMSs allow you to enforce rules that prevent the dropping of tables that are related to other tables. When these rules are enforced, if you issue a DROP TABLE statement against a table that is part of a relationship, the DBMS blocks the operation until the relationship was removed. It is a good idea to enable these options, if available, to prevent the accidental dropping of needed tables. |

## 24.4 Renaming Tables

Table renaming is supported differently by each DBMS. There is no hard and fast standard for this operation. DB2, MySQL, Oracle, and PostgreSQL users can use the RENAME statement. SQL Server and Sybase users can use the supplied sp\_rename stored procedure.

The basic syntax for all rename operations requires that you specify the old name and a new name. However, there are DBMS implementation differences. Refer to your own DBMS documentation for details on supported syntax.

## 24.5 Summary

In this lesson, you learned several new SQL statements. CREATE TABLE is used to create new tables, ALTER TABLE is used to change table columns (or other objects like constraints or indexes), and DROP TABLE is used to completely delete a table. These statements should be used with extreme caution, and only after backups have been made. As the exact syntax of each of these statements varies from one DBMS to another, you should consult your own DBMS documentation for more information.

# 25. Lesson 18. Using Views

In this lesson you'll learn exactly what views are, how they work, and when they should be used. You'll also see how views can be used to simplify some of the

## 25.1 Understanding Views

Views are virtual tables. Unlike tables that contain data, views simply contain queries that dynamically retrieve data when used.

|  |  |
| --- | --- |
| 说明: graphics/note_icon.gif | MySQL Support As this book goes to press, MySQL still does not support views (support for views is planned for MySQL 5). As such, the examples in this lesson will not work with MySQL at this time. |

The best way to understand views is to look at an example. Back in [Lesson 12](#Bookmark66)(See 19.), "Joining Tables," you used the following SELECT statement to retrieve data from three tables:

说明: graphics/input_icon.jpg

SELECT cust\_name, cust\_contact

FROM Customers, Orders, OrderItems

WHERE Customers.cust\_id = Orders.cust\_id

AND OrderItems.order\_num = Orders.order\_num

AND prod\_id = 'RGAN01';

That query was used to retrieve the customers who had ordered a specific product. Anyone needing this data would have to understand the table structure, as well as how to create the query and join the tables. To retrieve the same data for another product (or for multiple products), the last WHERE clause would have to be modified.

Now imagine that you could wrap that entire query in a virtual table called ProductCustomers. You could then simply do the following to retrieve the same data:

说明: graphics/input_icon.jpg

SELECT cust\_name, cust\_contact

FROM ProductCustomers

WHERE prod\_id = 'RGAN01';

This is where views come into play. ProductCustomers is a view, and as a view, it does not contain any columns or data. Instead it contains a query-the same query used above to join the tables properly.

|  |  |
| --- | --- |
| 说明: graphics/tip_icon.gif | DBMS Consistency You'll be relieved to know that view creation syntax is supported pretty consistently by all the major DBMSs. |

**Why Use Views**

You've already seen one use for views. Here are some other common uses:

* To reuse SQL statements.
* To simplify complex SQL operations. After the query is written, it can be reused easily, without having to know the details of the underlying query itself.
* To expose parts of a table instead of complete tables.
* To secure data. Users can be given access to specific subsets of tables instead of to entire tables.
* To change data formatting and representation. Views can return data formatted and presented differently from their underlying tables.

For the most part, after views are created, they can be used in the same way as tables. You can perform SELECT operations, filter and sort data, join views to other views or tables, and possibly even add and update data. (There are some restrictions on this last item. More on that in a moment.)

The important thing to remember is views are just that, views into data stored elsewhere. Views contain no data themselves, so the data they return is retrieved from other tables. When data is added or changed in those tables, the views will return that changed data.

|  |  |
| --- | --- |
| 说明: graphics/caution_icon.gif | Performance Issues Because views contain no data, any retrieval needed to execute a query must be processed every time the view is used. If you create complex views with multiple joins and filters, or if you nest views, you may find that performance is dramatically degraded. Be sure you test execution before deploying applications that use views extensively. |

**View Rules and Restrictions**

Before you create views yourself, there are some restrictions of which you should be aware. Unfortunately, the restrictions tend to be very DBMS specific, so check your own DBMS documentation before proceeding.

Here are some of the most common rules and restrictions governing view creation and usage:

* Like tables, views must be uniquely named. (They cannot be named with the name of any other table or view).
* There is no limit to the number of views that can be created.
* To create views, you must have security access. This is usually granted by the database administrator.
* Views can be nested; that is, a view may be built using a query that retrieves data from another view. The exact number of nested levels allowed varies from DBMS to DBMS. (Nesting views might seriously degrade query performance, so test this thoroughly before using it in production environments.)
* Many DBMSs prohibit the use of the ORDER BY clause in view queries.
* Some DBMSs require that every column returned be named-this will require the use of aliases if columns are calculated fields. (See [Lesson 7](#Bookmark40)(See 14.), "Creating Calculated Fields," for more information on column aliases.)
* Views cannot be indexed, nor can they have triggers or default values associated with them.
* Some DBMSs treat views as read-only queries-meaning you can retrieve data from views but not write data back to the underlying tables. Refer to your DBMS documentation for details.
* Some DBMSs allow you to create views that do not allow rows to be inserted or updated if that insertion or update will cause that row to no longer be part of the view. For example, if you have a view that retrieves only customers with email addresses, updating a customer to remove his email address would make that customer fall out of the view. This is the default behavior and is allowed, but depending on your DBMS you might be able to prevent this from occurring.

|  |  |
| --- | --- |
| 说明: graphics/tip_icon.gif | Refer to Your DBMS Documentation That's a long list of rules, and your own DBMS documentation will likely contain additional rules, too. It is worth taking the time to understand what restrictions you must adhere to before creating views. |

## 25.2 Creating Views

So now that you know what views are (and the rules and restrictions that govern them), let's look at view creation.

Views are created using the CREATE VIEW statement. Like CREATE TABLE, CREATE VIEW can only be used to create a view that does not exist.

|  |  |
| --- | --- |
| 说明: graphics/note_icon.gif | To remove a view, the DROP statement is used. The syntax is simply DROP VIEW viewname;.  To overwrite (or update) a view you must first DROP it and then recreate it. |

**Using Views to Simplify Complex Joins**

One of the most common uses of views is to hide complex SQL, and this often involves joins. Look at the following statement:

说明: graphics/input_icon.jpg

CREATE VIEW ProductCustomers AS

SELECT cust\_name, cust\_contact, prod\_id

FROM Customers, Orders, OrderItems

WHERE Customers.cust\_id = Orders.cust\_id

AND OrderItems.order\_num = Orders.order\_num;

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | This statement creates a view named ProductCustomers, which joins three tables to return a list of all customers who have ordered any product. If you were to SELECT \* FROM ProductCustomers, you'd list every customer who ordered anything. |

|  |  |
| --- | --- |
| 说明: graphics/tip_icon.gif | **CREATE VIEW** and SQL Server Unlike most SQL statements, Microsoft SQL Server does not support the use of a semicolon after a CREATE VIEW statement. |

To retrieve a list of customers who ordered product RGAN01 you can do the following:

说明: graphics/input_icon.jpg

SELECT cust\_name, cust\_contact

FROM ProductCustomers

WHERE prod\_id = 'RGAN01';

说明: graphics/output_icon.jpg

cust\_name cust\_contact

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Fun4All Denise L. Stephens

The Toy Store Kim Howard

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | This statement retrieves specific data from the view by issuing a WHERE clause. When the DBMS processes the request, it adds the specified WHERE clause to any existing WHERE clauses in the view query so that the data is filtered correctly. |

As you can see, views can greatly simplify the use of complex SQL statements. Using views, you can write the underlying SQL once and then reuse it as needed.

|  |  |
| --- | --- |
| 说明: graphics/tip_icon.gif | Creating Reusable Views It is a good idea to create views that are not tied to specific data. For example, the view created above returns customers for all products, not just product RGAN01 (for which the view was first created). Expanding the scope of the view enables it to be reused, making it even more useful. It also eliminates the need for you to create and maintain multiple similar views. |

**Using Views to Reformat Retrieved Data**

As mentioned above, another common use of views is for reformatting retrieved data. The following SELECT statement (from [Lesson 7](#Bookmark40)(See 14.), "Creating Calculated Fields") returns vendor name and location in a single combined calculated column:

说明: graphics/input_icon.jpg

SELECT RTRIM(vend\_name) + ' (' + RTRIM(vend\_country) + ')' AS vend\_title

FROM Vendors

ORDER BY vend\_name;

说明: graphics/output_icon.jpg

vend\_title

----------------------------------------------------

Bear Emporium (USA)

Bears R Us (USA)

Doll House Inc. (USA)

Fun and Games (England)

Furball Inc. (USA)

Jouets et ours (France)

The following is the same statement, but using the || syntax (as explained back in [Lesson 7](#Bookmark40)(See 14.)):

说明: graphics/input_icon.jpg

SELECT RTRIM(vend\_name) || ' (' || RTRIM(vend\_country) || ')' AS vend\_title

FROM Vendors

ORDER BY vend\_name;

说明: graphics/output_icon.jpg

vend\_title

----------------------------------------------------

Bear Emporium (USA)

Bears R Us (USA)

Doll House Inc. (USA)

Fun and Games (England)

Furball Inc. (USA)

Jouets et ours (France)

Now suppose that you regularly needed results in this format. Rather than perform the concatenation each time it was needed, you could create a view and use that instead. To turn this statement into a view, you can do the following:

说明: graphics/input_icon.jpg

CREATE VIEW VendorLocations AS

SELECT RTRIM(vend\_name) + ' (' + RTRIM(vend\_country) + ')' AS vend\_title

FROM Vendors;

Here's the same statement using || syntax:

说明: graphics/input_icon.jpg

CREATE VIEW VendorLocations AS

SELECT RTRIM(vend\_name) || ' (' || RTRIM(vend\_country) || ')' AS vend\_title

FROM Vendors;

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | This statement creates a view using the exact same query as the previous SELECT statement. To retrieve the data to create all mailing labels, simply do the following: |

说明: graphics/input_icon.jpg

SELECT \*

FROM VendorLocations;

说明: graphics/output_icon.jpg

vend\_title

----------------------------------------------------

Bear Emporium (USA)

Bears R Us (USA)

Doll House Inc. (USA)

Fun and Games (England)

Furball Inc. (USA)

Jouets et ours (France)

|  |  |
| --- | --- |
| 说明: graphics/note_icon.gif | **SELECT** Restrictions All Apply Earlier in this lesson I stated that the syntax used to create views was rather consistent between DBMSs. So why multiple versions of statements? A view simply wraps a SELECT statement, and the syntax of that SELECT must adhere to all the rules and restrictions of the DBMS being used. |

**Using Views to Filter Unwanted Data**

Views are also useful for applying common WHERE clauses. For example, you might want to define a CustomerEMailList view so that it filters out customers without email addresses. To do this, you can use the following statement

说明: graphics/input_icon.jpg

CREATE VIEW CustomerEMailList AS

SELECT cust\_id, cust\_name, cust\_email

FROM Customers

WHERE cust\_email IS NOT NULL;

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | Obviously, when sending email to a mailing list you'd want to ignore users who have no email address. The WHERE clause here filters out those rows that have NULL values in the cust\_email columns so that they'll not be retrieved. |

View CustomerEMailList can now be used like any table.

说明: graphics/input_icon.jpg

SELECT \*

FROM CustomerEMailList;

说明: graphics/output_icon.jpg

cust\_id cust\_name cust\_email

---------- ------------ ---------------------

1000000001 Village Toys sales@villagetoys.com

1000000003 Fun4All jjones@fun4all.com

1000000004 Fun4All dstephens@fun4all.com

|  |  |
| --- | --- |
| 说明: graphics/note_icon.gif | **WHERE** Clauses and **WHERE** Clauses If a WHERE clause is used when retrieving data from the view, the two sets of clauses (the one in the view and the one passed to it) will be combined automatically. |

**Using Views with Calculated Fields**

Views are exceptionally useful for simplifying the use of calculated fields. The following is a SELECT statement introduced in [Lesson 7](#Bookmark40)(See 14.). It retrieves the order items for a specific order, calculating the expanded price for each item:

说明: graphics/input_icon.jpg

SELECT prod\_id,

quantity,

item\_price,

quantity\*item\_price AS expanded\_price

FROM OrderItems

WHERE order\_num = 20008;

说明: graphics/output_icon.jpg

prod\_id quantity item\_price expanded\_price

------- -------- ---------- --------------

RGAN01 5 4.9900 24.9500

BR03 5 11.9900 59.9500

BNBG01 10 3.4900 34.9000

BNBG02 10 3.4900 34.9000

BNBG03 10 3.4900 34.9000

To turn this into a view, do the following:

说明: graphics/input_icon.jpg

CREATE VIEW OrderItemsExpanded AS

SELECT order\_num,

prod\_id,

quantity,

item\_price,

quantity\*item\_price AS expanded\_price

FROM OrderItems;

To retrieve the details for order 20008 (the output above), do the following:

说明: graphics/input_icon.jpg

SELECT \*

FROM OrderItemsExpanded

WHERE order\_num = 20008;

说明: graphics/output_icon.jpg

order\_num prod\_id quantity item\_price expanded\_price

--------- ------- -------- ---------- --------------

20008 RGAN01 5 4.99 24.95

20008 BR03 5 11.99 59.95

20008 BNBG01 10 3.49 34.90

20008 BNBG02 10 3.49 34.90

20008 BNBG03 10 3.49 34.90

As you can see, views are easy to create and even easier to use. Used correctly, views can greatly simplify complex data manipulation.

## 25.3 Summary

Views are virtual tables. They do not contain data, but instead, they contain queries that retrieve data as needed. Views provide a level of encapsulation around SQL SELECT statements and can be used to simplify data manipulation, as well as to reformat or secure underlying data.

# 26. Lesson 19. Working with Stored Procedures

In this lesson, you'll learn what stored procedures are, why they are used, and how. You'll also look at the basic syntax for creating and using them.

## 26.1 Understanding Stored Procedures

Most of the SQL statements that we've used thus far are simple in that they use a single statement against one or more tables. Not all operations are that simple-often, multiple statements will be needed to perform a complete operation. For example, consider the following scenario:

* To process an order, checks must be made to ensure that items are in stock.
* If items are in stock, they need to be reserved so that they are not sold to anyone else, and the available quantity must be reduced to reflect the correct amount in stock.
* Any items not in stock need to be ordered; this requires some interaction with the vendor.
* The customer needs to be notified as to which items are in stock (and can be shipped immediately) and which are back ordered.

This is obviously not a complete example, and it is even beyond the scope of the example tables that we have been using in this book, but it will suffice to help make a point. Performing this process requires many SQL statements against many tables. In addition, the exact SQL statements that need to be performed and their order are not fixed; they can (and will) vary according to which items are in stock and which are not.

How would you write this code? You could write each of the SQL statements individually and execute other statements conditionally, based on the result. You'd have to do this every time this processing was needed (and in every application that needed it).

You could create a stored procedure. Stored procedures are simply collections of one or more SQL statements saved for future use. You can think of them as batch files, although in truth they are more than that.

|  |  |
| --- | --- |
| 说明: graphics/note_icon.gif | Access and MySQL Stored procedures are not supported in Access. In addition, as this book goes to press, MySQL v4.x (the current version) does not support stored procedures (support is planned for MySQL 5). |

|  |  |
| --- | --- |
| 说明: graphics/note_icon.gif | There's a Lot More to It Stored procedures are complex, and full coverage of the subject requires more space than can be allocated here. This lesson will not teach you all you need to know about stored procedures. Rather, it is intended simply to introduce the subject so that you are familiar with what they are and what they can do. As such, the examples presented here provide syntax for Oracle and SQL Server only. |

## 26.2 Why to Use Stored Procedures

Now that you know what stored procedures are, why use them? There are lots of reasons, but here are the primary ones:

* To simplify complex operations (as seen in the previous example) by encapsulating processes into a single easy-to-use unit.
* To ensure data consistency by not requiring that a series of steps be created over and over. If all developers and applications use the same stored procedure, then the same code will be used by all.

An extension of this is to prevent errors. The more steps that need to be performed, the more likely it is that errors will be introduced. Preventing errors ensures data consistency.

* To simplify change management. If tables, column names, or business logic (or just about anything) changes, then only the stored procedure code needs to be updated, and no one else will need even to be aware that changes were made.

An extension of this is security. Restricting access to underlying data via stored procedures reduces the chance of data corruption (unintentional or otherwise).

* Because stored procedures are usually stored in a compiled form, the DBMS has to do less work to process the command. This results in improved performance.
* There are SQL language elements and features that are available only within single requests. Stored procedures can use these to write code that is more powerful and flexible.

In other words, there are three primary benefits-simplicity, security, and performance. Obviously all are extremely important. Before you run off to turn all your SQL code into stored procedures, here's the downside:

* Stored procedure syntax varies dramatically from one DBMS to the next. In fact, it is close to impossible to write truly portable stored procedures. Having said that, how the stored procedures call themselves (their names and how data is passed to them) can be kept relatively portable so that if you need to change to another DBMS at least your client application code may not need changing.
* Stored procedures tend to be more complex to write than basic SQL statements, and writing them requires a greater degree of skill and experience. As a result, many database administrators restrict stored procedure creation rights as a security measure (primarily due to the previous bullet item).

Nonetheless, stored procedures are very useful and should be used. In fact, most DBMSs come with all sorts of stored procedures that are used for database and table management. Refer to your DBMS documentation for more information on these.

|  |  |
| --- | --- |
| 说明: graphics/note_icon.gif | Can't Write Them? You Can Still Use Them Most DBMSs distinguish the security and access needed to write stored procedures from the security and access needed to execute them. This is a good thing; even if you can't (or don't want to) write your own stored procedures, you can still execute them when appro priate. |

## 26.3 Executing Stored Procedures

Stored procedures are executed far more often than they are written, so we'll start there. The SQL statement to execute a stored procedure is simply EXECUTE. EXECUTE takes the name of the stored procedure and any parameters that need to be passed to it. Take a look at this example:

说明: graphics/input_icon.jpg

EXECUTE AddNewProduct('JTS01',

'Stuffed Eiffel Tower',

6.49,

'Plush stuffed toy with the text La Tour Eiffel in red white and blue')

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | Here a stored procedure named AddNewProduct is executed; it adds a new product to the Products table. AddNewProduct takes four parameters-the vendor ID (the primary key from the Vendors table), the product name, price, and description. These four parameters match four expected variables within the stored procedure (defined as part of the stored procedure itself). The stored procedure adds a new row to the Products table and assigns these passed attributes to the appropriate columns. |

In the Products table you'll notice that there is another column that needs a value: the prod\_id column, which is the table's primary key. Why was this value not passed as an attribute to the stored procedure? To ensure that IDs are generated properly, it is safer to have that process automated (and not rely on end users). That is why a stored procedure is used in this example. This is what this stored procedure does:

* It validates the passed data, ensuring that all four parameters have values.
* It generates a unique ID to be used as the primary key.
* It inserts the new product into the Products table, storing the generated primary key and passed data in the appropriate columns.

This is the basic form of stored procedure execution. Depending on the DBMS used, other execution options include the following:

* Optional parameters, with default values assumed if a parameter is not provided
* Out-of-order parameters, specified in parameter= pairs
* Output parameters, allowing the stored procedure to update a parameter for use in the executing application
* Data retrieved by a SELECT statement
* Return codes, enabling the stored procedure to return a value to the executing application

## 26.4 Creating Stored Procedures

As already explained, writing a stored procedure is not trivial. To give you a taste for what is involved, let's look at a simple example-a stored procedure that counts the number of customers in a mailing list who have email addresses.

Here is the Oracle version:

说明: graphics/input_icon.jpg

CREATE PROCEDURE MailingListCount

(ListCount OUT NUMBER)

IS

BEGIN

SELECT \* FROM Customers

WHERE NOT cust\_email IS NULL;

ListCount := SQL%ROWCOUNT;

END;

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | This stored procedure takes a single parameter named ListCount. Instead of passing a value to the stored procedure, this parameter passes a value back from it. The keyword OUT is used to specify this behavior. Oracle supports parameters of types IN (those passed to stored procedures), OUT (those passed from stored procedures, as we've used here), and INOUT (those used to pass parameters to and from stored procedures). The stored procedure code itself is enclosed within BEGIN and END statements, and here a simple SELECT is performed to retrieve the customers with email addresses. Then ListCount (the output parameter passed) is set with the number of rows that were retrieved. |

Here's the Microsoft SQL Server version:

说明: graphics/input_icon.jpg

CREATE PROCEDURE MailingListCount

AS

DECLARE @cnt INTEGER

SELECT @cnt = COUNT(\*)

FROM Customers

WHERE NOT cust\_email IS NULL;

RETURN @cnt;

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | This stored procedure takes no parameters at all. The calling application retrieves the value by using SQL Server's return code support. Here a local variable named @cnt is declared using the DECLARE statement (all local variables in SQL Server are named starting with a @). This variable is then used in the SELECT statement so that it contains the value returned by the COUNT() function. Finally, the RETURN statement is used to return the count to the calling application as RETURN @cnt. |

Here's another example, this time to insert a new order in the Orders table. This is a SQL Server-only example, but it demonstrates some useful stored procedure uses and techniques:

说明: graphics/input_icon.jpg

CREATE PROCEDURE NewOrder @cust\_id CHAR(10)

AS

-- Declare variable for order number

DECLARE @order\_num INTEGER

-- Get current highest order number

SELECT @order\_num=MAX(order\_num)

FROM Orders

-- Determine next order number

SELECT @order\_num=@order\_num+1

-- Insert new order

INSERT INTO Orders(order\_num, order\_date, cust\_id)

VALUES(@order\_num, GETDATE(), @cust\_id)

-- Return order number

RETURN @order\_num;

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | This stored procedure creates a new order in the Orders table. It takes a single parameter, the ID of the customer placing the order. The other two table columns, the order number and order date, are generated automatically within the stored procedure itself. The code first declares a local variable to store the order number. Next, the current highest order number is retrieved (using a MAX() function) and incremented (using a SELECT statement). Then the order is inserted with an INSERT statement using the newly generated order number, the current system date (retrieved using the GETDATE() function), and the passed customer ID. Finally, the order number (which is needed to process order items) is returned as RETURN @order\_num. Notice that the code is commented-this should always be done when writing stored procedures. |

|  |  |
| --- | --- |
| 说明: graphics/tip_icon.gif | Comment Your Code All code should be commented, and stored procedures are no different. Adding comments will not affect performance at all, so there is no downside here (other than the time it takes to write them). The benefits are numerous and include making it easier for others (and yourself) to understand the code and safer to make changes at a later date.  The standard way to comment code is to precede it by -- (two hyphens). Some DBMSs support alternate comment syntax, but all support -- and so you are best off using that. |

Here's a quite different version of the same SQL Server code:

说明: graphics/input_icon.jpg

CREATE PROCEDURE NewOrder @cust\_id CHAR(10)

AS

-- Insert new order

INSERT INTO Orders(cust\_id)

VALUES(@cust\_id)

-- Return order number

SELECT order\_num = @@IDENTITY;

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | This stored procedure also creates a new order in the Orders table. This time the DBMS itself generates the order number. Most DBMSs support this type of functionality; SQL Server refers to these auto-incrementing columns as Identity fields (other DBMSs use names such as Auto Number or Sequences). Again, a single parameter is passed: the customer ID of the customer placing the order. The order number and order date are not specified at all-the DBMS uses a default value for the date (the GETDATE() function), and the order number is generated automatically. How can you find out what the generated ID is? SQL Server makes that available in the global variable @@IDENTITY, which is returned to the calling application (this time using a SELECT statement). |

As you can see, with stored procedures there are often many different ways to accomplish the same task. The method you choose will often be dictated by the features of the DBMS you are using.

## 26.5 Summary

In this lesson, you learned what stored procedures are and why they are used. You also learned the basics of stored procedure execution and creation syntax, and you saw some of the ways these can be used. Your own DBMS probably offers some form of these functions, as well as others not mentioned here. Refer to your DBMS documentation for more details.

# 27. Lesson 20. Managing Transaction Processing

In this lesson, you'll learn what transactions are and how to use COMMIT and ROLLBACK statements to manage transaction processing.

## 27.1 Understanding Transaction Processing

Transaction processing is used to maintain database integrity by ensuring that batches of SQL operations execute completely or not at all.

As explained back in [Lesson 12](#Bookmark66)(See 19.), "Joining Tables," relational databases are designed so that data is stored in multiple tables to facilitate easier data manipulation, management, and reuse. Without going in to the hows and whys of relational database design, take it as a given that well-designed database schemas are relational to some degree.

The Orders tables that you've been using in the past 18 lessons are a good example of this. Orders are stored in two tables: Orders stores actual orders, and OrderItems stores the individual items ordered. These two tables are related to each other using unique IDs called primary keys (as discussed in [Lesson 1](#Bookmark10)(See 8.), "Understanding SQL"). These tables, in turn, are related to other tables containing customer and product information.

The process of adding an order to the system is as follows:

1. Check if the customer is already in the database. If not, add him or her.
2. Retrieve the customer's ID.
3. Add a row to the Orders table associating it with the customer ID.
4. Retrieve the new order ID assigned in the Orders table.
5. Add one row to the OrderItems table for each item ordered, associating it with the Orders table by the retrieved ID (and with the Products table by product ID).

Now imagine that some database failure (for example, out of disk space, security restrictions, table locks) prevents this entire sequence from completing. What would happen to your data?

Well, if the failure occurred after the customer was added and before the Orders table was added, there is no real problem. It is perfectly valid to have customers without orders. When you run the sequence again, the inserted customer record will be retrieved and used. You can effectively pick up where you left off.

But what if the failure occurred after the Orders row was added, but before the OrderItems rows were added? Now you'd have an empty order sitting in your database.

Worse, what if the system failed during adding the OrderItems rows? Now you'd end up with a partial order in your database, but you wouldn't know it.

How do you solve this problem? That's where Transaction Processing comes in. Transaction Processing is a mechanism used to manage sets of SQL operations that must be executed in batches so as to ensure that databases never contain the results of partial operations. With Transaction Processing, you can ensure that sets of operations are not aborted mid-processing-they either execute in their entirety or not at all (unless explicitly instructed otherwise). If no error occurs, the entire set of statements is committed (written) to the database tables. If an error does occur, then a rollback (undo) can occur to restore the database to a known and safe state.

So, looking at the same example, this is how the process would work:

1. Check if the customer is already in the database; if not add him or her.
2. Commit the customer information.
3. Retrieve the customer's ID.
4. Add a row to the Orders table.
5. If a failure occurs while adding the row to Orders, roll back.
6. Retrieve the new order ID assigned in the Orders table.
7. Add one row to the OrderItems table for each item ordered.
8. If a failure occurs while adding rows to OrderItems, roll back all the OrderItems rows added and the Orders row.

When working with transactions and transaction processing, there are a few keywords that'll keep reappearing. Here are the terms you need to know:

* Transaction A block of SQL statements
* Rollback The process of undoing specified SQL statements
* Commit Writing unsaved SQL statements to the database tables
* Savepoint A temporary placeholder in a transaction set to which you can issue a rollback (as opposed to rolling back an entire transaction)

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| --- | --- |
| 说明: graphics/tip_icon.gif | Which Statements Can You Roll Back? Transaction processing is used to manage INSERT, UPDATE, and DELETE statements. You cannot roll back SELECT statements. (There would not be much point in doing so anyway.) You cannot roll back CREATE or DROP operations. These statements may be used in a transaction block, but if you perform a rollback they will not be undone. |

## 27.2 Controlling Transactions

Now that you know what transactions processing is, let's look at what is involved in managing transactions.

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| 说明: graphics/caution_icon.gif | Implementation Differences The exact syntax used to implement transaction processing differs from one DBMS to another. Refer to your DBMS documentation before proceeding. |

The key to managing transactions involves breaking your SQL statements into logical chunks and explicitly stating when data should be rolled back and when it should not.

Some DBMSs require that you explicitly mark the start and end of transaction blocks. In SQL Server, for example, you can do the following:

说明: graphics/input_icon.jpg

BEGIN TRANSACTION

...

COMMIT TRANSACTION

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | In this example, any SQL between the BEGIN TRANSACTION and COMMIT TRANSACTION statements must be executed entirely or not at all. |

The equivalent code in MySQL is:

说明: graphics/input_icon.jpg

START TRANSACTION

...

PostgreSQL uses the ANSI SQL syntax:

说明: graphics/input_icon.jpg

BEGIN;

...

Other DBMSs use variations of the above.

**Using ROLLBACK**

The SQL ROLLBACK command is used to roll back (undo) SQL statements, as seen in this next statement:

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DELETE FROM Orders;

ROLLBACK;

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | In this example, a DELETE operation is performed and then undone using a ROLLBACK statement. Although not the most useful example, it does demonstrate that, within a transaction block, DELETE operations (like INSERT and UPDATE operations) are never final. |

**Using COMMIT**

Usually SQL statements are executed and written directly to the database tables. This is known as an implicit commit-the commit (write or save) operation happens automatically.

Within a transaction block, however, commits might not occur implicitly. This, too, is DBMS specific. Some DBMSs treat a transaction end as an implicit commit; others do not.

To force an explicit commit, the COMMIT statement is used. The following is a SQL Server example:

说明: graphics/input_icon.jpg

BEGIN TRANSACTION

DELETE OrderItems WHERE order\_num = 12345

DELETE Orders WHERE order\_num = 12345

COMMIT TRANSACTION

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| --- | --- |
| 说明: graphics/analysis_icon.jpg | In this SQL Server example, order number 12345 is deleted entirely from the system. Because this involves updating two database tables, Orders and OrderItems, a transaction block is used to ensure that the order is not partially deleted. The final COMMIT statement writes the change only if no error occurred. If the first DELETE worked, but the second failed, the DELETE would not be committed. |

To accomplish the same thing in Oracle, you can do the following:

说明: graphics/input_icon.jpg

DELETE OrderItems WHERE order\_num = 12345;

DELETE Orders WHERE order\_num = 12345;

COMMIT;

**Using Savepoints**

Simple ROLLBACK and COMMIT statements enable you to write or undo an entire transaction. Although this works for simple transactions, more complex transactions might require partial commits or rollbacks.

For example, the process of adding an order described previously is a single transaction. If an error occurs, you only want to roll back to the point before the Orders row was added. You do not want to roll back the addition to the Customers table (if there was one).

To support the rollback of partial transactions, you must be able to put placeholders at strategic locations in the transaction block. Then, if a rollback is required, you can roll back to one of the placeholders.

In SQL, these placeholders are called savepoints. To create one in MySQL and Oracle, the SAVEPOINT statement is used, as follows:

说明: graphics/input_icon.jpg

SAVEPOINT delete1;

In SQL Server and Sybase, you do the following:

说明: graphics/input_icon.jpg

SAVE TRANSACTION delete1;

Each savepoint takes a unique name that identifies it so that, when you roll back, the DBMS knows where you are rolling back to. To roll back to this savepoint, do the following in SQL Server:

说明: graphics/input_icon.jpg

ROLLBACK TRANSACTION delete1;

In MySQL and Oracle you can do the following:

说明: graphics/input_icon.jpg

ROLLBACK TO delete1;

The following is a complete SQL Server example:

说明: graphics/input_icon.jpg

BEGIN TRANSACTION

INSERT INTO Customers(cust\_id, cust\_name)

VALUES('1000000010', 'Toys Emporium');

SAVE TRANSACTION StartOrder;

INSERT INTO Orders(order\_num, order\_date, cust\_id)

VALUES(20100,'2001/12/1','1000000010');

IF @@ERROR <> 0 ROLLBACK TRANSACTION StartOrder;

INSERT INTO OrderItems(order\_num, order\_item, prod\_id, quantity, item\_price)

VALUES(20010, 1, 'BR01', 100, 5.49);

IF @@ERROR <> 0 ROLLBACK TRANSACTION StartOrder;

INSERT INTO OrderItems(order\_num, order\_item, prod\_id, quantity, item\_price)

VALUES(20010, 2, 'BR03', 100, 10.99);

IF @@ERROR <> 0 ROLLBACK TRANSACTION StartOrder;

COMMIT TRANSACTION

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | Here are a set of four INSERT statements enclosed within a transaction block. A savepoint is defined after the first INSERT so that, if any of the subsequent INSERT operations fail, the transaction is only rolled back that far. In SQL Server, a variable named @@ERROR can be inspected to see if an operation succeeded. (Other DBMSs use different functions or variables to return this information.) If @@ERROR returns a value other than 0, an error occurred, and the transaction rolls back to the savepoint. If the entire transaction is processed, a COMMIT is issued to save the data. |

|  |  |
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| 说明: graphics/tip_icon.gif | The More Savepoints the Better You can have as many savepoints as you'd like within your SQL code, and the more the better. Why? Because the more savepoints you have the more flexibility you have in managing rollbacks exactly as you need them. |

## 27.3 Summary

In this lesson, you learned that transactions are blocks of SQL statements that must be executed as a batch. You learned how to use the COMMIT and ROLLBACK statements to explicitly manage when data is written and when it is undone. You also learned how to use savepoints to provide a greater level of control over rollback operations.

# 28. Lesson 21. Using Cursors

|  |
| --- |
| In this lesson, you'll learn what cursors are and how to use them. |

## 28.1 Understanding Cursors

SQL retrieval operations work with sets of rows known as result sets. The rows returned are all the rows that match a SQL statement-zero or more of them. Using simple SELECT statements, there is no way to get the first row, the next row, or the previous 10 rows. This is an integral part of how a relational DBMS works.

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| 说明: graphics/newterm_icon.gif | Result Set The results retrieved by a SQL query. |

Sometimes there is a need to step through rows forward or backward and one or more at a time. This is what cursors are used for. A cursor is a database query stored on the DBMS server-not a SELECT statement, but the result set retrieved by that statement. Once the cursor is stored, applications can scroll or browse up and down through the data as needed.

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| 说明: graphics/note_icon.gif | MySQL Support As this book goes to press, MySQL still does not support cursors (support for views is planned for MySQL 5). |

Different DBMSs support different cursor options and features. Some of the more common ones are:

* The capability to flag a cursor as read-only so that data can be read but not updated or deleted
* The capability to control the directional operations that can be performed (forward, backward, first, last, absolute position, relative position, and so on)
* The capability to flag some columns as editable and others as not editable
* Scope specification so as to be able to make the cursor accessible to a specific request that created it (a stored procedure, for example) or to all requests
* Instructing the DBMS to make a copy of the retrieved data (as opposed to pointing to the live data in the table) so that data does not change between the time the cursor is opened and the time it is accessed

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| 说明: graphics/note_icon.gif | Making Relational DBMSs Behave Like Nonrelational DBMSs As a point of reference, accessing and browsing rows in this fashion is actually the behavior of ISAM (Indexed Sequential Access Method) databases (such as Btrieve and dBASE). Cursors are an interesting part of the SQL specification in that they can make a relational database behave like an ISAM database. |

Cursors are used primarily by interactive applications in which users need to scroll up and down through screens of data, browsing or making changes.

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| --- | --- |
| 说明: graphics/note_icon.gif | Cursors and Web-Based Applications Cursors are rather useless when it comes to Web-based applications (ASP, ColdFusion, PHP, and JSP, for example). Cursors are designed to persist for the duration of a session between a client application and a server, but this client/server model does not fit in the Web application world because the application server is the database client, not the end user. As such, most Web application developers avoid the use of cursors and re-create the functionality themselves if needed. |

## 28.2 Working with Cursors

Using cursors involves several distinct steps:

* Before a cursor can be used it must be declared (defined). This process does not actually retrieve any data, it merely defines the SELECT statement to be used and any cursor options.
* Once it is declared, the cursor must be opened for use. This process actually retrieves the data using the previously defined SELECT statement.
* With the cursor populated with data, individual rows can be fetched (retrieved) as needed.
* When it is done, the cursor must be closed and possibly deallocated (depending on the DBMS).

Once a cursor is declared, it may be opened and closed as often as needed. Once it is open, fetch operations can be performed as often as needed.

**Creating Cursors**

Cursors are created using the DECLARE statement, which differs from one DBMS to the next. DECLARE names the cursor and takes a SELECT statement, complete with WHERE and other clauses if needed. To demonstrate this, we'll create a cursor that retrieves all customers without email addresses, as part of an application enabling an operator to provide missing email addresses.

Here is the DB2, SQL Server, and Sybase version:

说明: graphics/input_icon.jpg

DECLARE CustCursor CURSOR

FOR

SELECT \* FROM Customers

WHERE cust\_email IS NULL

Here is the Oracle and PostgreSQL version:

说明: graphics/input_icon.jpg

DECLARE CURSOR CustCursor

IS

SELECT \* FROM Customers

WHERE cust\_email IS NULL

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | In both versions, the DECLARE statement is used to define and name the cursor-in this case CustCursor. The SELECT statement defines a cursor containing all customers with no email address (a NULL value). |

Now that the cursor is defined, it is ready to be opened.

**Using Cursors**

Cursors are opened using the OPEN CURSOR statement, which is so simple a statement that most DBMSs support exactly the same syntax:

说明: graphics/input_icon.jpg

OPEN CURSOR CustCursor

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | When the OPEN CURSOR statement is processed, the query is executed, and the retrieved data is stored for subsequent browsing and scrolling. |

Now the cursor data can be accessed using the FETCH statement. FETCH specifies the rows to be retrieved, where they are to be retrieved from, and where they are to be stored (variable names, for example). The first example uses Oracle syntax to retrieve a single row from the cursor (the first row):

说明: graphics/input_icon.jpg

DECLARE TYPE CustCursor IS REF CURSOR RETURN Customers%ROWTYPE;

DECLARE CustRecord Customers%ROWTYPE

BEGIN

OPEN CustCursor;

FETCH CustCursor INTO CustRecord;

CLOSE CustCursor;

END;

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | In this example, FETCH is used to retrieve the current row (it'll start at the first row automatically) into a declared variable named CustRecord. Nothing is done with the retrieved data. |

In the next example (again, using Oracle syntax), the retrieved data is looped through from the first row to the last:

说明: graphics/input_icon.jpg

DECLARE TYPE CustCursor IS REF CURSOR RETURN Customers%ROWTYPE;

DECLARE CustRecord Customers%ROWTYPE

BEGIN

OPEN CustCursor;

LOOP

FETCH CustCursor INTO CustRecord;

EXIT WHEN CustCursor%NOTFOUND;

...

END LOOP;

CLOSE CustCursor;

END;

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | Like the previous example, this example uses FETCH to retrieve the current row into a declared variable named CustRecord. Unlike the previous example, the FETCH here is within a LOOP so that it is repeated over and over. The code EXIT WHEN CustCursor%NOTFOUND causes processing to be terminated (exiting the loop) when there are no more rows to be fetched. This example also does no actual processing; in real-world code you'd replace the ... placeholder with your own code. |

Here's another example, this time using Microsoft SQL Server syntax:

说明: graphics/input_icon.jpg

DECLARE @cust\_id CHAR(10),

@cust\_name CHAR(50),

@cust\_address CHAR(50),

@cust\_city CHAR(50),

@cust\_state CHAR(5),

@cust\_zip CHAR(10),

@cust\_country CHAR(50),

@cust\_contact CHAR(50),

@cust\_email CHAR(255),

OPEN CustCursor

FETCH NEXT FROM CustCursor

INTO @cust\_id, @cust\_name, @cust\_address,

@cust\_city, @cust\_state, @cust\_zip,

@cust\_country, @cust\_contact, @cust\_email

WHILE @@FETCH\_STATUS = 0

BEGIN

...

FETCH NEXT FROM CustCursor

INTO @cust\_id, @cust\_name, @cust\_address,

@cust\_city, @cust\_state, @cust\_zip,

@cust\_country, @cust\_contact, @cust\_email

END

CLOSE CustCursor

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | In this example, variables are declared for each of the retrieved columns, and the FETCH statements retrieve a row and save the values into those variables. A WHILE loop is used to loop through the rows, and the condition WHILE @@FETCH\_STATUS = 0 causes processing to be terminated (exiting the loop) when there are no more rows to be fetched. Again, this example does no actual processing; in real-world code you'd replace the ... placeholder with your own code. |

**Closing Cursors**

As already mentioned and seen in the previous examples, cursors need to be closed after they have been used. In addition, some DBMSs (such as SQL Server) require that the resources used by the cursor be explicitly deallocated. Here's the DB2, Oracle, and PostgreSQL syntax:

说明: graphics/input_icon.jpg

CLOSE CustCursor

Here's the Microsoft SQL Server version:

说明: graphics/input_icon.jpg

CLOSE CustCursor

DEALLOCATE CURSOR CustCursor

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| 说明: graphics/analysis_icon.jpg | The CLOSE statement is used to close cursors; once a cursor is closed, it cannot be reused without being opened again. However, a cursor does not need to be declared again to be used; an OPEN is sufficient. |

## 28.3 Summary

In this lesson, you learned what cursors are and why they are used. Your own DBMS probably offers some form of this function, as well as others not mentioned here. Refer to your DBMS documentation for more details.

# 29. Lesson 22. Understanding Advanced SQL Features

In this lesson, you'll look at several of the advanced data-manipulation features that have evolved with SQL: constraints, indexes, and triggers.

## 29.1 Understanding Constraints

SQL has evolved through many versions to become a very complete and powerful language. Many of the more powerful features are sophisticated tools that provide you with data-manipulation techniques such as constraints.

Relational tables and referential integrity have both been discussed several times in prior lessons. As I explained in those lessons, relational databases store data broken into multiple tables, each of which stores related data. Keys are used to create references from one table to another (thus the term referential integrity).

For relational database designs to work properly, you need a way to ensure that only valid data is inserted into tables. For example, if the Orders table stores order information and OrderItems stores order details, you want to ensure that any order IDs referenced in OrderItems exist in Orders. Similarly, any customers referred to in Orders must be in the Customers table.

Although you can perform checks before inserting new rows (do a SELECT on another table to make sure the values are valid and present), it is best to avoid this practice for the following reasons:

* If database integrity rules are enforced at the client level, every client is obliged to enforce those rules, and inevitably some clients won't.
* You must also enforce the rules on UPDATE and DELETE operations.
* Performing client-side checks is a time-consuming process. Having the DBMS do the checks for you is far more efficient.

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| 说明: graphics/newterm_icon.gif | Constraints Rules that govern how database data is inserted or manipulated. |

DBMSs enforce referential integrity by imposing constraints on database tables. Most constraints are defined in table definitions (using the CREATE TABLE or ALTER TABLE as discussed in [Lesson 17](#Bookmark89)(See 24.), "Creating and Manipulating Tables").

|  |  |
| --- | --- |
| 说明: graphics/caution_icon.gif | Caution There are several different types of constraints, and each DBMS provides its own level of support for them. Therefore, the examples shown here might not work as you see them. Refer to your DBMS documentation before proceeding. |

**Primary Keys**

I discussed primary keys briefly in [Lesson 1](#Bookmark10)(See 8.), "Understanding SQL." A primary key is a special constraint that is used to ensure that values in a column (or set of columns) are unique and never change, in other words, a column (or columns) in a table whose values uniquely identify each row in the table. This facilitates the direct manipulation of and interaction with individual rows. Without primary keys, it would be very difficult to safely UPDATE or DELETE specific rows without affecting any others.

Any column in a table can be established as the primary key, as long as it meets the following conditions:

* No two rows may have the same primary key value.
* Every row must have a primary key value. (Columns must not allow NULL values.)
* The column containing primary key values can never be modified or updated.
* Primary key values can never be reused. If a row is deleted from the table, its primary key must not be assigned to any new rows.

One way to define primary keys is to create them, as follows:

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CREATE TABLE Vendors

(

vend\_id CHAR(10) NOT NULL PRIMARY KEY,

vend\_name CHAR(50) NOT NULL,

vend\_address CHAR(50) NULL,

vend\_city CHAR(50) NULL,

vend\_state CHAR(5) NULL,

vend\_zip CHAR(10) NULL

vend\_country CHAR(50) NULL

);

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | In the above example, the keyword PRIMARY KEY is added to the table definition so that vend\_id becomes the primary key. |

说明: graphics/input_icon.jpg

ALTER TABLE Vendors

ADD CONSTRAINT PRIMARY KEY (vend\_id);

|  |  |
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| 说明: graphics/analysis_icon.jpg | Here the same column is defined as the primary key, but the CONSTRAINT syntax is used instead. This syntax can be used in CREATE TABLE and ALTER TABLE statements. |

**Foreign Keys**

A foreign key is a column in a table whose values must be listed in a primary key in another table. Foreign keys are an extremely important part of ensuring referential integrity. To understand foreign keys, let's look at an example.

The Orders table contains a single row for each order entered into the system. Customer information is stored in the Customers table. Orders in Orders are tied to specific rows in the Customers table by the customer ID. The customer ID is the primary key in the Customers table; each customer has a unique ID. The order number is the primary key in the Orders table; each order has a unique number.

The values in the customer ID column in the Orders table are not necessarily unique. If a customer has multiple orders, there will be multiple rows with the same customer ID (although each will have a different order number). At the same time, the only values that are valid within the customer ID column in Orders are the IDs of customers in the Customers table.

That's what a foreign key does. In our example, a foreign key is defined on the customer ID column in Orders so that the column can accept only values that are in the Customers table's primary key.

Here's one way to define this foreign key:

说明: graphics/input_icon.jpg

CREATE TABLE Orders

(

order\_num INTEGER NOT NULL PRIMARY KEY,

order\_date DATETIME NOT NULL,

cust\_id CHAR(10) NOT NULL REFERENCES Customers(cust\_id)

);

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | Here the table definition uses the REFERENCES keyword to state that any values in cust\_id must be in cust\_id in the Customers table. |

The same thing could have been accomplished using CONSTRAINT syntax in an ALTER TABLE statement:

说明: graphics/input_icon.jpg

ALTER TABLE Customers

ADD CONSTRAINT

FOREIGN KEY (cust\_id) REFERENCES Customers (cust\_id)

|  |  |
| --- | --- |
| 说明: graphics/tip_icon.gif | Foreign Keys Can Help Prevent Accidental Deletion In addition to helping enforce referential integrity, foreign keys serve another invaluable purpose. After a foreign key is defined, your DBMS does not allow the deletion of rows that have related rows in other tables. For example, you are not allowed to delete a customer who has associated orders. The only way to delete that customer is to first delete the related orders (which in turn means deleting the related order items). Because they require such methodical deletion, foreign keys can help prevent the accidental deletion of data.  However, some DBMSs support a feature called cascading delete. If enabled, this feature deletes all related data when a row is deleted from a table. For example, if cascading delete is enabled and a customer is deleted from the Customers table, any related order rows are deleted automatically. |

**Unique Constraints**

Unique constraints are used to ensure that all data in a column (or set of columns) is unique. They are similar to primary keys, but there are some important distinctions:

* A table can contain multiple unique constraints, but only one primary key is allowed per table.
* Unique constraint columns can contain NULL values.
* Unique constraint columns can be modified or updated.
* Unique constraint column values can be reused.
* Unlike primary keys, unique constraints cannot be used to define foreign keys.

An example of the use of constraints is an employees table. Every employee has a unique Social Security number, but you would not want to use it for the primary key because it is too long (in addition to the fact that you might not want that information easily available). Therefore, every employee also has a unique employee ID (a primary key) in addition to his Social Security number.

Because the employee ID is a primary key, you can be sure that it is unique. You also might want the DBMS to ensure that each Social Security number is unique, too (to make sure that a typo does not result in the use of someone else's number). You can do this by defining a UNIQUE constraint on the Social Security number column.

The syntax for unique constraints is similar to that for other constraints. Either the UNIQUE keyword is defined in the table definition or a separate CONSTRAINT is used.

**Check Constraints**

Check constraints are used to ensure that data in a column (or set of columns) meets a set of criteria that you specify. Common uses of this are

* Checking minimum or maximum values- for example, preventing an order of 0 (zero) items (even though 0 is a valid number)
* Specifying ranges- for example, making sure that a ship date is greater than or equal to today's date and not greater than a year from now
* Allowing only specific values- for example, allowing only M or F in a gender field

In other words, datatypes (discussed in [Lesson 1](#Bookmark10)(See 8.)) restrict the type of data that can be stored in a column. Check constraints place further restrictions within that datatype.

The following example applies a check constraint to the OrderItems table to ensure that all items have a quantity greater than 0:

说明: graphics/input_icon.jpg

CREATE TABLE OrderItems

(

order\_num INTEGER NOT NULL,

order\_item INTEGER NOT NULL,

prod\_id CHAR(10) NOT NULL,

quantity INTEGER NOT NULL CHECK (quantity > 0),

item\_price MONEY NOT NULL

);

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | With this constraint in place, any row inserted (or updated) will be checked to ensure that quantity is greater than 0. |

To check that a column named gender contains only M or F, you can do the following in an ALTER TABLE statement:

说明: graphics/input_icon.jpg

ADD CONSTRAINT CHECK (gender LIKE '[MF]')

|  |  |
| --- | --- |
| 说明: graphics/tip_icon.gif | User-Defined Datatypes Some DBMSs enable you to define your own datatypes. These are essentially simple datatypes with check constraints (or other constraints) defined. For example, you can define your own datatype called gender that is a single-character text datatype with a check constraint that restricts its values to M or F (and perhaps NULL for Unknown). You could then use this datatype in table definitions. The advantage of custom datatypes is that the constraints need to be applied only once (in the datatype definition), and they are automatically applied each time the datatype is used. Check your DBMS documentation to determine if user-defined datatypes are supported. |

## 29.2 Understanding Indexes

Indexes are used to sort data logically to improve the speed of searching and sorting operations. The best way to understand indexes is to envision the index at the back of a book (this book, for example).

Suppose you want to find all occurrences of the word datatype in this book. The simple way to do this would be to turn to page 1 and scan every line of every page looking for matches. Although that works, it is obviously not a workable solution. Scanning a few pages of text might be feasible, but scanning an entire book in that manner is not. As the amount of text to be searched increases, so does the time it takes to pinpoint the desired data.

That is why books have indexes. An index is an alphabetical list of words with references to their locations in the book. To search for datatype, you find that word in the index to determine what pages it appears on. Then, you turn to those specific pages to find your matches.

What makes an index work? Simply, it is the fact that it is sorted correctly. The difficulty in finding words in a book is not the amount of content that must be searched; rather, it is the fact that the content is not sorted by word. If the content is sorted like a dictionary, an index is not needed (which is why dictionaries don't have indexes).

Database indexes work in much the same way. Primary key data is always sorted; that's just something the DBMS does for you. Retrieving specific rows by primary key, therefore, is always a fast and efficient operation.

Searching for values in other columns is usually not as efficient, however. For example, what if you want to retrieve all customers who live in a specific state? Because the table is not sorted by state, the DBMS must read every row in the table (starting at the very first row) looking for matches, just as you would have to do if you were trying to find words in a book without using an index.

The solution is to use an index. You may define an index on one or more columns so that the DBMS keeps a sorted list of the contents for its own use. After an index is defined, the DBMS uses it in much the same way as you would use a book index. It searches the sorted index to find the location of any matches and then retrieves those specific rows.

But before you rush off to create dozens of indexes, bear in mind the following:

* Indexes improve the performance of retrieval operations, but they degrade the performance of data insertion, modification, and deletion. When these operations are executed, the DBMS has to update the index dynamically.
* Index data can take up lots of storage space.
* Not all data is suitable for indexing. Data that is not sufficiently unique (State, for example) will not benefit as much from indexing as data that has more possible values (First Name or Last Name, for example).
* Indexes are used for data filtering and for data sorting. If you frequently sort data in a specific order, that data might be a candidate for indexing.
* Multiple columns can be defined in an index (for example, State plus City). Such an index will be of use only when data is sorted in State plus City order. (If you want to sort by City, this index would not be of any use.)

There is no hard-and-fast rule as to what should be indexed and when. Most DBMSs provide utilities you can use to determine the effectiveness of indexes, and you should use these regularly.

Indexes are created with the CREATE INDEX statement (which varies dramatically from one DBMS to another). The following statement creates a simple index on the Products table's product name column:

说明: graphics/input_icon.jpg

CREATE INDEX prod\_name\_ind

ON PRODUCTS (prod\_name);

|  |  |
| --- | --- |
| 说明: graphics/analysis_icon.jpg | Every index must be uniquely named. Here the name prod\_name\_ind is defined after the keywords CREATE INDEX. ON is used to specify the table being indexed, and the columns to include in the index (just one in this example) are specified in parentheses after the table name. |

|  |  |
| --- | --- |
| 说明: graphics/tip_icon.gif | Revisiting Indexes Index effectiveness changes as table data is added or changed. Many database administrators find that what once was an ideal set of indexes might not be so ideal after several months of data manipulation. It is always a good idea to revisit indexes on a regular basis to fine-tune them as needed. |

## 29.3 Understanding Triggers

Triggers are special stored procedures that are executed automatically when specific database activity occurs. Triggers might be associated with INSERT, UPDATE, and DELETE operations (or any combination thereof) on specific tables.

|  |  |
| --- | --- |
| 说明: graphics/note_icon.gif | MySQL Support As this book goes to press, MySQL still does not support views (support for views is planned for MySQL 5.1). |

Unlike stored procedures (which are simply stored SQL statements), triggers are tied to individual tables. A trigger associated with INSERT operations on the Orders table will be executed only when a row is inserted into the Orders table. Similarly, a trigger on INSERT and UPDATE operations on the Customers table will be executed only when those specific operations occur on that table.

Within triggers, your code has access to the following:

* All new data in INSERT operations
* All new data and old data in UPDATE operations
* Deleted data in DELETE operations

Depending on the DBMS being used, triggers can be executed before or after a specified operation is performed.

The following are some common uses for triggers:

* Ensuring data consistency- for example, converting all state names to uppercase during an INSERT or UPDATE operation
* Performing actions on other tables based on changes to a table- for example, writing an audit trail record to a log table each time a row is updated or deleted
* Performing additional validation and rolling back data if needed- for example, making sure a customer's available credit has not been exceeded and blocking the insertion if it has
* Calculating computed column values or updating timestamps

As you probably expect by now, trigger creation syntax varies dramatically from one DBMS to another. Check your documentation for more details.

The following example creates a trigger that converts the cust\_state column in the Customers table to uppercase on all INSERT and UPDATE operations.

This is the SQL Server version:

说明: graphics/input_icon.jpg

CREATE TRIGGER customer\_state

ON Customers

FOR INSERT, UPDATE

AS

UPDATE Customers

SET cust\_state = Upper(cust\_state)

WHERE Customers.cust\_id = inserted.cust\_id;

This is the Oracle and PostgreSQL version:

说明: graphics/input_icon.jpg

CREATE TRIGGER customer\_state

AFTER INSERT OR UPDATE

FOR EACH ROW

BEGIN

UPDATE Customers

SET cust\_state = Upper(cust\_state)

WHERE Customers.cust\_id = :OLD.cust\_id

END;

|  |  |
| --- | --- |
| 说明: graphics/tip_icon.gif | Constraints Are Faster Than Triggers As a rule, constraints are processed more quickly than triggers, so whenever possible, use constraints instead. |

## 29.4 Database Security

There is nothing more valuable to an organization than its data, and data should always be protected from would-be thieves or casual browsers. Of course, at the same time data must be accessible to users who need access to it, and so most DBMSs provide administrators with mechanisms by which to grant or restrict access to data.

The foundation of any security system is user authorization and authentication. This is the process by which a user is validated to ensure he is who he says he is and that he is allowed to perform the operation he is trying to perform. Some DBMSs integrate with operating system security for this, others maintain their own user and password lists, and still others integrate with external directory services servers.

Some operations that are often secured

* Access to database administration features (creating tables, altering or dropping existing tables, and so on)
* Access to specific databases or tables
* The type of access (read-only, access to specific columns, and so on)
* Access to tables via views or stored procedures only
* Creation of multiple levels of security, thus allowing varying degrees of access and control based on login
* Restricting the ability to manage user accounts

Security is managed via the SQL GRANT and REVOKE statements, although most DBMSs provide interactive administration utilities that use the GRANT and REVOKE statements internally.

## 29.5 Summary

In this lesson, you learned how to use some advanced SQL features. Constraints are an important part of enforcing referential integrity; indexes can improve data retrieval performance; triggers can be used to perform pre- or post-execution processing; and security options can be used to manage data access. Your own DBMS probably offers some form of these features. Refer to your DBMS documentation for more details.

# 30. Appendix A. Sample Table Scripts

Writing SQL statements requires a good understanding of the underlying database design. Without knowing what information is stored in what table, how tables are related to each other, and the actual breakup of data within a row, it is impossible to write effective SQL.

You are strongly advised to actually try every example in every lesson in this book. All the lessons use a common set of data files. To assist you in better understanding the examples, and to enable you to follow along with the lessons, this appendix describes the tables used, their relationships, and how to build (or obtain) them.

## 30.1 Understanding the Sample Tables

The tables used throughout this book are part of an order entry system used by an imaginary distributor of toys. The tables are used to perform several tasks:

* Manage vendors
* Manage product catalogs
* Manage customer lists
* Enter customer orders

Making this all work requires five tables (that are closely interconnected as part of a relational database design). A description of each of the tables appears in the following sections.

|  |  |
| --- | --- |
| 说明: graphics/note_icon.gif | Simplified Examples The tables used here are by no means complete. A real-world order entry system would have to keep track of lots of other data that has not been included here (for example, payment and accounting information, shipment tracking, and more). However, these tables do demonstrate the kinds of data organization and relationships that you will encounter in most real installations. You can apply these techniques and technologies to your own databases. |

**Table Descriptions**

What follows is a description of each of the five tables, along with the name of the columns within each table and their descriptions.

**The Vendors Table**

The Vendors table stores the vendors whose products are sold. Every vendor has a record in this table, and that vendor ID (the vend\_id) column is used to match products with vendors.

| **Table A.1. Vendors Table Columns** | |
| --- | --- |
| Column | Description |
| vend\_id | Unique vendor ID |
| vend\_name | Vendor name |
| vend\_address | Vendor address |
| vend\_city | Vendor city |
| vend\_state | Vendor state |
| vend\_zip | Vendor zip code |
| vend\_country | Vendor country |

* All tables should have primary keys defined. This table should use vend\_id as its primary key.

**The Products Table**

The Products table contains the product catalog, one product per row. Each product has a unique ID (the prod\_id column) and is related to its vendor by vend\_id (the vendor's unique ID).

| **Table A.2. Products Table Columns** | |
| --- | --- |
| Column | Description |
| prod\_id | Unique product ID |
| vend\_id | Product vendor ID (relates to vend\_id in Vendors table) |
| prod\_name | Product name |
| prod\_price | Product price |
| prod\_desc | Product description |

* All tables should have primary keys defined. This table should use prod\_id as its primary key.
* To enforce referential integrity, a foreign key should be defined on vend\_id relating it to vend\_id in VENDORS.

**The Customers Table**

The Customers table stores all customer information. Each customer has a unique ID (the cust\_id column).

| **Table A.3. Customers Table Columns** | |
| --- | --- |
| Column | Description |
| cust\_id | Unique customer ID |
| cust\_name | Customer name |
| cust\_address | Customer address |
| cust\_city | Customer city |
| cust\_state | Customer state |
| cust\_zip | Customer zip code |
| cust\_country | Customer country |
| cust\_contact | Customer contact name |
| cust\_email | Customer contact email address |

* All tables should have primary keys defined. This table should use cust\_id as its primary key.

**The Orders Table**

The Orders table stores customer orders (but not order details). Each order is uniquely numbered (the order\_num column). Orders are associated with the appropriate customers by the cust\_id column (which relates to the customer's unique ID in the Customers table).

| **Table A.4. Orders Table Columns** | |
| --- | --- |
| Column | Description |
| order\_num | Unique order number |
| order\_date | Order date |
| cust\_id | Order customer ID (relates to cust\_id in Customers table) |

* All tables should have primary keys defined. This table should use order\_num as its primary key.
* To enforce referential integrity, a foreign key should be defined on cust\_id relating it to cust\_id in CUSTOMERS.

**The OrderItems Table**

The OrderItems table stores the actual items in each order, one row per item per order. For every row in Orders there are one or more rows in OrderItems. Each order item is uniquely identified by the order number plus the order item (first item in order, second item in order, and so on). Order items are associated with their appropriate order by the order\_num column (which relates to the order's unique ID in Orders). In addition, each order item contains the product ID of the item orders (which relates the item back to the Products table).

| **Table A.5. OrderItems Table Columns** | |
| --- | --- |
| Column | Description |
| order\_num | Order number (relates to order\_num in Orders table) |
| order\_item | Order item number (sequential within an order) |
| prod\_id | Product ID (relates to prod\_id in Products table) |
| quantity | Item quantity |
| item\_price | Item price |

* All tables should have primary keys defined. This table should use order\_num and order\_item as its primary keys.
* To enforce referential integrity, foreign keys should be defined on order\_num relating it to order\_num in Orders and prod\_id relating it to prod\_id in Products.

## 30.2 Obtaining the Sample Tables

In order to follow along with the examples, you need a set of populated tables. Everything you need to get up and running can be found on this book's Web page at [http://www.forta.com/books/0672325675/](http://www.forta.com/books/0672325675/" \t "_blank).

**Download a Ready-To-Use Microsoft Access MDB File**

You may download a fully populated Microsoft Access MDB file from the above URL. If you use this file you will not need to run any of the SQL creation and population scripts.

The Access MDB file may be used with any ODBC client utilities, as well as via scripting languages like ASP and ColdFusion.

**Download DBMS SQL Scripts**

Most DBMSs store data in formats that do not lend themselves to complete file distribution (as Access does). For these DBMSs you may download SQL scripts from [http://www.forta.com/books/0672325675/](http://www.forta.com/books/0672325675/" \t "_blank). There are two files for each DBMS:

* create.txt contains the SQL statements to create the five database tables (including defining all primary keys and foreign key constraints).
* populate.txt contains the SQL INSERT statements used to populate these tables.

The SQL statements in these files are very DBMS specific, so be sure to execute the one for your own DBMS. These scripts are provided as a convenience to readers, and no liability is assumed for problems that might arise from their use.

At the time that this book went to press, scripts were available for:

* IBM DB2
* Microsoft SQL Server
* MySQL
* Oracle
* PostgreSQL
* Sybase Adaptive Server

Other DBMSs may be added as needed or requested.

[Appendix B](#Bookmark122)(See 31.), "Working in Popular Applications," provides instructions on running the scripts in several popular environment.

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| --- | --- |
| 说明: graphics/note_icon.gif | Create, Then Populate You must run the table creation scripts before the table population scripts. Be sure to check for any error messages returned by these scripts. If the creation scripts fail you will need to remedy whatever problem might exist before continuing with table population. |

# 31. Appendix B. Working in Popular Applications

As explained in [Lesson 1](#Bookmark10)(See 8.), "Understanding SQL," SQL is not an application, it is a language. To follow along with the examples in this book, you need an application that supports the execution of SQL statements.

This appendix describes the steps for executing SQL statements in some of the more commonly used applications.

You can use any application listed below, and many others, to test and experiment with SQL code. So which should you use?

* Many DBMSs come with their own client utilities, so those are a good place to start. However, these tend to not have the most intuitive user interfaces.
* Windows users likely have a utility named Microsoft Query on their computers. This is a simple utility that is very effective for testing simple statements.
* A wonderful Windows only option is George Poulose's Query Tool. There is a link to this on the book Web page at [http://www.forta.com/books/0672325667/](http://www.forta.com/books/0672325667/" \t "_blank).
* Aqua Data Studio is an incredibly useful free Java based utility that will run on Windows, Linux, Unix, Mac OSX, and other computers. There is a link to this utility on the book Web page at [http://www.forta.com/books/0672325667/](http://www.forta.com/books/0672325667/" \t "_blank).

Any of these are good options, and there are others too. For additional recommendations visit the book Web page.

## 31.1 Using Aqua Data Studio

Aqua Data Studio is a free Java based SQL client. It runs on all major platforms, and supports all major DBMSs (as well as ODBC). To execute a SQL statement in Aqua Data Studio, do the following:

1. Launch Aqua Data Studio.
2. DBMSs must be registered before they can be used. Select Register Server from the Server menu.
3. Select the DBMS you are using from the displayed list (select Generic ODBC to use Microsoft Access or any ODBC data base, this requires that an ODBC data source be defined as explained at the end of this appendix). Based on the DBMS selected, you will be prompted for path or login information. Fill in the form and click OK. Once registered, the server will appear in the list on the left.
4. Select a server from the list of registered servers.
5. Launch the Query Analyzer by selecting Query Analyzer from the Server menu, or by pressing Ctrl-Q.
6. Type your SQL in the query window (the top window).
7. To execute your SQL, select Execute from the Query menu, or press Ctrl-E, or click the Execute button (the one with the green arrow).
8. Results will be displayed in the lower window.

## 31.2 Using DB2

IBM's DB2 is a powerful high-end, multiplatform DBMS. It comes with a whole suite of client tools that may be used to execute SQL statements. The instructions that follow use the Java based Command Center utility because it is one of the simplest and most versatile of the bundled applications:

1. Launch the Command Center.
2. Select the Script tab.
3. Enter the SQL statement in the Script box.
4. Select Execute from the Script menu, or click the Execute button, to execute the script.
5. Raw data results will be displayed in the lower window. Switch to the Results tab to display results in a grid format.
6. Command Center features an interactive SQL statement builder called SQL Assist. This can be executed from the Interactive tab.

## 31.3 Using Macromedia ColdFusion

Macromedia ColdFusion is a Web-application development platform. ColdFusion uses a tag-based language to create scripts. To test your SQL, create a simple page that you can execute by calling it from your Web browser. Perform the following steps:

1. Before using any databases from within ColdFusion code, a Data Source must be defined. The ColdFusion Administrator program provides a Web-based interface to define Data Sources (refer to the ColdFusion documentation for help if needed).
2. Create a new ColdFusion page (with a CFM extension).
3. Use the CFML <CFQUERY> and </CFQUERY> tags to create a query block. Name it using the NAME attribute and define the Data Source in the DATASOURCE attribute.
4. Type your SQL statement between the <CFQUERY> and </CFQUERY> tags.
5. Use <CFDUMP> or a <CFOUTPUT> loop to display the query results.
6. Save the page in any executable directory beneath the Web server root.
7. Execute the page by calling it from a Web browser.

## 31.4 Using Microsoft Access

Microsoft Access is usually used interactively to create and manage databases and to interact and manipulate data, and Access features a Query Designer that can be used to build a SQL statement interactively. A frequently overlooked feature of this Query Designer is that it also lets you specify SQL for direct execution. This enables you to use Access to send SQL statements to any ODBC Data Source, although it is best suited for executing SQL against an open database. To use this feature, do the following:

1. Launch Microsoft Access. You will be prompted to open (or create) a database. Open the database that you want to use.
2. Select Queries in the Database window. Then click on the New button and select Design View.
3. You'll be prompted with a Show Table dialog. Close that window without selecting any tables.
4. From the View menu, select SQL View to display the Query window.
5. Type your SQL statement in the Query window.
6. To execute the SQL statement click on the Run button (the one with the red exclamation mark). This will switch the view to Datasheet View (which displays the results in a grid).
7. Toggle between SQL View and Datasheet View as needed (you'll need to go back to SQL View to change your SQL). You can also use Design View to interactively build SQL statements.

Microsoft Access also supports a Pass-Through mode that enables you to use Access to send SQL statements to any ODBC Data Source. This feature should be used to interact with external databases, and never with Access databases directly. To use this feature, do the following:

1. Microsoft Access uses ODBC to interact with databases, so an ODBC Data Source must be present before proceeding (see the earlier instructions).
2. Launch Microsoft Access. You will be prompted to open (or create) a database. Open any database.
3. Select Queries in the Database window. Then click on the New button and select Design View.
4. You'll be prompted with a Show Table dialog. Close that window without selecting any tables.
5. From the Query menu, select SQL Specific and then select Pass-Through (older versions of Access called this option SQL Pass-Through).
6. From the View menu, select Properties to display the Query Properties dialog.
7. Click in the ODBC Connect Str field and then click the … button to display the Select Data Source dialog, which you can use to select the ODBC Data Source.
8. Select your Data Source and click OK to return to the Query Properties dialog.
9. Click on the Returns Records field. If you are executing a SELECT statement (or any statement that returns results), set Returns Records to Yes. If you are executing a SQL statement that does not return data (for example, INSERT, UPDATE, or DELETE) set Return Records to No.
10. Type your SQL statement in the SQL Pass-Through Query window.
11. To execute the SQL statement click on the Run button (the one with the red exclamation mark).

|  |  |
| --- | --- |
| 说明: graphics/tip_icon.gif | Using Access Pass-Through Mode Access pass-through mode works best when connecting to DBMSs other than Access. When connecting to an Access MDB file you are best off using any of the other client options discussed here. |

## 31.5 Using Microsoft ASP

Microsoft ASP is a scripting platform for creating Web-based applications. To test your SQL statements within an ASP page, you must create a page that you can execute by calling it from your Web browser. Here are the steps needed to execute a SQL statement within an ASP page:

1. ASP uses ODBC to interact with databases, so an ODBC Data Source must be present before proceeding (refer to the end of this appendix).
2. Create a new ASP page (with an ASP extension) using any text editor.
3. Use Server.CreateObject to create an instance of the ADODB.Connection object.
4. Use the Open method to open the desired ODBC Data Source.
5. Pass your SQL statement to a call to the Execute method. The Execute method returns a result set. Use a Set command to save the result returned into a result set.
6. To display the results, you must loop through the retrieved data using a <% Do While NOT EOF %> loop.
7. Save the page in any executable directory beneath the Web server root.
8. Execute the page by calling it from a Web browser.

## 31.6 Using Microsoft ASP.NET

Microsoft ASP.NET is a scripting platform for creating Web-based applications using the .NET framework. To test SQL statements within an ASP.NET page, you must create a page that you can execute by calling it from your browser. There are multiple ways to accomplish this, but here is one option:

1. Create a new file with a .aspx extensions.
2. Create a database connection using SqlConnection() or OleDbConnection().
3. Use either SqlCommand() or OleDbCommand() to pass the statement to the DBMS.
4. Create a DataReader using ExecuteReader.
5. Loop through the returned reader to obtain the returned values.
6. Save the page in any executable directory beneath the Web server root.
7. Execute the page by calling it from a Web browser.

## 31.7 Using Microsoft Query

Microsoft Query is a standalone SQL query tool and is an ideal utility for testing SQL statements against ODBC Data Sources. Microsoft Query is optionally installed with other Microsoft products, as well as with other third-party products.

|  |  |
| --- | --- |
| 说明: graphics/tip_icon.gif | Obtaining MS-Query MS-Query is often installed with other Microsoft products (for example, Office) although it may only be installed if a complete installation was performed. If it is not present under the Start button, use Start Find to locate it on your system. (It is often present without your knowing it.) The files to look for are MSQRY32.EXE or MSQUERY.EXE. |

To use Microsoft Query, do the following:

1. Microsoft Query uses ODBC to interact with databases, so an ODBC Data Source must be present before you can proceed (see the instructions at the end of this appendix).
2. Before you can use Microsoft Query, it must be installed on your computer. Browse your program groups beneath the Start button to locate it.
3. From the File menu, select Execute SQL to display the Execute SQL window.
4. Click the Data Sources button to select the desired ODBC Data Source. If the Data Source you need is not listed, click Other to locate it. After you have selected the correct Data Source, click the Use button.
5. Type your SQL statement in the SQL Statement box.
6. Click Execute to execute the SQL statement and to display any returned data.

## 31.8 Using Microsoft SQL Server

Microsoft SQL Server features a Windows-based query analysis tool called SQL Query Analyzer. Although this tool is primarily designed to analyze SQL statement execution and optimization, it does present an ideal environment for testing and experimenting with SQL statements. Here's how to use the SQL Query Analyzer:

1. Launch the SQL Query Analyzer application (from the Microsoft SQL Server program group).
2. You'll be prompted for server and login information. Log in to your SQL Server (starting the server if appropriate).
3. When the query screen is displayed, select the database from the drop-down DB list box on the toolbar.
4. Type your SQL in the large text window, and then click the Execute Query button (the one with the green arrow) to execute it. (You can also click F5 or select Execute from the Query menu.)
5. The results will be displayed in a separate pane beneath the SQL window.
6. Click the tabs at the bottom of the query screen to toggle between seeing data and seeing returned messages and information.

## 31.9 Using MySQL

MySQL comes with a command line utility named mysql. This is a text only tool that can be used to execute any SQL statements. To use mysql, do the following:

1. Type mysql to launch the utility. Depending on how security is defined, you may need to use the -u and -p parameters to specify login information.
2. At the mysql> prompt type USE database (specifying the name of the database to be used) to open your database.
3. Type your SQL at the mysql> prompt, making sure to terminate every statement with a semicolon (;). Results will be displayed on the screen.
4. Type \h for a list of commands that you may use, \s for status information (including MySQL version information).
5. Type \q to quit the mysql utility.

## 31.10 Using Oracle

Oracle comes with a Java based management tool called Enterprise Manager. This is actually a suite of tools, one of which is named SQL\*Plus Worksheet. Here's how to use this tool:

1. Launch SQL\*Plus Worksheet (either directly, or from within the Oracle Enterprise Manager).
2. You'll be prompted for login information. Provide a user name and password and connect to the database server.
3. The SQL Worksheet screen is divided into two panes. Type your SQL in the upper pane.
4. To execute the SQL statement, click the Execute button (the one with the picture of the lightning bolt). Results will be displayed in the lower pane.

## 31.11 Using PHP

PHP is a popular Web scripting language. PHP provides functions and libraries used to connect to a variety of databases, and so the code used to execute a SQL statement can vary based on the DBMS used (and how it is being accessed). As such, it is impossible to provide steps that can be used in each and every situation. Refer to PHP documentation for instructions on how to connect to your specific DBMS.

## 31.12 Using PostgreSQL

PostgreSQL comes with a command line utility named psql. This is a text only tool that can be used to execute any SQL statements. To use psql, do the following:

1. Type psql to launch the utility. To load a specific database specify it on the command line as psql database (PostgreSQL does not support the USE command).
2. Type your SQL at the = prompt, making sure to terminate every statement with a semicolon (;). Results will be displayed on the screen.
3. Type \? for a list of commands that you may use.
4. Type \h for SQL help, \h statement for help on specific SQL statement (for example, \h SELECT).
5. Type \q to quit the psql utility.

## 31.13 Using Query Tool

Query Tool is a standalone SQL query tool created by George Poulose, and is an ideal utility for testing SQL statements against ODBC Data Sources. (There's an ADO version too).

|  |  |
| --- | --- |
| 说明: graphics/tip_icon.gif | Obtaining Query Tool Query Tool can be downloaded from the Web. To obtain a copy follow the link at the book's Web site: [http://www.forta.com/books/0672321289/](http://www.forta.com/books/0672321289/" \t "_blank). |

To use Query Tool, do the following:

1. Query Tool uses ODBC to interact with databases, so an ODBC Data Source must be present before you can proceed (see the earlier instructions).
2. Before you can use Query Tool, it must be installed on your computer. Browse your program groups beneath the Start button to locate it.
3. A popup dialog will prompt you for the ODBC Data Source to be used. If the Data Source you need is not listed, click New to create it. After you have selected the correct Data Source, click the OK button.
4. Type your SQL statement in the upper right window.
5. Click the Execute button (the one with the blue arrow) to execute the SQL statement and to display any returned data in the lower pane. (You can also click F5 or select Execute from the Query menu.)

## 31.14 Using Sybase

Sybase Adaptive Server comes with a Java based utility named SQL Advantage. This utility is very similar to Microsoft SQL Server's Query Analyzer (the products share a common origin). To use SQL Advantage, do the following:

1. Execute the SQL Advantage application.
2. You will be prompted for login information, provide your login name and password.
3. When the query screen is displayed, select the database from the drop-down list box on the toolbar.
4. Type your SQL in the window displayed.
5. To execute your query click the Execute button, select Execute Query from the Query menu, or press Ctrl-E.
6. The results (if there are any) will be displayed in a new window.

## 31.15 Configuring ODBC Data Sources

Several of the applications described above use ODBC for database integration, and so we'll start with a brief overview of ODBC and instructions for configuring ODBC Data Sources.

ODBC is a standard that is used to enable clients' applications to interact with different backend databases or underlying database engines. Using ODBC, it is possible to write code in one client and have those tools interact with almost any database or DBMS.

ODBC itself is not a database. Rather, ODBC is a wrapper around databases that makes all databases behave in a consistent and clearly defined fashion. It accomplishes this by using software drivers that have two primary functions. First, they encapsulate any native database features or peculiarities and hide these from the client. Second, they provide a common language for interacting with these databases (performing translations when needed). The language used by ODBC is SQL.

ODBC client applications do not interact with databases directly. Instead, they interact with ODBC Data Sources. A Data Source is a logical database that includes the driver (each database type has its own driver) and information on how to connect to the database (file paths, server names, and so forth).

After ODBC Data Sources are defined, any ODBC-compliant application can use them. ODBC Data Sources are not application specific; they are system specific.

|  |  |
| --- | --- |
| 说明: graphics/caution_icon.gif | ODBC Differences There are many different versions of the ODBC applet, making it impossible to provide exact instructions that would apply to all versions. Pay close attention to the prompts when setting up your own Data Sources. |

ODBC Data Sources are defined using the Windows Control Panel's ODBC applet. To set up an ODBC Data Source, do the following:

1. Open the Windows Control Panel's ODBC applet.
2. Most ODBC Data Sources should be set up to be system-wide Data Sources (as opposed to user-specific Data Sources), so select System DSN, if that option is available to you.
3. Click the Add button to add a new Data Source.
4. Select the driver to use. There is usually a default set of drivers that provides support for major Microsoft products. Other drivers might be installed on your system. You must select a driver that matches the type of database to which you'll be connecting.
5. Depending on the type of database or DBMS, you are prompted for server name or file path information and possibly login information. Provide this information as requested and then follow the rest of the prompts to create the Data Source.

# 32. Appendix C. SQL Statement Syntax

To help you find the syntax you need when you need it, this appendix lists the syntax for the most frequently used SQL operations. Each statement starts with a brief description and then displays the appropriate syntax. For added convenience, you'll also find cross references to the lessons where specific statements are taught.

When reading statement syntax, remember the following:

* The | symbol is used to indicate one of several options, so NULL|NOT NULL means specify either NULL or NOT NULL.
* Keywords or clauses contained within square parentheses [like this] are optional.
* The syntax listed below will work with almost all DBMSs. You are advised to consult your own DBMS documentation for details of implementing specific syntactical changes.

## 32.1 ALTER TABLE

ALTER TABLE is used to update the schema of an existing table. To create a new table, use CREATE TABLE. See [Lesson 17](#Bookmark89)(See 24.), "Creating and Manipulating Tables," for more information.

说明: graphics/input_icon.jpg

ALTER TABLE tablename

(

ADD|DROP column datatype [NULL|NOT NULL] [CONSTRAINTS],

ADD|DROP column datatype [NULL|NOT NULL] [CONSTRAINTS],

...

);

## 32.2 COMMIT

COMMIT is used to write a transaction to the database. See [Lesson 20](#Bookmark105)(See 27.), "Managing Transaction Processing," for more information.

说明: graphics/input_icon.jpg

COMMIT [TRANSACTION];

## 32.3 CREATE INDEX

CREATE INDEX is used to create an index on one or more columns. See [Lesson 22](#Bookmark113)(See 29.), "Understanding Advanced SQL Features," for more information.

说明: graphics/input_icon.jpg

CREATE INDEX indexname

ON tablename (column, ...);

## 32.4 CREATE PROCEDURE

CREATE PROCEDURE is used to create a stored procedure. See [Lesson 19](#Bookmark99)(See 26.), "Working with Stored Procedures," for more information. Oracle uses a different syntax as described in that lesson.

说明: graphics/input_icon.jpg

CREATE PROCEDURE procedurename [parameters] [options]

AS

SQL statement;

## 32.5 CREATE TABLE

CREATE TABLE is used to create new database tables. To update the schema of an existing table, use ALTER TABLE. See [Lesson 17](#Bookmark89)(See 24.) for more information.

说明: graphics/input_icon.jpg

CREATE TABLE tablename

(

column datatype [NULL|NOT NULL] [CONSTRAINTS],

column datatype [NULL|NOT NULL] [CONSTRAINTS],

...

);

## 32.6 CREATE VIEW

CREATE VIEW is used to create a new view of one or more tables. See [Lesson 18](#Bookmark95)(See 25.), "Using Views," for more information.

说明: graphics/input_icon.jpg

CREATE VIEW viewname AS

SELECT columns, ...

FROM tables, ...

[WHERE ...]

[GROUP BY ...]

[HAVING ...];

## 32.7 DELETE

DELETE deletes one or more rows from a table. See [Lesson 16](#Bookmark84)(See 23.), "Updating and Deleting Data," for more information.

说明: graphics/input_icon.jpg

DELETE FROM tablename

[WHERE ...];

## 32.8 DROP

DROP permanently removes database objects (tables, views, indexes, and so forth). See [Lessons 17](#Bookmark89)(See 24.) and [18](#Bookmark95)(See 25.) for more information.

说明: graphics/input_icon.jpg

DROP INDEX|PROCEDURE|TABLE|VIEW indexname|procedurename|tablename|viewname;

## 32.9 INSERT

INSERT adds a single row to a table. See [Lesson 15](#Bookmark80)(See 22.), "Inserting Data," for more information.

说明: graphics/input_icon.jpg

INSERT INTO tablename [(columns, ...)]

VALUES(values, ...);

## 32.10 INSERT SELECT

INSERT SELECT inserts the results of a SELECT into a table. See [Lesson 15](#Bookmark80)(See 22.) for more information.

说明: graphics/input_icon.jpg

INSERT INTO tablename [(columns, ...)]

SELECT columns, ... FROM tablename, ...

[WHERE ...];

## 32.11 ROLLBACK

ROLLBACK is used to undo a transaction block. See [Lesson 20](#Bookmark105)(See 27.) for more information.

说明: graphics/input_icon.jpg

ROLLBACK [ TO savepointname];

or

说明: graphics/input_icon.jpg

ROLLBACK TRANSACTION;

## 32.12 SELECT

SELECT is used to retrieve data from one or more tables (or views). See [Lesson 2](#Bookmark15)(See 9.), "Retrieving Data"; [Lesson 3](#Bookmark21)(See 10.), "Sorting Retrieved Data"; and [Lesson 4](#Bookmark27)(See 11.), "Filtering Data," for more basic information. ([Lessons 2](#Bookmark15)(See 9.)-[14](#Bookmark76)(See 21.) all cover aspects of SELECT.)

说明: graphics/input_icon.jpg

SELECT columnname, ...

FROM tablename, ...

[WHERE ...]

[UNION ...]

[GROUP BY ...]

[HAVING ...]

[ORDER BY ...];

## 32.13 UPDATE

UPDATE updates one or more rows in a table. See [Lesson 16](#Bookmark84)(See 23.) for more information.

说明: graphics/input_icon.jpg

UPDATE tablename

SET columname = value, ...

[WHERE ...];

# 33. Appendix D. Using SQL Datatypes

As explained in [Lesson 1](#Bookmark10)(See 8.), "Understanding SQL," datatypes are basically rules that define what data may be stored in a column and how that data is actually stored.

Datatypes are used for several reasons:

* Datatypes enable you to restrict the type of data that can be stored in a column. For example, a numeric datatype column will only accept numeric values.
* Datatypes allow for more efficient storage, internally. Numbers and date time values can be stored in a more condensed format than text strings.
* Datatypes allow for alternate sorting orders. If everything is treated as strings, 1 comes before 10, which comes before 2. (Strings are sorted in dictionary sequence, one character at a time starting from the left.) As numeric datatypes, the numbers would be sorted correctly.

When designing tables, pay careful attention to the datatypes being used. Using the wrong datatype can seriously impact your application. Changing the datatypes of existing populated columns is not a trivial task. (In addition, doing so can result in data loss.)

Although this lesson is by no means a complete tutorial on datatypes and how they are to be used, it explains the major datatype types, what they are used for, and compatibility issues that you should be aware of.

|  |  |
| --- | --- |
| 说明: graphics/caution_icon.gif | No Two DBMSs Are Exactly Alike It's been said before, but it needs to be said again. Unfortunately, datatypes can vary dramatically from one DBMS to the next. Even the same datatype name can mean different things to different DBMSs. Be sure you consult your DBMS documentation for details on exactly what it supports and how. |

## 33.1 String Datatypes

The most commonly used datatypes are string datatypes. These store strings: for example, names, addresses, phone numbers, and zip codes. There are basically two types of string datatype that you can use-fixed-length strings and variable-length strings (see [Table D.1](#Bookmark153_app04table01)).

Fixed length strings are datatypes that are defined to accept a fixed number of characters, and that number is specified when the table is created. For example, you might allow 30 characters in a first-name column or 11 characters in a social-security-number column (the exact number needed allowing for the two dashes). Fixed-length columns do not allow more than the specified number of characters. They also allocate storage space for as many characters as specified. So, if the string Ben is stored in a 30-character first-name field, a full 30 characters are stored (and the text may be padded with spaces or nulls as needed).

Variable-length strings store text of any length (the maximum varies by datatype and DBMS). Some variable-length datatypes have a fixed-length minimum. Others are entirely variable. Either way, only the data specified is saved (and no extra data is stored).

If variable-length datatypes are so flexible, why would you ever want to used fixed-length datatypes? The answer is performance. DBMSs can sort and manipulate fixed-length columns far more quickly than they can sort variable-length columns. In addition, many DBMSs will not allow you to index variable-length columns (or the variable portion of a column). This also dramatically impacts performance. (See [Lesson 22](#Bookmark113)(See 29.), "Understanding Advanced SQL Features," for more information on indexes.)

| **Table D.1. String Datatypes** | |
| --- | --- |
| Datatype | Description |
| CHAR | Fixed length string from 1 to 255 chars long. Its size must be specified at create time. |
| NCHAR | Special form of CHAR designed to support multibyte or Unicode characters. (The exact specifications vary dramatically from one implementation to the next.) |
| NVARCHAR | Special form of TEXT designed to support multibyte or Unicode characters. (Exact specifications vary dramatically from one implementation to the next.) |
| TEXT (also called LONG or MEMO or VARCHAR) | Variable-length text. |

|  |  |
| --- | --- |
| 说明: graphics/tip_icon.gif | Using Quotes Regardless of the form of string datatype being used, string values must always be surrounded by single quotes. |

|  |  |
| --- | --- |
| 说明: graphics/caution_icon.gif | When Numeric Values Are Not Numeric Values You might think that phone numbers and zip codes should be stored in numeric fields (after all, they only store numeric data), but doing so would not be advisable. If you store the zip code 01234 in a numeric field, the number 1234 would be saved. You'd actually lose a digit.  The basic rule to follow is: If the number is a number used in calculations (sums, averages, and so on), it belongs in a numeric datatype column. If it is used as a literal string (that happens to contain only digits), it belongs in a string datatype column. |

## 33.2 Numeric Datatypes

Numeric datatypes store numbers. Most DBMSs support multiple numeric datatypes, each with a different range of numbers that can be stored in it. Obviously, the larger the supported range, the more storage space needed. In addition, some numeric datatypes support the use of decimal points (and fractional numbers) whereas others support only whole numbers. [Table D.2](#Bookmark154_app04table02) lists common uses for various datatypes. Not all DBMSs follow the exact naming conventions and descriptions listed here.

| **Table D.2. Numeric Datatypes** | |
| --- | --- |
| Datatype | Description |
| BIT | Single bit value, either 0 or 1, used primarily for on/off flags |
| DECIMAL (also called NUMERIC) | Fixed or floating point values with varying levels of precision |
| FLOAT (also called NUMBER) | Floating point values |
| INT (also called INTEGER) | 4-byte integer value that supports numbers from -2147483648 to 2147483647 |
| REAL | 4-byte floating point values |
| SMALLINT | 2-byte integer value that supports numbers from -32768 to 32767 |
| TINYINT | 1-byte integer value that supports numbers from 0 to 255 |

|  |  |
| --- | --- |
| 说明: graphics/tip_icon.gif | Not Using Quotes Unlike strings, numeric values should never be enclosed within quotes. |

|  |  |
| --- | --- |
| 说明: graphics/tip_icon.gif | Currency Datatypes Most DBMSs support a special numeric datatype for storing monetary values. Usually called MONEY or CURRENCY, these datatypes are essentially DECIMAL datatypes with specific ranges that make them well-suited for storing currency values. |

## 33.3 Date and Time Datatypes

All DBMSs support datatypes designed for the storage of date and time values (see [Table D.3](#Bookmark155_app04table03)). Like numeric values, most DBMSs support multiple datatypes, each with different ranges and levels of precision.

| **Table D.3. Date and Time Datatypes** | |
| --- | --- |
| Datatype | Description |
| DATE | Date value |
| DATETIME (also known as TIMESTAMP) | Date time values |
| SMALLDATETIME | Date time values with accuracy to the minute (no seconds or milliseconds) |
| TIME | Time value |

|  |  |
| --- | --- |
| 说明: graphics/caution_icon.gif | Specifying Dates There is no standard way to define a date that will be understood by every DBMS. Most implementations understand formats like 2004-12-30 or Dec 30th, 2004, but even those can be problematic to some DBMSs. Make sure to consult your DBMS documentation for a list of the date formats that it will recognize. |

|  |  |
| --- | --- |
| 说明: graphics/tip_icon.gif | ODBC Dates Because every DBMS has its own format for specifying dates, ODBC created a format of its own that will work with every database when ODBC is being used. The ODBC format looks like {d '2004-12-30'} for dates, {t '21:46:29'} for times, and {ts '2004-12-30 21:46:29'} for date time values. If you are using SQL via ODBC, be sure your dates and times are formatted in this fashion. |

## 33.4 Binary Datatypes

Binary datatypes are some of the least compatible (and, fortunately, also some of the least used) datatypes. Unlike all the datatypes explained thus far, which have very specific uses, binary datatypes can contain any data, even binary information, such as graphic images, multimedia, and word processor documents (see [Table D.4](#Bookmark156_app04table04)).

| **Table D.4. Binary Datatypes** | |
| --- | --- |
| Datatype | Description |
| BINARY | Fixed-length binary data (maximum length may vary from 255 bytes to 8,000 bytes, depending on implementation) |
| LONG RAW | Variable-length binary data up to 2GB |
| RAW (called BINARY by some implementations) | Fixed-length binary data up to 255 bytes |
| VARBINARY | Variable-length binary data (typically, maximum length varies from 255 bytes to 8,000 bytes, depending on implementation) |

|  |  |
| --- | --- |
| 说明: graphics/note_icon.gif | Comparing Datatypes If you would like to see a real-world example of database comparisons, look at the table creation scripts used to build the example tables in this book (see [Appendix A](#Bookmark119)(See 30.), "Sample Table Scripts"). By comparing the scripts used for different DBMSs you'll see first hand just how complex a task datatype matching is. |

# 34. Appendix E. SQL Reserved Words

SQL is a language made up of keywords-special words that are used in performing SQL operations. Special care must be taken to not use these keywords when naming databases, tables, columns, and any other database objects. Thus, these keywords are considered reserved.

This appendix contains a list of the more common reserved words found in major DBMSs. Please note the following:

* Keywords tend to be very DBMS-specific, and not all the keywords that follow are used by all DBMSs.
* Many DBMSs have extended the list of SQL reserved words to include terms specific to their implementations. Most DBMS-specific keywords are not listed in the following section.
* To ensure future compatibility and portability, it is a good idea to avoid any and all reserved words, even those not reserved by your own DBMS.

| ABORT | ABSOLUTE | ACTION |
| --- | --- | --- |
| ACTIVE | ADD | AFTER |
| ALL | ALLOCATE | ALTER |
| ANALYZE | AND | ANY |
| ARE | AS | ASC |
| ASCENDING | ASSERTION | AT |
| AUTHORIZATION | AUTO | AUTO-INCREMENT |
| AUTOINC | AVG | BACKUP |
| BEFORE | BEGIN | BETWEEN |
| BIGINT | BINARY | BIT |
| BLOB | BOOLEAN | BOTH |
| BREAK | BROWSE | BULK |
| BY | BYTES | CACHE |
| CALL | CASCADE | CASCADED |
| CASE | CAST | CATALOG |
| CHANGE | CHAR | CHARACTER |
| CHARACTER\_LENGTH | CHECK | CHECKPOINT |
| CLOSE | CLUSTER | CLUSTERED |
| COALESCE | COLLATE | COLUMN |
| COLUMNS | COMMENT | COMMIT |
| COMMITTED | COMPUTE | COMPUTED |
| CONDITIONAL | CONFIRM | CONNECT |
| CONNECTION | CONSTRAINT | CONSTRAINTS |
| CONTAINING | CONTAINS | CONTAINSTABLE |
| CONTINUE | CONTROLROW | CONVERT |
| COPY | COUNT | CREATE |
| CROSS | CSTRING | CUBE |
| CURRENT | CURRENT\_DATE | CURRENT\_TIME |
| CURRENT\_TIMESTAMP | CURRENT\_USER | CURSOR |
| DATABASE | DATABASES | DATE |
| DATETIME | DAY | DBCC |
| DEALLOCATE | DEBUG | DEC |
| DECIMAL | DECLARE | DEFAULT |
| DELETE | DENY | DESC |
| DESCENDING | DESCRIBE | DISCONNECT |
| DISK | DISTINCT | DISTRIBUTED |
| DIV | DO | DOMAIN |
| DOUBLE | DROP | DUMMY |
| DUMP | ELSE | ELSEIF |
| ENCLOSED | END | ERRLVL |
| ERROREXIT | ESCAPE | ESCAPED |
| EXCEPT | EXCEPTION | EXEC |
| EXECUTE | EXISTS | EXIT |
| EXPLAIN | EXTEND | EXTERNAL |
| EXTRACT | FALSE | FETCH |
| FIELD | FIELDS | FILE |
| FILLFACTOR | FILTER | FLOAT |
| FLOPPY | FOR | FORCE |
| FOREIGN | FOUND | FREETEXT |
| FREETEXTTABLE | FROM | FULL |
| FUNCTION | GENERATOR | GET |
| GLOBAL | GO | GOTO |
| GRANT | GROUP | HAVING |
| HOLDLOCK | HOUR | IDENTITY |
| IF | IN | INACTIVE |
| INDEX | INDICATOR | INFILE |
| INNER | INOUT | INPUT |
| INSENSITIVE | INSERT | INT |
| INTEGER | INTERSECT | INTERVAL |
| INTO | IS | ISOLATION |
| JOIN | KEY | KILL |
| LANGUAGE | LAST | LEADING |
| LEFT | LENGTH | LEVEL |
| LIKE | LIMIT | LINENO |
| LINES | LISTEN | LOAD |
| LOCAL | LOCK | LOGFILE |
| LONG | LOWER | MANUAL |
| MATCH | MAX | MERGE |
| MESSAGE | MIN | MINUTE |
| MIRROREXIT | MODULE | MONEY |
| MONTH | MOVE | NAMES |
| NATIONAL | NATURAL | NCHAR |
| NEXT | NEW | NO |
| NOCHECK | NONCLUSTERED | NONE |
| NOT | NULL | NULLIF |
| NUMERIC | OF | OFF |
| OFFSET | OFFSETS | ON |
| ONCE | ONLY | OPEN |
| OPTION | OR | ORDER |
| OUTER | OUTPUT | OVER |
| OVERFLOW | OVERLAPS | PAD |
| PAGE | PAGES | PARAMETER |
| PARTIAL | PASSWORD | PERCENT |
| PERM | PERMANENT | PIPE |
| PLAN | POSITION | PRECISION |
| PREPARE | PRIMARY | PRINT |
| PRIOR | PRIVILEGES | PROC |
| PROCEDURE | PROCESSEXIT | PROTECTED |
| PUBLIC | PURGE | RAISERROR |
| READ | READTEXT | REAL |
| REFERENCES | REGEXP | RELATIVE |
| RENAME | REPEAT | REPLACE |
| REPLICATION | REQUIRE | RESERV |
| RESERVING | RESET | RESTORE |
| RESTRICT | RETAIN | RETURN |
| RETURNS | REVOKE | RIGHT |
| ROLLBACK | ROLLUP | ROWCOUNT |
| RULE | SAVE | SAVEPOINT |
| SCHEMA | SECOND | SECTION |
| SEGMENT | SELECT | SENSITIVE |
| SEPARATOR | SEQUENCE | SESSION\_USER |
| SET | SETUSER | SHADOW |
| SHARED | SHOW | SHUTDOWN |
| SINGULAR | SIZE | SMALLINT |
| SNAPSHOT | SOME | SORT |
| SPACE | SQL | SQLCODE |
| SQLERROR | STABILITY | STARTING |
| STARTS | STATISTICS | SUBSTRING |
| SUM | SUSPEND | TABLE |
| TABLES | TAPE | TEMP |
| TEMPORARY | TEXT | TEXTSIZE |
| THEN | TIME | TIMESTAMP |
| TO | TOP | TRAILING |
| TRAN | TRANSACTION | TRANSLATE |
| TRIGGER | TRIM | TRUE |
| TRUNCATE | UNCOMMITTED | UNION |
| UNIQUE | UNTIL | UPDATE |
| UPDATETEXT | UPPER | USAGE |
| USE | USER | USING |
| VALUE | VALUES | VARCHAR |
| VARIABLE | VARYING | VERBOSE |
| VIEW | VOLUME | WAIT |
| WAITFOR | WHEN | WHERE |
| WHILE | WITH | WORK |
| WRITE | WRITETEXT | XOR |
| YEAR | ZONE |  |

# 35. Index

## 35.1 index\_SYMBOL

[% (percent sign) wildcard](#Bookmark37_idd1e6603)(See 13.1)  [2nd](#Bookmark37_idd1e6691)(See 13.1)  [3rd](#Bookmark37_idd1e6790)(See 13.1)  [4th](#Bookmark37_idd1e6888)(See 13.1)  [5th](#Bookmark37_idd1e6959)(See 13.1)    
' (single quotation marks)  
    [WHERE clause operators and](#Bookmark29_idd1e4385)(See 11.2)    
\* (wildcard character)  
    [queries](#Bookmark19_idd1e2584)(See 9.4)  [2nd](#Bookmark19_idd1e2658)(See 9.4)    
[\*= (equality) operator](#Bookmark72_idd1e16595)(See 20.2)    
+ (plus sign)  
    [concatenation operator](#Bookmark42_idd1e8117)(See 14.2)  [2nd](#Bookmark42_idd1e8239)(See 14.2)    
+ (plus sign) operator  
    [outer joins](#Bookmark72_idd1e16672)(See 20.2)    
, (commas)  
    [multiple coliumn separatio](#Bookmark18_idd1e2448)(See 9.3)    
[@ character](#Bookmark103_idd1e23177)(See 26.4)    
[@@ERROR variable](#Bookmark107_idd1e24268)(See 27.2)    
[@@IDENTITY global variable](#Bookmark103_idd1e23363)(See 26.4)    
[[] (square brackets) wildcard](#Bookmark37_idd1e7367)(See 13.1)  [2nd](#Bookmark37_idd1e7489)(See 13.1)  [3rd](#Bookmark37_idd1e7569)(See 13.1)  [4th](#Bookmark37_idd1e7674)(See 13.1)    
[^ (caret) character](#Bookmark37_idd1e7518)(See 13.1)    
[\_ (underscore) wildcard](#Bookmark37_idd1e7098)(See 13.1)  [2nd](#Bookmark37_idd1e7190)(See 13.1)  [3rd](#Bookmark37_idd1e7301)(See 13.1)    
[| (pipe) symbol](#Bookmark138_idd1e29286)(See 32.)    
|| (double pipes)  
    [concatenation operator](#Bookmark42_idd1e8127)(See 14.2)  [2nd](#Bookmark42_idd1e8249)(See 14.2)

## 35.2 index\_A

[ABS() function](#Bookmark47_idd1e10526)(See 15.2)    
Access (Microsoft)  
    [DISTINCT argument support](#Bookmark51_idd1e12006)(See 16.2)    
    [example tables for](#Bookmark121_idd1e27544)(See 30.2)    
    [pass-through mode](#Bookmark126_idd1e28298)(See 31.4)    
    [running](#Bookmark126_idd1e28101)(See 31.4)  [2nd](#Bookmark126_idd1e28175)(See 31.4)  [3rd](#Bookmark126_idd1e28274)(See 31.4)    
    [sorting by alias](#Bookmark58_idd1e13392)(See 17.4)    
    [stored procedure support](#Bookmark100_idd1e22690)(See 26.1)    
adding  
    [rows to tables](#Bookmark147_idd1e29808)(See 32.9)    
aggregate functions  
    [ALL argument](#Bookmark51_idd1e11918)(See 16.2)    
    [AVG()](#Bookmark50_idd1e10919)(See 16.1)  [2nd](#Bookmark50_idd1e11005)(See 16.1)  [3rd](#Bookmark50_idd1e11065)(See 16.1)    
    [combining](#Bookmark52_idd1e12206)(See 16.3)  [2nd](#Bookmark52_idd1e12260)(See 16.3)    
    [COUNT()](#Bookmark50_idd1e11154)(See 16.1)  [2nd](#Bookmark50_idd1e11235)(See 16.1)  [3rd](#Bookmark50_idd1e11307)(See 16.1)    
    [defined](#Bookmark50_idd1e10768)(See 16.1)    
    [DISTINCT argument](#Bookmark51_idd1e11949)(See 16.2)  [2nd](#Bookmark51_idd1e12174)(See 16.2)    
    [joins and](#Bookmark73_idd1e16838)(See 20.3)  [2nd](#Bookmark73_idd1e16909)(See 20.3)  [3rd](#Bookmark73_idd1e16981)(See 20.3)    
    [MAX()](#Bookmark50_idd1e11375)(See 16.1)  [2nd](#Bookmark50_idd1e11423)(See 16.1)    
    [MIN()](#Bookmark50_idd1e11533)(See 16.1)  [2nd](#Bookmark50_idd1e11581)(See 16.1)    
    [naming aliases](#Bookmark52_idd1e12303)(See 16.3)    
    [overview](#Bookmark50_idd1e10700)(See 16.1)  [2nd](#Bookmark50_idd1e10742)(See 16.1)    
    [SUM()](#Bookmark50_idd1e11682)(See 16.1)  [2nd](#Bookmark50_idd1e11765)(See 16.1)  [3rd](#Bookmark50_idd1e11815)(See 16.1)    
aliases  
    [alternative uses](#Bookmark42_idd1e8874)(See 14.2)    
    columns  
        [creating](#Bookmark71_idd1e15653)(See 20.1)    
    [concatenating fields](" \l "Bookmark42_idd1e8705)(See 14.2)  [2nd](#Bookmark42_idd1e8850)(See 14.2)    
    [names](#Bookmark42_idd1e8898)(See 14.2)    
    naming  
        [aggregate functions and](#Bookmark52_idd1e12322)(See 16.3)    
    [table names](#Bookmark71_idd1e15694)(See 20.1)  [2nd](#Bookmark71_idd1e15778)(See 20.1)  [3rd](#Bookmark71_idd1e15846)(See 20.1)    
        [self joins](#Bookmark72_idd1e15901)(See 20.2)  [2nd](#Bookmark72_idd1e15980)(See 20.2)  [3rd](#Bookmark72_idd1e16077)(See 20.2)  [4th](#Bookmark72_idd1e16145)(See 20.2)    
ALL argument  
    [aggregate functions](#Bookmark51_idd1e11930)(See 16.2)    
ALL clause  
    [grouping data](#Bookmark56_idd1e12707)(See 17.2)    
[alphabetical sort order](#Bookmark25_idd1e3286)(See 10.4)  [2nd](#Bookmark25_idd1e3342)(See 10.4)  [3rd](#Bookmark25_idd1e3416)(See 10.4)  [4th](#Bookmark25_idd1e3501)(See 10.4)    
[ALTER TABLE statement](#Bookmark91_idd1e21198)(See 24.2)  [2nd](#Bookmark91_idd1e21269)(See 24.2)  [3rd](#Bookmark91_idd1e21326)(See 24.2)    
ALTER TABLE statements  
    [CHECK constraints](#Bookmark114_idd1e25797)(See 29.1)    
    [CONSTRAINT syntax](#Bookmark114_idd1e25463)(See 29.1)    
    [syntax](#Bookmark139_idd1e29335)(See 32.1)    
[AND keyword](#Bookmark29_idd1e4590)(See 11.2)    
[AND operator](#Bookmark32_idd1e5020)(See 12.1)  [2nd](#Bookmark32_idd1e5102)(See 12.1)  [3rd](#Bookmark32_idd1e5170)(See 12.1)    
[ANSI SQL](#Bookmark12_idd1e1929)(See 8.2)    
applications  
    [filtering query results](#Bookmark28_idd1e3813)(See 11.1)    
    SQL compatibility  
        [Aqua Data Studio](#Bookmark123_idd1e27807)(See 31.1)  [2nd](#Bookmark123_idd1e27865)(See 31.1)    
        [ColdFusion (Macromedia)](#Bookmark125_idd1e27979)(See 31.3)  [2nd](#Bookmark125_idd1e28053)(See 31.3)    
        [DB2 (IBM)](#Bookmark124_idd1e27890)(See 31.2)  [2nd](#Bookmark124_idd1e27947)(See 31.2)    
        [Microsoft Access](#Bookmark126_idd1e28089)(See 31.4)  [2nd](#Bookmark126_idd1e28163)(See 31.4)  [3rd](#Bookmark126_idd1e28262)(See 31.4)    
        [Microsoft ASP](#Bookmark127_idd1e28319)(See 31.5)  [2nd](#Bookmark127_idd1e28394)(See 31.5)    
        [Microsoft ASP.NET](#Bookmark128_idd1e28421)(See 31.6)  [2nd](#Bookmark128_idd1e28489)(See 31.6)    
        [Microsoft Query](#Bookmark129_idd1e28519)(See 31.7)  [2nd](#Bookmark129_idd1e28594)(See 31.7)    
        [Microsoft SQL Server](#Bookmark130_idd1e28636)(See 31.8)  [2nd](#Bookmark130_idd1e28694)(See 31.8)    
        [MySQL](#Bookmark131_idd1e28721)(See 31.9)    
        [ODBC configuration](#Bookmark137_idd1e29133)(See 31.15)  [2nd](#Bookmark137_idd1e29185)(See 31.15)  [3rd](#Bookmark137_idd1e29227)(See 31.15)    
        [Oracle](#Bookmark132_idd1e28795)(See 31.10)    
        [PHP scripting language](#Bookmark133_idd1e28850)(See 31.11)    
        [PostgreSQL](#Bookmark134_idd1e28877)(See 31.12)    
        [Query Tool](#Bookmark135_idd1e28957)(See 31.13)  [2nd](#Bookmark135_idd1e29032)(See 31.13)    
        [selection criteria](#Bookmark122_idd1e27735)(See 31.)    
        [Sybase Adaptive Server](#Bookmark136_idd1e29070)(See 31.14)  [2nd](#Bookmark136_idd1e29114)(See 31.14)    
Aqua Data Studio  
    [running](#Bookmark123_idd1e27814)(See 31.1)  [2nd](#Bookmark123_idd1e27872)(See 31.1)    
    [Web site](#Bookmark122_idd1e27781)(See 31.)    
arguements  
    [DBMS support](#Bookmark51_idd1e12169)(See 16.2)    
arguments  
    ALL  
        [aggregate functions](#Bookmark51_idd1e11935)(See 16.2)    
argumentsDISTINCT  
    [aggregate functions](#Bookmark51_idd1e11966)(See 16.2)  [2nd](#Bookmark51_idd1e12191)(See 16.2)    
[AS keyword](#Bookmark42_idd1e8735)(See 14.2)  [2nd](#Bookmark42_idd1e8807)(See 14.2)    
    [Oracle support](#Bookmark71_idd1e15826)(See 20.1)    
ASC keyword  
    [query results sort order](#Bookmark25_idd1e3504)(See 10.4)    
ASP (Microsoft)  
    [running](#Bookmark127_idd1e28331)(See 31.5)  [2nd](#Bookmark127_idd1e28406)(See 31.5)    
ASP.NET (Microsoft)  
    [running](#Bookmark128_idd1e28433)(See 31.6)  [2nd](#Bookmark128_idd1e28501)(See 31.6)    
[authentication](#Bookmark117_idd1e26518)(See 29.4)    
[authorization](#Bookmark117_idd1e26515)(See 29.4)    
[AVG() function](#Bookmark50_idd1e10817)(See 16.1)  [2nd](#Bookmark50_idd1e10931)(See 16.1)  [3rd](#Bookmark50_idd1e11017)(See 16.1)  [4th](#Bookmark50_idd1e11077)(See 16.1)    
    [DISTINCT argument](#Bookmark51_idd1e12023)(See 16.2)    
    [NULL values](#Bookmark50_idd1e11127)(See 16.1)

## 35.3 index\_B

[BETWEEN operator](#Bookmark47_idd1e10358)(See 15.2)    
[BETWEEN operator (WHERE clause)](#Bookmark29_idd1e4545)(See 11.2)    
[between specified values operator (WHERE clause)](#Bookmark29_idd1e4090)(See 11.2)    
[BINARY datatype](#Bookmark156_idd1e30756)(See 33.4)    
[binary datatypes](#Bookmark156_idd1e30712)(See 33.4)    
[BIT datatype](#Bookmark154_idd1e30400)(See 33.2)

## 35.4 index\_C

calculated fields  
    [concatenating fields](#Bookmark42_idd1e7982)(See 14.2)  [2nd](#Bookmark42_idd1e8074)(See 14.2)  [3rd](#Bookmark42_idd1e8208)(See 14.2)  [4th](#Bookmark42_idd1e8292)(See 14.2)  [5th](#Bookmark42_idd1e8438)(See 14.2)  [6th](#Bookmark42_idd1e8577)(See 14.2)    
        [column aliases](#Bookmark42_idd1e8670)(See 14.2)  [2nd](#Bookmark42_idd1e8815)(See 14.2)    
    [mathematical calculations](#Bookmark43_idd1e8968)(See 14.3)  [2nd](#Bookmark43_idd1e9026)(See 14.3)  [3rd](#Bookmark43_idd1e9090)(See 14.3)  [4th](#Bookmark44_idd1e9226)(See 14.4)    
    [overview](#Bookmark41_idd1e7785)(See 14.1)  [2nd](#Bookmark41_idd1e7845)(See 14.1)  [3rd](#Bookmark41_idd1e7917)(See 14.1)    
    [subqueries](#Bookmark64_idd1e14241)(See 18.3)  [2nd](#Bookmark64_idd1e14322)(See 18.3)  [3rd](#Bookmark64_idd1e14386)(See 18.3)  [4th](#Bookmark64_idd1e14490)(See 18.3)    
    [views](#Bookmark97_idd1e22477)(See 25.2)  [2nd](#Bookmark97_idd1e22528)(See 25.2)  [3rd](#Bookmark97_idd1e22564)(See 25.2)    
calculated values  
    [totaling](#Bookmark50_idd1e11755)(See 16.1)    
Cartesian Product  
    [joins and](#Bookmark68_idd1e15035)(See 19.2)  [2nd](#Bookmark68_idd1e15099)(See 19.2)  [3rd](#Bookmark68_idd1e15142)(See 19.2)  [4th](#Bookmark68_idd1e15190)(See 19.2)    
[cascading deletes](#Bookmark114_idd1e25518)(See 29.1)    
case sensitivity  
    [query result sort order](#Bookmark25_idd1e3545)(See 10.4)    
    [SQL statements](#Bookmark17_idd1e2390)(See 9.2)    
[CHAR string datatype](#Bookmark153_idd1e30245)(See 33.1)    
charactrers  
    searching for  
        [% (percent sign) wildcard](#Bookmark37_idd1e6560)(See 13.1)  [2nd](#Bookmark37_idd1e6701)(See 13.1)  [3rd](#Bookmark37_idd1e6800)(See 13.1)  [4th](#Bookmark37_idd1e6898)(See 13.1)  [5th](#Bookmark37_idd1e6969)(See 13.1)    
        [[] (square brackets) wildcard](#Bookmark37_idd1e7377)(See 13.1)  [2nd](#Bookmark37_idd1e7499)(See 13.1)  [3rd](#Bookmark37_idd1e7579)(See 13.1)  [4th](#Bookmark37_idd1e7684)(See 13.1)    
        [\_ (underscore) wildcard](#Bookmark37_idd1e7055)(See 13.1)  [2nd](#Bookmark37_idd1e7200)(See 13.1)  [3rd](#Bookmark37_idd1e7311)(See 13.1)    
[check constraints](#Bookmark114_idd1e25641)(See 29.1)  [2nd](#Bookmark114_idd1e25738)(See 29.1)  [3rd](#Bookmark114_idd1e25775)(See 29.1)    
[clauses](#Bookmark22_idd1e2824)(See 10.1)    
    ALL  
        [grouping data](#Bookmark56_idd1e12712)(See 17.2)    
    [GROUP BY](#Bookmark56_idd1e12428)(See 17.2)  [2nd](#Bookmark56_idd1e12520)(See 17.2)  [3rd](#Bookmark56_idd1e12650)(See 17.2)    
    HAVING  
        [grouping data](#Bookmark57_idd1e12849)(See 17.3)    
    [IS NULL](#Bookmark29_idd1e4739)(See 11.2)    
    SELECT statements  
        [order of](#Bookmark59_idd1e13478)(See 17.5)    
    [WHERE](#Bookmark28_idd1e3654)(See 11.1)  [2nd](#Bookmark28_idd1e3716)(See 11.1)  [3rd](#Bookmark28_idd1e3754)(See 11.1)    
        [AND operator](#Bookmark32_idd1e5013)(See 12.1)  [2nd](#Bookmark32_idd1e5095)(See 12.1)  [3rd](#Bookmark32_idd1e5163)(See 12.1)    
        [checking against single value](#Bookmark29_idd1e4200)(See 11.2)  [2nd](#Bookmark29_idd1e4257)(See 11.2)    
        [checking for nonmatches](#Bookmark29_idd1e4311)(See 11.2)  [2nd](#Bookmark29_idd1e4411)(See 11.2)    
        [checking for NULL value](#Bookmark29_idd1e4650)(See 11.2)  [2nd](#Bookmark29_idd1e4781)(See 11.2)    
        [checking for range of values](#Bookmark29_idd1e4517)(See 11.2)  [2nd](#Bookmark29_idd1e4605)(See 11.2)    
        [IN operator](#Bookmark33_idd1e5728)(See 12.2)  [2nd](#Bookmark33_idd1e5798)(See 12.2)  [3rd](#Bookmark33_idd1e5868)(See 12.2)  [4th](#Bookmark33_idd1e5977)(See 12.2)    
        [joins and](#Bookmark68_idd1e15007)(See 19.2)  [2nd](#Bookmark68_idd1e15084)(See 19.2)  [3rd](#Bookmark68_idd1e15127)(See 19.2)  [4th](#Bookmark68_idd1e15176)(See 19.2)    
        [multiple query criteria](#Bookmark32_idd1e4939)(See 12.1)    
        [NOT operator](#Bookmark34_idd1e6038)(See 12.3)  [2nd](#Bookmark34_idd1e6158)(See 12.3)  [3rd](#Bookmark34_idd1e6240)(See 12.3)    
        [operator support by DBMS](#Bookmark29_idd1e4487)(See 11.2)    
        [operators](#Bookmark29_idd1e3902)(See 11.2)  [2nd](#Bookmark29_idd1e4115)(See 11.2)    
        [OR operator](#Bookmark32_idd1e5221)(See 12.1)  [2nd](#Bookmark32_idd1e5293)(See 12.1)  [3rd](#Bookmark32_idd1e5361)(See 12.1)    
        [order of evaluation](#Bookmark32_idd1e5412)(See 12.1)  [2nd](#Bookmark32_idd1e5526)(See 12.1)  [3rd](#Bookmark32_idd1e5646)(See 12.1)    
        [positioning](#Bookmark28_idd1e3865)(See 11.1)    
        [SOUNDEX function](#Bookmark47_idd1e10129)(See 15.2)    
client-based results fomatting  
    [compared to server-based](#Bookmark41_idd1e7965)(See 14.1)    
CLOSE statements  
    [closing cursors](#Bookmark111_idd1e24921)(See 28.2)    
cloumns  
    [insert STATEMENT AND](#Bookmark81_idd1e18513)(See 22.1)    
code  
    commenting  
        [stored procedures](#Bookmark103_idd1e23282)(See 26.4)    
code (programming)  
    [commenting](#Bookmark46_idd1e9543)(See 15.1)    
    [portability](#Bookmark46_idd1e9506)(See 15.1)    
ColdFusion (Macromedia)  
    [running](#Bookmark125_idd1e27991)(See 31.3)  [2nd](#Bookmark125_idd1e28065)(See 31.3)    
column aliases  
    [alternative uses](#Bookmark42_idd1e8879)(See 14.2)    
    [concatening fields](#Bookmark42_idd1e8710)(See 14.2)  [2nd](#Bookmark42_idd1e8855)(See 14.2)    
columns  
    aliases  
        [creating](#Bookmark71_idd1e15660)(See 20.1)    
        [names](#Bookmark42_idd1e8915)(See 14.2)    
    AVG() function  
        [individual columns](#Bookmark50_idd1e11099)(See 16.1)    
    [breaking data correctly](#Bookmark11_idd1e1531)(See 8.1)    
    [concepts](#Bookmark11_idd1e1485)(See 8.1)  [2nd](#Bookmark11_idd1e1539)(See 8.1)    
    [Customers example table](#Bookmark120_idd1e27019)(See 30.1)    
    [derived](#Bookmark42_idd1e8944)(See 14.2)    
    [fully qualified names](#Bookmark68_idd1e14950)(See 19.2)    
    [GROUP BY clause](#Bookmark56_idd1e12591)(See 17.2)    
    grouping data  
        [specifying by relative position](#Bookmark56_idd1e12751)(See 17.2)    
    [Identity fields](#Bookmark103_idd1e23345)(See 26.4)    
    [INSERT SELECT statements](#Bookmark81_idd1e18981)(See 22.1)    
    INSERT statement  
        [omitting columns](#Bookmark81_idd1e18748)(See 22.1)    
    multiple  
        [sorting query results by](#Bookmark23_idd1e2978)(See 10.2)  [2nd](#Bookmark23_idd1e3041)(See 10.2)    
    nonselected  
        [sorting query results by](#Bookmark24_idd1e3230)(See 10.3)    
    NULL value  
        [checking for](#Bookmark29_idd1e4685)(See 11.2)    
    [NULL value columns](#Bookmark90_idd1e20656)(See 24.1)  [2nd](#Bookmark90_idd1e20709)(See 24.1)  [3rd](#Bookmark90_idd1e20769)(See 24.1)    
    [OrderItems example table](#Bookmark120_idd1e27344)(See 30.1)    
    [Orders example table](#Bookmark120_idd1e27202)(See 30.1)    
    padded spaces  
        [RTRIM() funuction](#Bookmark42_idd1e8469)(See 14.2)  [2nd](#Bookmark42_idd1e8552)(See 14.2)    
    position  
        [sorting query results by](#Bookmark24_idd1e3077)(See 10.3)  [2nd](#Bookmark24_idd1e3149)(See 10.3)  [3rd](#Bookmark24_idd1e3187)(See 10.3)    
    [primary keys](#Bookmark11_idd1e1686)(See 8.1)  [2nd](#Bookmark11_idd1e1740)(See 8.1)    
    [Products example table](#Bookmark120_idd1e26867)(See 30.1)    
    retrieving  
        [all](#Bookmark19_idd1e2572)(See 9.4)  [2nd](#Bookmark19_idd1e2629)(See 9.4)    
        [individual](#Bookmark17_idd1e2162)(See 9.2)  [2nd](#Bookmark17_idd1e2260)(See 9.2)    
        [multiple](#Bookmark18_idd1e2422)(See 9.3)  [2nd](#Bookmark18_idd1e2502)(See 9.3)    
        [unknown](#Bookmark19_idd1e2696)(See 9.4)    
    [separating names in queries](#Bookmark18_idd1e2443)(See 9.3)    
    sorting data  
        [descending on multiple columns](#Bookmark25_idd1e3448)(See 10.4)    
    [subquery result restrictions](#Bookmark63_idd1e14181)(See 18.2)    
    [updating multiple](#Bookmark85_idd1e19569)(See 23.1)    
    values  
        [deleting](#Bookmark85_idd1e19709)(See 23.1)    
    [Vendors example table](#Bookmark120_idd1e26709)(See 30.1)    
[columns.](#Bookmark41_idd1e7894)(See 14.1)  [See also [fields](#Bookmark41_idd1e7804)(See 14.1)]  
combined queries  
    [creating](#Bookmark78_idd1e17187)(See 21.2)  [2nd](#Bookmark78_idd1e17241)(See 21.2)  [3rd](#Bookmark78_idd1e17321)(See 21.2)  [4th](#Bookmark78_idd1e17383)(See 21.2)  [5th](#Bookmark78_idd1e17459)(See 21.2)  [6th](#Bookmark78_idd1e17530)(See 21.2)    
    [duplicate rows and](#Bookmark78_idd1e17754)(See 21.2)  [2nd](#Bookmark78_idd1e17834)(See 21.2)  [3rd](#Bookmark78_idd1e17892)(See 21.2)    
    [overview](#Bookmark77_idd1e17078)(See 21.1)    
    [performance](#Bookmark78_idd1e17627)(See 21.2)    
    [rules](#Bookmark78_idd1e17648)(See 21.2)    
    [sorting results](#Bookmark78_idd1e18005)(See 21.2)  [2nd](#Bookmark78_idd1e18097)(See 21.2)    
Command Center utility  
    [running](#Bookmark124_idd1e27907)(See 31.2)  [2nd](#Bookmark124_idd1e27964)(See 31.2)    
commas (,)  
    [multiple column separation](#Bookmark18_idd1e2453)(See 9.3)    
commenting  
    programming code  
        [importance of](#Bookmark46_idd1e9548)(See 15.1)    
    [stored procedure code](#Bookmark103_idd1e23277)(See 26.4)    
COMMIT statement  
    [syntax](#Bookmark140_idd1e29392)(See 32.2)    
[COMMIT statement (transaction processing)](#Bookmark107_idd1e23987)(See 27.2)  [2nd](#Bookmark107_idd1e24064)(See 27.2)    
commits (transaction processing)  
    [defined](#Bookmark106_idd1e23671)(See 27.1)    
compatibility  
    [datatype](#Bookmark11_idd1e1591)(See 8.1)    
    functions  
        [DBMS support considerations](#Bookmark46_idd1e9339)(See 15.1)  [2nd](#Bookmark46_idd1e9470)(See 15.1)    
    [WHERE clause operators](#Bookmark29_idd1e4174)(See 11.2)    
compatibility (SQL code)  
    applications  
        [selection criteria](#Bookmark122_idd1e27742)(See 31.)    
concatenating  
    [fields](#Bookmark42_idd1e8008)(See 14.2)  [2nd](#Bookmark42_idd1e8100)(See 14.2)  [3rd](#Bookmark42_idd1e8234)(See 14.2)  [4th](#Bookmark42_idd1e8318)(See 14.2)  [5th](#Bookmark42_idd1e8464)(See 14.2)  [6th](#Bookmark42_idd1e8603)(See 14.2)    
        [cloumn aliases](#Bookmark42_idd1e8698)(See 14.2)  [2nd](#Bookmark42_idd1e8843)(See 14.2)    
        [mathematical calcualtions](#Bookmark43_idd1e8994)(See 14.3)  [2nd](#Bookmark43_idd1e9052)(See 14.3)  [3rd](#Bookmark43_idd1e9116)(See 14.3)  [4th](#Bookmark44_idd1e9252)(See 14.4)    
        [MySQL](#Bookmark42_idd1e8396)(See 14.2)    
[concatenation operators](#Bookmark42_idd1e8137)(See 14.2)  [2nd](#Bookmark42_idd1e8259)(See 14.2)    
configuring  
    [ODBC](#Bookmark137_idd1e29145)(See 31.15)  [2nd](#Bookmark137_idd1e29197)(See 31.15)  [3rd](#Bookmark137_idd1e29239)(See 31.15)    
CONSTRAINT syntax  
    [ALTER TABLE statements](#Bookmark114_idd1e25468)(See 29.1)    
constraints  
    [speed](#Bookmark116_idd1e26465)(See 29.3)    
constraints (referential integrity)  
    [check constraints](#Bookmark114_idd1e25644)(See 29.1)  [2nd](#Bookmark114_idd1e25741)(See 29.1)  [3rd](#Bookmark114_idd1e25778)(See 29.1)    
    [foreign keys keys](#Bookmark114_idd1e25308)(See 29.1)  [2nd](#Bookmark114_idd1e25375)(See 29.1)  [3rd](#Bookmark114_idd1e25441)(See 29.1)    
    [overview](#Bookmark114_idd1e24972)(See 29.1)  [2nd](#Bookmark114_idd1e25052)(See 29.1)  [3rd](#Bookmark114_idd1e25119)(See 29.1)    
    [primary keys](#Bookmark114_idd1e25163)(See 29.1)  [2nd](#Bookmark114_idd1e25233)(See 29.1)  [3rd](#Bookmark114_idd1e25279)(See 29.1)    
    [unique constraints](#Bookmark114_idd1e25536)(See 29.1)  [2nd](#Bookmark114_idd1e25615)(See 29.1)    
copying  
    [tables](#Bookmark82_idd1e19263)(See 22.2)    
[COS() function](#Bookmark47_idd1e10545)(See 15.2)    
[COUNT() function](#Bookmark50_idd1e10836)(See 16.1)  [2nd](#Bookmark50_idd1e11166)(See 16.1)  [3rd](#Bookmark50_idd1e11247)(See 16.1)  [4th](#Bookmark50_idd1e11319)(See 16.1)    
    [DISTINCT argument](#Bookmark51_idd1e12082)(See 16.2)    
    [joins and](#Bookmark73_idd1e16861)(See 20.3)    
    [NULL values](#Bookmark50_idd1e11348)(See 16.1)    
[COUNT\* subquery](#Bookmark64_idd1e14302)(See 18.3)    
CREATE INDEX statement  
    [syntax](#Bookmark141_idd1e29444)(See 32.3)  [2nd](#Bookmark142_idd1e29506)(See 32.4)    
[CREATE INDEX statements](#Bookmark115_idd1e26051)(See 29.2)    
[CREATE TABLE statement](#Bookmark90_idd1e20342)(See 24.1)  [2nd](#Bookmark90_idd1e20437)(See 24.1)  [3rd](#Bookmark90_idd1e20508)(See 24.1)  [4th](#Bookmark90_idd1e20547)(See 24.1)    
    [DEFAULT keyword](#Bookmark90_idd1e20930)(See 24.1)  [2nd](#Bookmark90_idd1e20988)(See 24.1)  [3rd](#Bookmark90_idd1e21032)(See 24.1)    
    [syntax](#Bookmark143_idd1e29566)(See 32.5)    
[CREATE VIEW statement](#Bookmark97_idd1e21971)(See 25.2)    
    [syntax](#Bookmark144_idd1e29632)(See 32.6)    
creating  
    [indexes](#Bookmark115_idd1e26117)(See 29.2)  [2nd](#Bookmark141_idd1e29434)(See 32.3)    
    [stored procedures](#Bookmark142_idd1e29491)(See 32.4)    
    [tables](#Bookmark143_idd1e29556)(See 32.5)    
    [triggers](#Bookmark116_idd1e26427)(See 29.3)    
    views  
        [rules and restrictions](#Bookmark96_idd1e21849)(See 25.1)    
[cross joins](#Bookmark68_idd1e15267)(See 19.2)    
[currency datatypes](#Bookmark154_idd1e30528)(See 33.2)    
cursors  
    [accessing](#Bookmark111_idd1e24719)(See 28.2)  [2nd](#Bookmark111_idd1e24760)(See 28.2)  [3rd](#Bookmark111_idd1e24809)(See 28.2)  [4th](#Bookmark111_idd1e24846)(See 28.2)    
    [closing](#Bookmark111_idd1e24866)(See 28.2)  [2nd](#Bookmark111_idd1e24931)(See 28.2)    
    [creating](#Bookmark111_idd1e24590)(See 28.2)  [2nd](#Bookmark111_idd1e24657)(See 28.2)    
    [implementing](#Bookmark111_idd1e24533)(See 28.2)    
    [limitations](#Bookmark110_idd1e24521)(See 28.1)    
    [opening](#Bookmark111_idd1e24687)(See 28.2)    
    options  
        [support for](#Bookmark110_idd1e24430)(See 28.1)    
    [overview](#Bookmark110_idd1e24359)(See 28.1)    
    [Web-based applications](#Bookmark110_idd1e24511)(See 28.1)    
[Customers table](#Bookmark120_idd1e27016)(See 30.1)

## 35.5 index\_D

data  
    [breaking correctly (columns)](#Bookmark11_idd1e1526)(See 8.1)    
    deleting  
        [guidelines](#Bookmark87_idd1e20126)(See 23.3)    
        [TRUNCATE TABLE statement](#Bookmark86_idd1e20056)(See 23.2)    
    filtering  
        [indexes](#Bookmark115_idd1e25987)(See 29.2)    
    manipulation functions  
        [date and time](#Bookmark47_idd1e10412)(See 15.2)    
    [security](#Bookmark117_idd1e26492)(See 29.4)    
    updating  
        [guidelines](#Bookmark87_idd1e20112)(See 23.3)    
[data and time datatypes](#Bookmark155_idd1e30552)(See 33.3)    
[Database Management System.](#Bookmark11_idd1e1374)(See 8.1)  [See [DBMS](#Bookmark163_idd1e1369)(See 35.5)]  
[databases](#Bookmark11_idd1e1411)(See 8.1)  [See also [tables](#Bookmark11_idd1e1386)(See 8.1)]  
    [concepts](#Bookmark11_idd1e1284)(See 8.1)  [2nd](#Bookmark11_idd1e1316)(See 8.1)    
    [defined](#Bookmark11_idd1e1364)(See 8.1)    
    [droppig objects](#Bookmark146_idd1e29734)(See 32.8)    
    indexes  
        [cautions](#Bookmark115_idd1e26010)(See 29.2)    
        [creating](#Bookmark115_idd1e26122)(See 29.2)    
    [scalability](#Bookmark67_idd1e14713)(See 19.1)    
    [schemas](#Bookmark11_idd1e1465)(See 8.1)    
    [security](#Bookmark117_idd1e26497)(See 29.4)    
    tables  
        [creating](#Bookmark143_idd1e29549)(See 32.5)    
        [triggers](#Bookmark116_idd1e26262)(See 29.3)    
[DATALENGTH() function](#Bookmark47_idd1e9817)(See 15.2)    
[datatypes](#Bookmark11_idd1e1563)(See 8.1)    
    [binary](#Bookmark156_idd1e30715)(See 33.4)    
    [compatibility](#Bookmark11_idd1e1596)(See 8.1)    
    [currency](#Bookmark154_idd1e30531)(See 33.2)    
    [data and time](#Bookmark155_idd1e30555)(See 33.3)    
    [defining](#Bookmark114_idd1e25853)(See 29.1)    
    [numeric](#Bookmark154_idd1e30359)(See 33.2)    
    [string](#Bookmark153_idd1e30167)(See 33.1)    
    [usefulness of](#Bookmark152_idd1e30084)(See 33.)    
date (system)  
    [default value syntax](#Bookmark90_idd1e21042)(See 24.1)    
[date and time functions](#Bookmark47_idd1e9605)(See 15.2)  [2nd](#Bookmark47_idd1e10146)(See 15.2)  [3rd](#Bookmark47_idd1e10194)(See 15.2)  [4th](#Bookmark47_idd1e10296)(See 15.2)  [5th](#Bookmark47_idd1e10404)(See 15.2)  [6th](#Bookmark47_idd1e10456)(See 15.2)    
[DATE dataype](#Bookmark155_idd1e30596)(See 33.3)  [2nd](#Bookmark155_idd1e30635)(See 33.3)    
[DATEPART() function](#Bookmark47_idd1e10241)(See 15.2)    
[DATETIME datatype](#Bookmark155_idd1e30609)(See 33.3)    
DB2 (IBM)  
    [running](#Bookmark124_idd1e27897)(See 31.2)  [2nd](#Bookmark124_idd1e27954)(See 31.2)    
DBMS  
    [(Database Management System)](#Bookmark11_idd1e1369)(See 8.1)    
    [accidental table deletion](#Bookmark92_idd1e21489)(See 24.3)    
    [datatype differences](#Bookmark152_idd1e30143)(See 33.)    
    functions  
        [support considerations](#Bookmark46_idd1e9327)(See 15.1)  [2nd](#Bookmark46_idd1e9458)(See 15.1)    
    [indexes](#Bookmark115_idd1e26059)(See 29.2)    
    [interactive tools](#Bookmark67_idd1e14766)(See 19.1)    
    [ISAM databases](#Bookmark110_idd1e24484)(See 28.1)    
    LIKE operator  
        [search patterns and](#Bookmark37_idd1e6466)(See 13.1)    
    [NULL value differences](#Bookmark90_idd1e20804)(See 24.1)    
    [query sort order](#Bookmark22_idd1e2777)(See 10.1)    
    [security mechanisms](#Bookmark117_idd1e26507)(See 29.4)    
    [SQL extensions](#Bookmark12_idd1e1898)(See 8.2)    
    transaction processing  
        [implementation differences](#Bookmark107_idd1e23805)(See 27.2)    
    [triggers](#Bookmark116_idd1e26357)(See 29.3)    
    [TRIM functions](#Bookmark42_idd1e8636)(See 14.2)    
    [UNION statements](#Bookmark78_idd1e18174)(See 21.2)    
    [user-defined datatypes](#Bookmark114_idd1e25843)(See 29.1)    
    [view creation](#Bookmark96_idd1e21716)(See 25.1)    
    views  
        [rules and restrictions](#Bookmark96_idd1e21878)(See 25.1)    
    WHERE claue  
        [allowed operators](#Bookmark29_idd1e4842)(See 11.2)    
[DECIMAL datatype](#Bookmark154_idd1e30413)(See 33.2)    
DECLARE statements  
    cursors  
        [creating](#Bookmark111_idd1e24595)(See 28.2)  [2nd](#Bookmark111_idd1e24662)(See 28.2)    
    [stored procedures](#Bookmark103_idd1e23167)(See 26.4)    
default values  
    [tables](#Bookmark90_idd1e20918)(See 24.1)  [2nd](#Bookmark90_idd1e20976)(See 24.1)  [3rd](#Bookmark90_idd1e21020)(See 24.1)    
defining  
    [datatypes](#Bookmark114_idd1e25848)(See 29.1)    
[DELETE FROM statements](#Bookmark86_idd1e19917)(See 23.2)    
[DELETE statement](#Bookmark86_idd1e19771)(See 23.2)  [2nd](#Bookmark86_idd1e19885)(See 23.2)  [3rd](#Bookmark86_idd1e19993)(See 23.2)    
    [FROM keyword](#Bookmark86_idd1e19951)(See 23.2)    
    [guidelines](#Bookmark87_idd1e20164)(See 23.3)    
    [security privileges](#Bookmark86_idd1e19854)(See 23.2)    
    [syntax](#Bookmark145_idd1e29691)(See 32.7)    
    [transaction processing](#Bookmark106_idd1e23734)(See 27.1)    
    [TRUNCATE TABLE statement](#Bookmark86_idd1e20063)(See 23.2)    
DELETE statements  
    [rollbacks](#Bookmark107_idd1e23949)(See 27.2)    
    [triggers](#Bookmark116_idd1e26191)(See 29.3)    
    [WHERE clause](#Bookmark86_idd1e19822)(See 23.2)    
deleting  
    [column values](#Bookmark85_idd1e19716)(See 23.1)    
    data  
        [guidelines](#Bookmark87_idd1e20119)(See 23.3)    
        [TRUNCATE TABLE statement](#Bookmark86_idd1e20049)(See 23.2)    
    [rows](#Bookmark145_idd1e29679)(See 32.7)    
    [tables](#Bookmark92_idd1e21424)(See 24.3)  [2nd](#Bookmark92_idd1e21464)(See 24.3)    
        [preventing accidental deletion](#Bookmark92_idd1e21499)(See 24.3)    
deleting rows  
    [preventing accidential](#Bookmark114_idd1e25499)(See 29.1)    
[derived columns.](#Bookmark42_idd1e8939)(See 14.2)  [See [aliases](#Bookmark160_idd1e8705)(See 35.2)]  
DESC keyword  
    [query results sort order](#Bookmark25_idd1e3289)(See 10.4)  [2nd](#Bookmark25_idd1e3345)(See 10.4)  [3rd](#Bookmark25_idd1e3419)(See 10.4)    
[dictionary sort order (query results)](#Bookmark25_idd1e3576)(See 10.4)    
DISTINCT argument  
    [AVG() function](#Bookmark51_idd1e12035)(See 16.2)    
    [COUNT() function](#Bookmark51_idd1e12087)(See 16.2)    
double pipes (||)  
    [contenation operator](#Bookmark42_idd1e8132)(See 14.2)  [2nd](#Bookmark42_idd1e8254)(See 14.2)    
downloading  
    [example tables](#Bookmark121_idd1e27510)(See 30.2)    
        [Microsoft Access MDB file](#Bookmark121_idd1e27537)(See 30.2)    
        [SQL scripts](#Bookmark121_idd1e27591)(See 30.2)    
DROP statement  
    [syntax](#Bookmark146_idd1e29744)(See 32.8)    
[DROP TABLE statement](#Bookmark92_idd1e21411)(See 24.3)  [2nd](#Bookmark92_idd1e21451)(See 24.3)    
dropping  
    [database objects](#Bookmark146_idd1e29739)(See 32.8)

## 35.6 index\_E

empty strings  
    [compared to NULL values](#Bookmark90_idd1e20893)(See 24.1)    
[equality (\*=) operator](#Bookmark72_idd1e16603)(See 20.2)    
[equality operator (WHERE clause)](#Bookmark29_idd1e3967)(See 11.2)    
establishing  
    [primary keys](#Bookmark11_idd1e1752)(See 8.1)    
example tables  
    [Customers table](#Bookmark120_idd1e27011)(See 30.1)    
    [downloading](#Bookmark121_idd1e27505)(See 30.2)    
    [functions of](#Bookmark120_idd1e26631)(See 30.1)    
    [Microsoft Access MDB file](#Bookmark121_idd1e27532)(See 30.2)    
    [OrderItems table](#Bookmark120_idd1e27336)(See 30.1)    
    [Orders table](#Bookmark120_idd1e27194)(See 30.1)    
    [Products table](#Bookmark120_idd1e26859)(See 30.1)    
    [SQL scripts](#Bookmark121_idd1e27586)(See 30.2)    
    [Vendors table](#Bookmark120_idd1e26701)(See 30.1)    
[EXCEPT statements](#Bookmark78_idd1e18179)(See 21.2)    
EXECUTE statement  
    [stored procedures](#Bookmark102_idd1e22889)(See 26.3)  [2nd](#Bookmark102_idd1e22945)(See 26.3)  [3rd](#Bookmark102_idd1e23013)(See 26.3)  [4th](#Bookmark103_idd1e23037)(See 26.4)  [5th](#Bookmark103_idd1e23109)(See 26.4)  [6th](#Bookmark103_idd1e23208)(See 26.4)  [7th](#Bookmark103_idd1e23258)(See 26.4)  [8th](#Bookmark103_idd1e23389)(See 26.4)    
[EXP() function](#Bookmark47_idd1e10564)(See 15.2)    
[explicit commits](#Bookmark107_idd1e24020)(See 27.2)    
[extensions](#Bookmark12_idd1e1908)(See 8.2)

## 35.7 index\_F

FETCH statement  
    [accessing cursors](#Bookmark111_idd1e24724)(See 28.2)  [2nd](#Bookmark111_idd1e24765)(See 28.2)  [3rd](#Bookmark111_idd1e24814)(See 28.2)  [4th](#Bookmark111_idd1e24851)(See 28.2)    
[fields](#Bookmark41_idd1e7906)(See 14.1)  [See also [calculated fields](#Bookmark41_idd1e7785)(See 14.1)]  
    [.](#Bookmark41_idd1e7899)(See 14.1)  [See also [columns](#Bookmark41)(See 14.1)]  
    aliases  
        [names](#Bookmark42_idd1e8908)(See 14.2)    
    calculated  
        [concatenating fields](#Bookmark42_idd1e8001)(See 14.2)  [2nd](#Bookmark42_idd1e8093)(See 14.2)  [3rd](#Bookmark42_idd1e8227)(See 14.2)  [4th](#Bookmark42_idd1e8311)(See 14.2)  [5th](#Bookmark42_idd1e8457)(See 14.2)  [6th](#Bookmark42_idd1e8596)(See 14.2)  [7th](#Bookmark42_idd1e8691)(See 14.2)  [8th](#Bookmark42_idd1e8836)(See 14.2)    
        [mathematical calculations](#Bookmark43_idd1e8987)(See 14.3)  [2nd](#Bookmark43_idd1e9045)(See 14.3)  [3rd](#Bookmark43_idd1e9109)(See 14.3)  [4th](#Bookmark44_idd1e9245)(See 14.4)    
        [overview](#Bookmark41_idd1e7804)(See 14.1)  [2nd](#Bookmark41_idd1e7864)(See 14.1)  [3rd](#Bookmark41_idd1e7936)(See 14.1)    
        [subqueries](#Bookmark64_idd1e14246)(See 18.3)  [2nd](#Bookmark64_idd1e14327)(See 18.3)  [3rd](#Bookmark64_idd1e14391)(See 18.3)  [4th](#Bookmark64_idd1e14495)(See 18.3)    
        [views](#Bookmark97_idd1e22487)(See 25.2)  [2nd](#Bookmark97_idd1e22538)(See 25.2)  [3rd](#Bookmark97_idd1e22574)(See 25.2)    
filtering  
    [by subqueries](#Bookmark63_idd1e13779)(See 18.2)  [2nd](#Bookmark63_idd1e13849)(See 18.2)  [3rd](#Bookmark63_idd1e13925)(See 18.2)  [4th](#Bookmark63_idd1e14086)(See 18.2)  [5th](#Bookmark63_idd1e14159)(See 18.2)    
    data  
        [indexes](#Bookmark115_idd1e25980)(See 29.2)    
    [data groups](#Bookmark57_idd1e12783)(See 17.3)  [2nd](#Bookmark57_idd1e12940)(See 17.3)  [3rd](#Bookmark57_idd1e13013)(See 17.3)  [4th](#Bookmark57_idd1e13075)(See 17.3)    
    [query results](#Bookmark28_idd1e3649)(See 11.1)  [2nd](#Bookmark28_idd1e3711)(See 11.1)  [3rd](#Bookmark28_idd1e3749)(See 11.1)    
        [application level](#Bookmark28_idd1e3818)(See 11.1)    
        [WHERE clause operators](#Bookmark29_idd1e3921)(See 11.2)  [2nd](#Bookmark29_idd1e4134)(See 11.2)  [3rd](#Bookmark29_idd1e4221)(See 11.2)  [4th](#Bookmark29_idd1e4278)(See 11.2)  [5th](#Bookmark29_idd1e4332)(See 11.2)  [6th](#Bookmark29_idd1e4432)(See 11.2)  [7th](#Bookmark29_idd1e4538)(See 11.2)  [8th](#Bookmark29_idd1e4626)(See 11.2)  [9th](#Bookmark29_idd1e4671)(See 11.2)  [10th](#Bookmark29_idd1e4802)(See 11.2)    
    query reults  
        [AND operator](#Bookmark32_idd1e4992)(See 12.1)  [2nd](#Bookmark32_idd1e5074)(See 12.1)  [3rd](#Bookmark32_idd1e5142)(See 12.1)    
        [IN operator](#Bookmark33_idd1e5707)(See 12.2)  [2nd](#Bookmark33_idd1e5777)(See 12.2)  [3rd](#Bookmark33_idd1e5847)(See 12.2)  [4th](#Bookmark33_idd1e5956)(See 12.2)    
        [multiple criteria](#Bookmark32_idd1e4920)(See 12.1)    
        [NOT operator](#Bookmark34_idd1e6017)(See 12.3)  [2nd](#Bookmark34_idd1e6137)(See 12.3)  [3rd](#Bookmark34_idd1e6219)(See 12.3)    
        [OR operator](#Bookmark32_idd1e5200)(See 12.1)  [2nd](#Bookmark32_idd1e5272)(See 12.1)  [3rd](#Bookmark32_idd1e5340)(See 12.1)    
        [order of evaluation](#Bookmark32_idd1e5391)(See 12.1)  [2nd](#Bookmark32_idd1e5505)(See 12.1)  [3rd](#Bookmark32_idd1e5625)(See 12.1)    
    [with views](#Bookmark97_idd1e22378)(See 25.2)  [2nd](#Bookmark97_idd1e22418)(See 25.2)    
filters  
    [LIKE operator](#Bookmark37_idd1e6361)(See 13.1)  [2nd](#Bookmark37_idd1e6439)(See 13.1)  [3rd](#Bookmark37_idd1e6525)(See 13.1)    
        [% (percent sign) wildcard](#Bookmark37_idd1e6567)(See 13.1)  [2nd](#Bookmark37_idd1e6655)(See 13.1)  [3rd](#Bookmark37_idd1e6754)(See 13.1)  [4th](#Bookmark37_idd1e6852)(See 13.1)  [5th](#Bookmark37_idd1e6923)(See 13.1)    
        [[] (square brackets) wildcard](#Bookmark37_idd1e7331)(See 13.1)  [2nd](#Bookmark37_idd1e7453)(See 13.1)  [3rd](#Bookmark37_idd1e7533)(See 13.1)  [4th](#Bookmark37_idd1e7638)(See 13.1)    
        [\_ (underscore) wildcard](#Bookmark37_idd1e7062)(See 13.1)  [2nd](#Bookmark37_idd1e7154)(See 13.1)  [3rd](#Bookmark37_idd1e7265)(See 13.1)    
[fixed length strings](#Bookmark153_idd1e30178)(See 33.1)    
[FLOAT datatype](#Bookmark154_idd1e30426)(See 33.2)    
[foreign keys](#Bookmark114_idd1e25327)(See 29.1)  [2nd](#Bookmark114_idd1e25394)(See 29.1)  [3rd](#Bookmark114_idd1e25460)(See 29.1)    
formatting  
    [query data](#Bookmark18_idd1e2540)(See 9.3)    
    [retrieved data with views](#Bookmark97_idd1e22181)(See 25.2)  [2nd](#Bookmark97_idd1e22222)(See 25.2)  [3rd](#Bookmark97_idd1e22271)(See 25.2)  [4th](#Bookmark97_idd1e22304)(See 25.2)    
    [server-based compared to client-based](#Bookmark41_idd1e7960)(See 14.1)    
    [statements](#Bookmark90_idd1e20596)(See 24.1)    
    [subqueries](#Bookmark63_idd1e14033)(See 18.2)    
FROM clause  
    [creating joins](#Bookmark68_idd1e14903)(See 19.2)    
[FROM keyword](#Bookmark17_idd1e2199)(See 9.2)    
    [DELETE statement](#Bookmark86_idd1e19956)(See 23.2)    
    [UPDATE statement](#Bookmark85_idd1e19678)(See 23.1)    
[full outer joins](#Bookmark72_idd1e16756)(See 20.2)    
[fully qualified column names](#Bookmark68_idd1e14962)(See 19.2)    
functions  
    [ABS()](#Bookmark47_idd1e10529)(See 15.2)    
    [advisability of using](#Bookmark46_idd1e9555)(See 15.1)    
    aggregate  
        [ALL argument](#Bookmark51_idd1e11923)(See 16.2)    
        [AVG()](#Bookmark50_idd1e10924)(See 16.1)  [2nd](#Bookmark50_idd1e11010)(See 16.1)  [3rd](#Bookmark50_idd1e11070)(See 16.1)    
        [combining](#Bookmark52_idd1e12211)(See 16.3)  [2nd](#Bookmark52_idd1e12265)(See 16.3)    
        [COUNT()](#Bookmark50_idd1e11159)(See 16.1)  [2nd](#Bookmark50_idd1e11240)(See 16.1)  [3rd](#Bookmark50_idd1e11312)(See 16.1)    
        [defined](#Bookmark50_idd1e10773)(See 16.1)    
        [DISTINCT argument](#Bookmark51_idd1e11954)(See 16.2)  [2nd](#Bookmark51_idd1e12179)(See 16.2)    
        [joins and](#Bookmark73_idd1e16848)(See 20.3)  [2nd](#Bookmark73_idd1e16919)(See 20.3)  [3rd](#Bookmark73_idd1e16991)(See 20.3)    
        [MAX()](#Bookmark50_idd1e11380)(See 16.1)  [2nd](#Bookmark50_idd1e11428)(See 16.1)    
        [MIN()](#Bookmark50_idd1e11538)(See 16.1)  [2nd](#Bookmark50_idd1e11586)(See 16.1)    
        [naming aliases](#Bookmark52_idd1e12308)(See 16.3)    
        [overview](#Bookmark50_idd1e10705)(See 16.1)  [2nd](#Bookmark50_idd1e10747)(See 16.1)    
        [SUM()](#Bookmark50_idd1e11687)(See 16.1)  [2nd](#Bookmark50_idd1e11770)(See 16.1)  [3rd](#Bookmark50_idd1e11820)(See 16.1)    
    [AVG()](#Bookmark50_idd1e10820)(See 16.1)  [2nd](#Bookmark50_idd1e10934)(See 16.1)  [3rd](#Bookmark50_idd1e11020)(See 16.1)  [4th](#Bookmark50_idd1e11080)(See 16.1)    
        [DISTINCT argument](#Bookmark51_idd1e12028)(See 16.2)    
        [NULL values](#Bookmark50_idd1e11132)(See 16.1)    
    [COS()](#Bookmark47_idd1e10548)(See 15.2)    
    [COUNT()](#Bookmark50_idd1e10839)(See 16.1)  [2nd](#Bookmark50_idd1e11169)(See 16.1)  [3rd](#Bookmark50_idd1e11250)(See 16.1)  [4th](#Bookmark50_idd1e11322)(See 16.1)    
        [DISTINCT argument](#Bookmark51_idd1e12092)(See 16.2)    
        [NULL values](#Bookmark50_idd1e11353)(See 16.1)    
    [DATALENGTH()](#Bookmark47_idd1e9820)(See 15.2)    
    [date and time](#Bookmark47_idd1e9608)(See 15.2)  [2nd](#Bookmark47_idd1e10149)(See 15.2)  [3rd](#Bookmark47_idd1e10197)(See 15.2)  [4th](#Bookmark47_idd1e10299)(See 15.2)  [5th](#Bookmark47_idd1e10407)(See 15.2)  [6th](#Bookmark47_idd1e10459)(See 15.2)    
    [DATEPART()](#Bookmark47_idd1e10244)(See 15.2)    
    [defined](#Bookmark46_idd1e9287)(See 15.1)    
    [EXP()](#Bookmark47_idd1e10567)(See 15.2)    
    [LCASE()](#Bookmark47_idd1e9878)(See 15.2)    
    [LEFT()](#Bookmark47_idd1e9786)(See 15.2)    
    [LEN()](#Bookmark47_idd1e9812)(See 15.2)    
    [LENGTH()](#Bookmark47_idd1e9828)(See 15.2)    
    [LOWER()](#Bookmark47_idd1e9847)(See 15.2)    
    [LTRIM()](#Bookmark47_idd1e9870)(See 15.2)    
    [MAX()](#Bookmark50_idd1e10858)(See 16.1)  [2nd](#Bookmark50_idd1e11390)(See 16.1)  [3rd](#Bookmark50_idd1e11438)(See 16.1)    
        [DISTINCT argument](#Bookmark51_idd1e12139)(See 16.2)    
        [non-numeric data](#Bookmark50_idd1e11467)(See 16.1)    
        [NULL values](#Bookmark50_idd1e11500)(See 16.1)    
    [MIN()](#Bookmark50_idd1e10877)(See 16.1)  [2nd](#Bookmark50_idd1e11548)(See 16.1)  [3rd](#Bookmark50_idd1e11596)(See 16.1)    
        [DISTINCT argument](#Bookmark51_idd1e12132)(See 16.2)    
        [non-numeric data](#Bookmark50_idd1e11625)(See 16.1)    
        [NULL values](#Bookmark50_idd1e11658)(See 16.1)    
    [numeric](#Bookmark47_idd1e9596)(See 15.2)  [2nd](#Bookmark47_idd1e10477)(See 15.2)  [3rd](#Bookmark47_idd1e10657)(See 15.2)    
    [PI()](#Bookmark47_idd1e10586)(See 15.2)    
    [RIGHT()](#Bookmark47_idd1e9898)(See 15.2)    
    [RTRIM()](#Bookmark42_idd1e8486)(See 14.2)  [2nd](#Bookmark42_idd1e8569)(See 14.2)  [3rd](#Bookmark47_idd1e9917)(See 15.2)    
    [SIN()](#Bookmark47_idd1e10605)(See 15.2)    
    [SOUNDEX()](#Bookmark47_idd1e9939)(See 15.2)  [2nd](#Bookmark47_idd1e10073)(See 15.2)    
        [support for](#Bookmark47_idd1e10020)(See 15.2)    
    [SQRT()](#Bookmark47_idd1e10624)(See 15.2)    
    [SUM()](#Bookmark50_idd1e10896)(See 16.1)  [2nd](#Bookmark50_idd1e11697)(See 16.1)  [3rd](#Bookmark50_idd1e11780)(See 16.1)  [4th](#Bookmark50_idd1e11830)(See 16.1)    
        [multiple columns and](#Bookmark50_idd1e11859)(See 16.1)    
        [NULL values](#Bookmark50_idd1e11887)(See 16.1)    
    [support considerations](#Bookmark46_idd1e9334)(See 15.1)  [2nd](#Bookmark46_idd1e9465)(See 15.1)    
    [system](#Bookmark47_idd1e9623)(See 15.2)    
    [TAN()](#Bookmark47_idd1e10643)(See 15.2)    
    [text](#Bookmark47_idd1e9584)(See 15.2)  [2nd](#Bookmark47_idd1e9662)(See 15.2)  [3rd](#Bookmark47_idd1e9709)(See 15.2)    
        [list of common](#Bookmark47_idd1e9733)(See 15.2)    
    [to\_char](#Bookmark47_idd1e10342)(See 15.2)    
    [to\_number](#Bookmark47_idd1e10347)(See 15.2)    
    [TRIM](#Bookmark42_idd1e8646)(See 14.2)    
    [types of](#Bookmark47_idd1e9570)(See 15.2)    
    [UCASE()](#Bookmark47_idd1e9970)(See 15.2)    
    [UPPER()](#Bookmark47_idd1e9670)(See 15.2)  [2nd](#Bookmark47_idd1e9717)(See 15.2)  [3rd](#Bookmark47_idd1e9962)(See 15.2)    
    [YEAR()](#Bookmark47_idd1e10276)(See 15.2)

## 35.8 index\_G

global variables  
    [@@IDENTITY](#Bookmark103_idd1e23366)(See 26.4)    
[GRANT statements](#Bookmark117_idd1e26568)(See 29.4)    
[greater than operator (WHERE clause)](#Bookmark29_idd1e4048)(See 11.2)    
[greater than or equal to operator (WHERE clause)](#Bookmark29_idd1e4062)(See 11.2)    
[GROUP BY clause](#Bookmark56_idd1e12425)(See 17.2)  [2nd](#Bookmark56_idd1e12517)(See 17.2)  [3rd](#Bookmark56_idd1e12647)(See 17.2)    
    [compared to ORDER BY clause](#Bookmark58_idd1e13154)(See 17.4)  [2nd](#Bookmark58_idd1e13300)(See 17.4)  [3rd](#Bookmark58_idd1e13342)(See 17.4)  [4th](#Bookmark58_idd1e13437)(See 17.4)    
grouping  
    [operators](#Bookmark32_idd1e5549)(See 12.1)    
[grouping data](#Bookmark55_idd1e12401)(See 17.1)    
    columns  
        [specifying by position](#Bookmark56_idd1e12758)(See 17.2)    
    [compared to sorting](#Bookmark58_idd1e13159)(See 17.4)  [2nd](#Bookmark58_idd1e13305)(See 17.4)  [3rd](#Bookmark58_idd1e13347)(See 17.4)  [4th](#Bookmark58_idd1e13442)(See 17.4)    
    [filtering groups](#Bookmark57_idd1e12778)(See 17.3)  [2nd](#Bookmark57_idd1e12935)(See 17.3)  [3rd](#Bookmark57_idd1e13008)(See 17.3)  [4th](#Bookmark57_idd1e13070)(See 17.3)    
    [GROUP BY clause](#Bookmark56_idd1e12420)(See 17.2)  [2nd](#Bookmark56_idd1e12512)(See 17.2)  [3rd](#Bookmark56_idd1e12642)(See 17.2)    
    [nested groups](#Bookmark56_idd1e12570)(See 17.2)

## 35.9 index\_H

|  |
| --- |
| HAVING clause     [grouping data](#Bookmark57_idd1e12844)(See 17.3) |

## 35.10 index\_I

IBM DB2  
    [running](#Bookmark124_idd1e27902)(See 31.2)  [2nd](#Bookmark124_idd1e27959)(See 31.2)    
[Identity fields](#Bookmark103_idd1e23350)(See 26.4)    
[IN operator](#Bookmark33_idd1e5735)(See 12.2)  [2nd](#Bookmark33_idd1e5805)(See 12.2)  [3rd](#Bookmark33_idd1e5875)(See 12.2)  [4th](#Bookmark33_idd1e5984)(See 12.2)    
indexes  
    [cautions](#Bookmark115_idd1e25998)(See 29.2)    
    [creating](#Bookmark115_idd1e26112)(See 29.2)  [2nd](#Bookmark141_idd1e29439)(See 32.3)    
    [overview](#Bookmark115_idd1e25865)(See 29.2)  [2nd](#Bookmark115_idd1e25916)(See 29.2)  [3rd](#Bookmark115_idd1e26020)(See 29.2)  [4th](#Bookmark115_idd1e26088)(See 29.2)    
    [revisiting](#Bookmark115_idd1e26155)(See 29.2)    
[inner joins](#Bookmark68_idd1e15287)(See 19.2)  [2nd](#Bookmark68_idd1e15344)(See 19.2)    
[INSERT SELECT statement](#Bookmark81_idd1e18801)(See 22.1)  [2nd](#Bookmark81_idd1e18945)(See 22.1)  [3rd](#Bookmark81_idd1e19022)(See 22.1)    
    [syntax](#Bookmark148_idd1e29856)(See 32.10)    
INSERT SELECT statements  
    [SELECT INTO statement comparison](#Bookmark82_idd1e19138)(See 22.2)    
INSERT statement  
    [completing rows](#Bookmark81_idd1e18331)(See 22.1)  [2nd](#Bookmark81_idd1e18383)(See 22.1)  [3rd](#Bookmark81_idd1e18491)(See 22.1)  [4th](#Bookmark81_idd1e18533)(See 22.1)    
    [INTO keyword](#Bookmark81_idd1e18444)(See 22.1)    
    [overview](#Bookmark81_idd1e18247)(See 22.1)    
    [partial rows](#Bookmark81_idd1e18641)(See 22.1)  [2nd](#Bookmark81_idd1e18695)(See 22.1)    
    [query data](#Bookmark81_idd1e18804)(See 22.1)  [2nd](#Bookmark81_idd1e18921)(See 22.1)  [3rd](#Bookmark81_idd1e18998)(See 22.1)    
    [security privileges](#Bookmark81_idd1e18309)(See 22.1)    
    [syntax](#Bookmark147_idd1e29813)(See 32.9)    
    [transaction processing](#Bookmark106_idd1e23724)(See 27.1)    
INSERT statements  
    [columns lists](#Bookmark81_idd1e18584)(See 22.1)    
    [omitting columns](#Bookmark81_idd1e18736)(See 22.1)    
    [rollbacks](#Bookmark107_idd1e24271)(See 27.2)    
    [triggers](#Bookmark116_idd1e26181)(See 29.3)    
    [VALUES](#Bookmark81_idd1e18619)(See 22.1)    
[INT datatype](#Bookmark154_idd1e30439)(See 33.2)    
[integrity.](#Bookmark114_idd1e24991)(See 29.1)  [See [referential integrity](#Bookmark177_idd1e15891)(See 35.19)]  
[interactive DBMS tools](#Bookmark67_idd1e14778)(See 19.1)    
[INTERSECT statements](#Bookmark78_idd1e18182)(See 21.2)    
[INTO keyword](#Bookmark81_idd1e18436)(See 22.1)    
[IS NULL clause](#Bookmark29_idd1e4736)(See 11.2)    
ISAM  
    [(Indexed Sequential Access Method) databases](#Bookmark110_idd1e24489)(See 28.1)    
ISTINCT argument  
    [aggregate functions](#Bookmark51_idd1e11961)(See 16.2)  [2nd](#Bookmark51_idd1e12186)(See 16.2)

## 35.11 index\_J

joins  
    [aggregate functions and](#Bookmark73_idd1e16843)(See 20.3)  [2nd](#Bookmark73_idd1e16914)(See 20.3)  [3rd](#Bookmark73_idd1e16986)(See 20.3)    
    [Cartesian Product](#Bookmark68_idd1e15040)(See 19.2)  [2nd](#Bookmark68_idd1e15104)(See 19.2)  [3rd](#Bookmark68_idd1e15147)(See 19.2)  [4th](#Bookmark68_idd1e15195)(See 19.2)    
    [creating](#Bookmark68_idd1e14813)(See 19.2)  [2nd](#Bookmark68_idd1e14859)(See 19.2)    
    [cross joins](#Bookmark68_idd1e15255)(See 19.2)    
    [inner joins](#Bookmark68_idd1e15290)(See 19.2)  [2nd](#Bookmark68_idd1e15347)(See 19.2)    
    [multiple tables](#Bookmark68_idd1e15397)(See 19.2)  [2nd](#Bookmark68_idd1e15455)(See 19.2)  [3rd](#Bookmark68_idd1e15552)(See 19.2)  [4th](#Bookmark68_idd1e15596)(See 19.2)    
    [natural joins](#Bookmark72_idd1e16193)(See 20.2)  [2nd](#Bookmark72_idd1e16259)(See 20.2)  [3rd](#Bookmark72_idd1e16290)(See 20.2)    
    outer  
        [left](#Bookmark72_idd1e16625)(See 20.2)    
        [right](#Bookmark72_idd1e16615)(See 20.2)    
        [sytax](#Bookmark72_idd1e16647)(See 20.2)    
    [outer joins](#Bookmark72_idd1e16320)(See 20.2)  [2nd](#Bookmark72_idd1e16399)(See 20.2)  [3rd](#Bookmark72_idd1e16495)(See 20.2)  [4th](#Bookmark72_idd1e16538)(See 20.2)  [5th](#Bookmark72_idd1e16692)(See 20.2)  [6th](#Bookmark72_idd1e16774)(See 20.2)    
        [full](#Bookmark72_idd1e16764)(See 20.2)    
        [types](#Bookmark72_idd1e16746)(See 20.2)    
    [overview](#Bookmark67_idd1e14566)(See 19.1)  [2nd](#Bookmark67_idd1e14581)(See 19.1)    
    [performance considerations](#Bookmark68_idd1e15481)(See 19.2)    
    [self joins](#Bookmark72_idd1e15886)(See 20.2)  [2nd](#Bookmark72_idd1e15965)(See 20.2)  [3rd](#Bookmark72_idd1e16062)(See 20.2)  [4th](#Bookmark72_idd1e16130)(See 20.2)    
    [usefulness of](#Bookmark67_idd1e14732)(See 19.1)    
    [views](#Bookmark97_idd1e22007)(See 25.2)  [2nd](#Bookmark97_idd1e22071)(See 25.2)  [3rd](#Bookmark97_idd1e22126)(See 25.2)    
    [WHERE clause](#Bookmark68_idd1e14997)(See 19.2)  [2nd](#Bookmark68_idd1e15074)(See 19.2)  [3rd](#Bookmark68_idd1e15117)(See 19.2)  [4th](#Bookmark68_idd1e15166)(See 19.2)    
    [WHERE clauses](#Bookmark68_idd1e15236)(See 19.2)

## 35.12 index\_K

keys  
    [primary](#Bookmark11_idd1e1681)(See 8.1)  [2nd](#Bookmark11_idd1e1713)(See 8.1)  [3rd](#Bookmark11_idd1e1787)(See 8.1)    
[keywords](#Bookmark16_idd1e2084)(See 9.1)    
    [AND](#Bookmark29_idd1e4593)(See 11.2)  [2nd](#Bookmark32_idd1e5137)(See 12.1)    
    [AS](#Bookmark42_idd1e8738)(See 14.2)  [2nd](#Bookmark42_idd1e8810)(See 14.2)    
        [Oracle support](#Bookmark71_idd1e15831)(See 20.1)    
    ASC  
        [query results sort order](#Bookmark25_idd1e3509)(See 10.4)    
    DEFAULT  
        [table values](#Bookmark90_idd1e20923)(See 24.1)  [2nd](#Bookmark90_idd1e20981)(See 24.1)  [3rd](#Bookmark90_idd1e21025)(See 24.1)    
    DESC  
        [query results sort order](#Bookmark25_idd1e3294)(See 10.4)  [2nd](#Bookmark25_idd1e3350)(See 10.4)  [3rd](#Bookmark25_idd1e3424)(See 10.4)    
    [FROM](#Bookmark17_idd1e2202)(See 9.2)  [2nd](#Bookmark85_idd1e19683)(See 23.1)    
    [IN](#Bookmark33_idd1e5951)(See 12.2)    
    [INTO](#Bookmark81_idd1e18439)(See 22.1)    
    [NOT](#Bookmark34_idd1e6083)(See 12.3)    
    [OR](#Bookmark32_idd1e5335)(See 12.1)    
    [REFERENCES](#Bookmark114_idd1e25427)(See 29.1)    
    [UNIQUE](#Bookmark114_idd1e25598)(See 29.1)

## 35.13 index\_L

languages  
    [SQL](#Bookmark12_idd1e1826)(See 8.2)    
[LCASE() function](#Bookmark47_idd1e9875)(See 15.2)    
[LEFT keyword (outer joins)](#Bookmark72_idd1e16518)(See 20.2)    
[left outer joins](#Bookmark72_idd1e16622)(See 20.2)    
[LEFT() function](#Bookmark47_idd1e9783)(See 15.2)    
[LEN() function](#Bookmark47_idd1e9809)(See 15.2)    
[LENGTH() function](#Bookmark47_idd1e9825)(See 15.2)    
[less than operator (WHERE clause)](#Bookmark29_idd1e4006)(See 11.2)    
[less than or equal to operator (WHERE clause)](#Bookmark29_idd1e4020)(See 11.2)    
[LIKE operator](#Bookmark37_idd1e6343)(See 13.1)  [2nd](#Bookmark37_idd1e6421)(See 13.1)  [3rd](#Bookmark37_idd1e6507)(See 13.1)    
    [% (percent sign) wildcard](#Bookmark37_idd1e6581)(See 13.1)  [2nd](#Bookmark37_idd1e6669)(See 13.1)  [3rd](#Bookmark37_idd1e6768)(See 13.1)  [4th](#Bookmark37_idd1e6866)(See 13.1)  [5th](#Bookmark37_idd1e6937)(See 13.1)    
    [[] (square brackets)](#Bookmark37_idd1e7345)(See 13.1)  [2nd](#Bookmark37_idd1e7467)(See 13.1)  [3rd](#Bookmark37_idd1e7547)(See 13.1)  [4th](#Bookmark37_idd1e7652)(See 13.1)    
    [\_ (underscore) wildcard](#Bookmark37_idd1e7076)(See 13.1)  [2nd](#Bookmark37_idd1e7168)(See 13.1)  [3rd](#Bookmark37_idd1e7279)(See 13.1)    
local varialbes  
    [@ character](#Bookmark103_idd1e23172)(See 26.4)    
logical operators  
    [defined](#Bookmark32_idd1e4971)(See 12.1)    
[LONG RAW datatype](#Bookmark156_idd1e30769)(See 33.4)    
[LOWER() function](#Bookmark47_idd1e9844)(See 15.2)    
[LTRIM() function](#Bookmark42_idd1e8651)(See 14.2)  [2nd](#Bookmark47_idd1e9867)(See 15.2)

## 35.14 index\_M

Macromedia ColdFusion  
    [running](#Bookmark125_idd1e27986)(See 31.3)  [2nd](#Bookmark125_idd1e28060)(See 31.3)    
manipulation functions  
    [date and time](#Bookmark47_idd1e10399)(See 15.2)    
[mathematical calcualtions](#Bookmark43_idd1e9001)(See 14.3)  [2nd](#Bookmark43_idd1e9059)(See 14.3)  [3rd](#Bookmark43_idd1e9123)(See 14.3)  [4th](#Bookmark44_idd1e9259)(See 14.4)    
[mathematical operators](#Bookmark43_idd1e9146)(See 14.3)    
[MAX() function](#Bookmark50_idd1e10855)(See 16.1)  [2nd](#Bookmark50_idd1e11387)(See 16.1)  [3rd](#Bookmark50_idd1e11435)(See 16.1)    
    [DISTINCT argument](#Bookmark51_idd1e12127)(See 16.2)    
    [non-numeric data](#Bookmark50_idd1e11462)(See 16.1)    
    [NULL values](#Bookmark50_idd1e11495)(See 16.1)    
Microsoft Access  
    [DISTINCT argument support](#Bookmark51_idd1e12001)(See 16.2)    
    [example tables for](#Bookmark121_idd1e27549)(See 30.2)    
    [pass-through mode](#Bookmark126_idd1e28293)(See 31.4)    
    [running](#Bookmark126_idd1e28096)(See 31.4)  [2nd](#Bookmark126_idd1e28170)(See 31.4)  [3rd](#Bookmark126_idd1e28269)(See 31.4)    
    [sorting by alias](#Bookmark58_idd1e13397)(See 17.4)    
    [stored procedure support](#Bookmark100_idd1e22695)(See 26.1)    
Microsoft ASP  
    [running](#Bookmark127_idd1e28326)(See 31.5)  [2nd](#Bookmark127_idd1e28401)(See 31.5)    
Microsoft ASP.NET  
    [running](#Bookmark128_idd1e28428)(See 31.6)  [2nd](#Bookmark128_idd1e28496)(See 31.6)    
Microsoft Query  
    [running](#Bookmark129_idd1e28526)(See 31.7)  [2nd](#Bookmark129_idd1e28601)(See 31.7)    
Microsoft SQL Server  
    [running](#Bookmark130_idd1e28643)(See 31.8)  [2nd](#Bookmark130_idd1e28701)(See 31.8)    
[MIN() function](#Bookmark50_idd1e10874)(See 16.1)  [2nd](#Bookmark50_idd1e11545)(See 16.1)  [3rd](#Bookmark50_idd1e11593)(See 16.1)    
    [DISTINCT argument](#Bookmark51_idd1e12122)(See 16.2)    
    [non-numeric data](#Bookmark50_idd1e11620)(See 16.1)    
    [NULL values](#Bookmark50_idd1e11653)(See 16.1)    
MySQL  
    [concatenation](#Bookmark42_idd1e8391)(See 14.2)    
    [cursor support](#Bookmark110_idd1e24422)(See 28.1)    
    [NOT operator](#Bookmark34_idd1e6283)(See 12.3)    
    [running](#Bookmark131_idd1e28728)(See 31.9)    
    [stored procedure support](#Bookmark100_idd1e22700)(See 26.1)    
    [subquery support](#Bookmark62_idd1e13739)(See 18.1)    
    views  
        [support for](#Bookmark96_idd1e21637)(See 25.1)

## 35.15 index\_N

names  
    [tables](#Bookmark11_idd1e1438)(See 8.1)    
        [reserved words and](#Bookmark16_idd1e2077)(See 9.1)    
naming  
    [aliases](#Bookmark42_idd1e8903)(See 14.2)    
        [aggregate functions and](#Bookmark52_idd1e12315)(See 16.3)    
    columns  
        [fully qualified names](#Bookmark68_idd1e14955)(See 19.2)    
    [indexes](#Bookmark115_idd1e26107)(See 29.2)    
    tables  
        [aliases](#Bookmark71_idd1e15704)(See 20.1)  [2nd](#Bookmark71_idd1e15788)(See 20.1)  [3rd](#Bookmark71_idd1e15856)(See 20.1)    
[natural joins](#Bookmark72_idd1e16190)(See 20.2)  [2nd](#Bookmark72_idd1e16256)(See 20.2)  [3rd](#Bookmark72_idd1e16287)(See 20.2)    
navigating tables  
    [cursors](#Bookmark110_idd1e24403)(See 28.1)    
[NCHAR string datatype](#Bookmark153_idd1e30261)(See 33.1)    
[nested data groups](#Bookmark56_idd1e12575)(See 17.2)    
[non-equality operator (WHERE clause)](#Bookmark29_idd1e3981)(See 11.2)    
non-numeric data  
    [MAX() function](#Bookmark50_idd1e11474)(See 16.1)    
    [MIN() function](#Bookmark50_idd1e11632)(See 16.1)    
[not greater than operator (WHERE clause)](#Bookmark29_idd1e4076)(See 11.2)    
[not less than operator (WHERE clause)](#Bookmark29_idd1e4034)(See 11.2)    
[NOT operator](#Bookmark34_idd1e6045)(See 12.3)  [2nd](#Bookmark34_idd1e6165)(See 12.3)  [3rd](#Bookmark34_idd1e6247)(See 12.3)    
    [character searching and](#Bookmark37_idd1e7633)(See 13.1)    
NULL keyword  
    [updating columns](#Bookmark85_idd1e19739)(See 23.1)    
[NULL value operator (WHERE clause)](#Bookmark29_idd1e4107)(See 11.2)    
NULL values  
    [AVG() function](#Bookmark50_idd1e11122)(See 16.1)    
    [checking for](#Bookmark29_idd1e4692)(See 11.2)    
    [compared to empty strings](#Bookmark90_idd1e20881)(See 24.1)    
    [COUNT() function](#Bookmark50_idd1e11343)(See 16.1)    
    [MAX() function](#Bookmark50_idd1e11507)(See 16.1)    
    [MIN() function](#Bookmark50_idd1e11665)(See 16.1)    
    [primary keys](#Bookmark90_idd1e20840)(See 24.1)    
    [SUM() function](#Bookmark50_idd1e11894)(See 16.1)    
    [table columns](#Bookmark90_idd1e20651)(See 24.1)  [2nd](#Bookmark90_idd1e20704)(See 24.1)  [3rd](#Bookmark90_idd1e20764)(See 24.1)    
[numeric datatypes](#Bookmark154_idd1e30356)(See 33.2)    
[numeric functions](#Bookmark47_idd1e9593)(See 15.2)  [2nd](#Bookmark47_idd1e10474)(See 15.2)  [3rd](#Bookmark47_idd1e10654)(See 15.2)    
numeric values  
    [quotes](#Bookmark154_idd1e30495)(See 33.2)    
    [storing](#Bookmark153_idd1e30335)(See 33.1)    
[NVARCHAR string datatype](#Bookmark153_idd1e30274)(See 33.1)

## 35.16 index\_O

ODBC  
    [configuration](#Bookmark137_idd1e29140)(See 31.15)  [2nd](#Bookmark137_idd1e29192)(See 31.15)  [3rd](#Bookmark137_idd1e29234)(See 31.15)    
[ODBC dates](#Bookmark155_idd1e30698)(See 33.3)    
[OPEN CURSOR statements](#Bookmark111_idd1e24679)(See 28.2)    
OPEN statements  
    [opening cursors](#Bookmark111_idd1e24926)(See 28.2)    
operators  
    [\*= (equality)](#Bookmark72_idd1e16598)(See 20.2)    
    + (plus sign)  
        [outer joins](#Bookmark72_idd1e16682)(See 20.2)    
    [AND](#Bookmark32_idd1e5023)(See 12.1)  [2nd](#Bookmark32_idd1e5105)(See 12.1)  [3rd](#Bookmark32_idd1e5173)(See 12.1)    
    [BETWEEN](#Bookmark47_idd1e10361)(See 15.2)    
    [concatenation](#Bookmark42_idd1e8140)(See 14.2)  [2nd](#Bookmark42_idd1e8262)(See 14.2)    
    [defined](#Bookmark32_idd1e4966)(See 12.1)    
    [grouping related](#Bookmark32_idd1e5544)(See 12.1)    
    [HAVING clause](#Bookmark57_idd1e12896)(See 17.3)    
    [IN](#Bookmark33_idd1e5738)(See 12.2)  [2nd](#Bookmark33_idd1e5808)(See 12.2)  [3rd](#Bookmark33_idd1e5878)(See 12.2)  [4th](#Bookmark33_idd1e5987)(See 12.2)    
    [LIKE](#Bookmark37_idd1e6346)(See 13.1)  [2nd](#Bookmark37_idd1e6424)(See 13.1)  [3rd](#Bookmark37_idd1e6510)(See 13.1)    
        [% (percent sign) wildcard](#Bookmark37_idd1e6586)(See 13.1)  [2nd](#Bookmark37_idd1e6674)(See 13.1)  [3rd](#Bookmark37_idd1e6773)(See 13.1)  [4th](#Bookmark37_idd1e6871)(See 13.1)  [5th](#Bookmark37_idd1e6942)(See 13.1)    
        [[] (square brackets) wildcard](#Bookmark37_idd1e7350)(See 13.1)  [2nd](#Bookmark37_idd1e7472)(See 13.1)  [3rd](#Bookmark37_idd1e7552)(See 13.1)  [4th](#Bookmark37_idd1e7657)(See 13.1)    
        [\_ (underscore) wildcard](#Bookmark37_idd1e7081)(See 13.1)  [2nd](#Bookmark37_idd1e7173)(See 13.1)  [3rd](#Bookmark37_idd1e7284)(See 13.1)    
    [mathematical](#Bookmark43_idd1e9141)(See 14.3)    
    [NOT](#Bookmark34_idd1e6048)(See 12.3)  [2nd](#Bookmark34_idd1e6168)(See 12.3)  [3rd](#Bookmark34_idd1e6250)(See 12.3)    
    [OR](#Bookmark32_idd1e5231)(See 12.1)  [2nd](#Bookmark32_idd1e5303)(See 12.1)  [3rd](#Bookmark32_idd1e5371)(See 12.1)    
    [order of evaluation](#Bookmark32_idd1e5419)(See 12.1)  [2nd](#Bookmark32_idd1e5533)(See 12.1)  [3rd](#Bookmark32_idd1e5653)(See 12.1)    
    [predicates](#Bookmark37_idd1e6499)(See 13.1)    
    [WHERE clause](#Bookmark29_idd1e3909)(See 11.2)  [2nd](#Bookmark29_idd1e4122)(See 11.2)    
        [checking against single value](#Bookmark29_idd1e4207)(See 11.2)  [2nd](#Bookmark29_idd1e4264)(See 11.2)    
        [checking for nonmatches](#Bookmark29_idd1e4318)(See 11.2)  [2nd](#Bookmark29_idd1e4418)(See 11.2)    
        [checking for NULL value](#Bookmark29_idd1e4657)(See 11.2)  [2nd](#Bookmark29_idd1e4788)(See 11.2)    
        [checking for range of values](#Bookmark29_idd1e4524)(See 11.2)  [2nd](#Bookmark29_idd1e4612)(See 11.2)    
        [compatibility](#Bookmark29_idd1e4179)(See 11.2)    
[OR operator](#Bookmark32_idd1e5228)(See 12.1)  [2nd](#Bookmark32_idd1e5300)(See 12.1)  [3rd](#Bookmark32_idd1e5368)(See 12.1)    
Oracle  
    [commits](#Bookmark107_idd1e24080)(See 27.2)    
    cursors  
        [closing](#Bookmark111_idd1e24871)(See 28.2)    
        [creating](#Bookmark111_idd1e24620)(See 28.2)    
        [retrieving data](#Bookmark111_idd1e24729)(See 28.2)    
    [date and time manipulation functions](#Bookmark47_idd1e10307)(See 15.2)    
    [date formatting](#Bookmark47_idd1e10436)(See 15.2)    
    [running](#Bookmark132_idd1e28802)(See 31.10)    
    [savepoints](#Bookmark107_idd1e24146)(See 27.2)    
    [stored procedures](#Bookmark103_idd1e23045)(See 26.4)    
    [triggers](#Bookmark116_idd1e26432)(See 29.3)    
ORDER BY clause  
    [(SELECT statement)](#Bookmark22_idd1e2844)(See 10.1)    
    [ascending/desccending sort order](#Bookmark25_idd1e3281)(See 10.4)  [2nd](#Bookmark25_idd1e3337)(See 10.4)  [3rd](#Bookmark25_idd1e3411)(See 10.4)  [4th](#Bookmark25_idd1e3496)(See 10.4)    
    [compared to GROUP BY clause](#Bookmark58_idd1e13149)(See 17.4)  [2nd](#Bookmark58_idd1e13295)(See 17.4)  [3rd](#Bookmark58_idd1e13337)(See 17.4)  [4th](#Bookmark58_idd1e13432)(See 17.4)    
    [positioning](#Bookmark22_idd1e2914)(See 10.1)    
    [sorting by column position](#Bookmark24_idd1e3084)(See 10.3)  [2nd](#Bookmark24_idd1e3156)(See 10.3)  [3rd](#Bookmark24_idd1e3194)(See 10.3)    
    [sorting by multiple columns](#Bookmark23_idd1e2985)(See 10.2)  [2nd](#Bookmark23_idd1e3048)(See 10.2)    
    [sorting by nonselected columns](#Bookmark24_idd1e3237)(See 10.3)    
[OrderItems table](#Bookmark120_idd1e27341)(See 30.1)    
[Orders table](#Bookmark120_idd1e27199)(See 30.1)    
ourter joins  
    [right](#Bookmark72_idd1e16637)(See 20.2)    
[outer joins](#Bookmark72_idd1e16317)(See 20.2)  [2nd](#Bookmark72_idd1e16396)(See 20.2)  [3rd](#Bookmark72_idd1e16492)(See 20.2)  [4th](#Bookmark72_idd1e16535)(See 20.2)  [5th](#Bookmark72_idd1e16689)(See 20.2)  [6th](#Bookmark72_idd1e16771)(See 20.2)    
    [full](#Bookmark72_idd1e16759)(See 20.2)    
    [left](#Bookmark72_idd1e16632)(See 20.2)    
    [syntax](#Bookmark72_idd1e16380)(See 20.2)  [2nd](#Bookmark72_idd1e16642)(See 20.2)    
    [types](#Bookmark72_idd1e16741)(See 20.2)    
[overwriting tables](#Bookmark90_idd1e20618)(See 24.1)

## 35.17 index\_P

parentheses  
    [multiple query criteria order of evaluation](#Bookmark32_idd1e5554)(See 12.1)    
[pass-through mode (Microsoft Access)](#Bookmark126_idd1e28303)(See 31.4)    
patterns (searching)  
    [wildcards](#Bookmark37_idd1e6366)(See 13.1)  [2nd](#Bookmark37_idd1e6444)(See 13.1)  [3rd](#Bookmark37_idd1e6530)(See 13.1)    
        [% (percent sign)](#Bookmark37_idd1e6574)(See 13.1)  [2nd](#Bookmark37_idd1e6662)(See 13.1)  [3rd](#Bookmark37_idd1e6761)(See 13.1)  [4th](#Bookmark37_idd1e6859)(See 13.1)  [5th](#Bookmark37_idd1e6930)(See 13.1)    
        [[] (square brackets)](#Bookmark37_idd1e7338)(See 13.1)  [2nd](#Bookmark37_idd1e7460)(See 13.1)  [3rd](#Bookmark37_idd1e7540)(See 13.1)  [4th](#Bookmark37_idd1e7645)(See 13.1)    
        [\_ (underscore)](#Bookmark37_idd1e7069)(See 13.1)  [2nd](#Bookmark37_idd1e7161)(See 13.1)  [3rd](#Bookmark37_idd1e7272)(See 13.1)    
[percent sign (%) wildcard](#Bookmark37_idd1e6600)(See 13.1)  [2nd](#Bookmark37_idd1e6688)(See 13.1)  [3rd](#Bookmark37_idd1e6787)(See 13.1)  [4th](#Bookmark37_idd1e6885)(See 13.1)  [5th](#Bookmark37_idd1e6956)(See 13.1)    
performance  
    [combining queries](#Bookmark78_idd1e17622)(See 21.2)    
    [deleting data](#Bookmark86_idd1e20041)(See 23.2)    
    [indexes](#Bookmark115_idd1e25963)(See 29.2)    
    [joins and](#Bookmark68_idd1e15486)(See 19.2)    
    [subqueries](#Bookmark63_idd1e14206)(See 18.2)    
    [views](#Bookmark96_idd1e21799)(See 25.1)    
PHP scripting language  
    [running](#Bookmark133_idd1e28857)(See 31.11)    
[PI() function](#Bookmark47_idd1e10583)(See 15.2)    
[pipe (|) symbol](#Bookmark138_idd1e29289)(See 32.)    
[placeholders.](#Bookmark107_idd1e24132)(See 27.2)  [See [savepoints](#Bookmark178_idd1e24112)(See 35.20)]  
plus sign (+)  
    [concatenation operator](#Bookmark42_idd1e8122)(See 14.2)  [2nd](#Bookmark42_idd1e8244)(See 14.2)    
plus sign (+) operator  
    [outer joins](#Bookmark72_idd1e16677)(See 20.2)    
portability  
    [defined](#Bookmark46_idd1e9496)(See 15.1)    
    [INSERT statements and](#Bookmark81_idd1e18589)(See 22.1)    
PostgreSQL  
    [filter query data](#Bookmark28_idd1e3788)(See 11.1)    
    [running](#Bookmark134_idd1e28884)(See 31.12)    
[predicates (operators)](#Bookmark37_idd1e6496)(See 13.1)    
[primary keys](#Bookmark114_idd1e25182)(See 29.1)  [2nd](#Bookmark114_idd1e25252)(See 29.1)  [3rd](#Bookmark114_idd1e25298)(See 29.1)    
    [concepts](#Bookmark11_idd1e1676)(See 8.1)  [2nd](#Bookmark11_idd1e1708)(See 8.1)  [3rd](#Bookmark11_idd1e1792)(See 8.1)    
    [Customer example table](#Bookmark120_idd1e27160)(See 30.1)    
    [importance](#Bookmark11_idd1e1732)(See 8.1)    
    [NULL values](#Bookmark90_idd1e20835)(See 24.1)    
    [OrderItems example table](#Bookmark120_idd1e27456)(See 30.1)    
    [Orders example table](#Bookmark120_idd1e27283)(See 30.1)    
    [Products example table](#Bookmark120_idd1e26970)(See 30.1)    
    [Vendors example table](#Bookmark120_idd1e26828)(See 30.1)    
processing  
    [subqueries](#Bookmark63_idd1e13966)(See 18.2)    
    [transactions.](#Bookmark106_idd1e23431)(See 27.1)  [See [transaction processing](#Bookmark179_idd1e23426)(See 35.21)]  
[Products table](#Bookmark120_idd1e26864)(See 30.1)    
programming code  
    [commenting](#Bookmark46_idd1e9538)(See 15.1)    
    [portability](#Bookmark46_idd1e9501)(See 15.1)

## 35.18 index\_Q

queries  
    calculated fields  
        [concatenating fields](#Bookmark42_idd1e7994)(See 14.2)  [2nd](#Bookmark42_idd1e8086)(See 14.2)  [3rd](#Bookmark42_idd1e8220)(See 14.2)  [4th](#Bookmark42_idd1e8304)(See 14.2)  [5th](#Bookmark42_idd1e8450)(See 14.2)  [6th](#Bookmark42_idd1e8589)(See 14.2)  [7th](#Bookmark42_idd1e8684)(See 14.2)  [8th](#Bookmark42_idd1e8829)(See 14.2)    
        [mathematical calculations](#Bookmark43_idd1e8980)(See 14.3)  [2nd](#Bookmark43_idd1e9038)(See 14.3)  [3rd](#Bookmark43_idd1e9102)(See 14.3)  [4th](#Bookmark44_idd1e9238)(See 14.4)    
        [overview](#Bookmark41_idd1e7797)(See 14.1)  [2nd](#Bookmark41_idd1e7857)(See 14.1)  [3rd](#Bookmark41_idd1e7929)(See 14.1)    
    combined  
        [creating](#Bookmark78_idd1e17192)(See 21.2)  [2nd](#Bookmark78_idd1e17246)(See 21.2)  [3rd](#Bookmark78_idd1e17326)(See 21.2)  [4th](#Bookmark78_idd1e17388)(See 21.2)  [5th](#Bookmark78_idd1e17464)(See 21.2)  [6th](#Bookmark78_idd1e17535)(See 21.2)    
        [duplicate rows and](#Bookmark78_idd1e17759)(See 21.2)  [2nd](#Bookmark78_idd1e17839)(See 21.2)  [3rd](#Bookmark78_idd1e17897)(See 21.2)    
        [overview](#Bookmark77_idd1e17083)(See 21.1)    
        [performance](#Bookmark78_idd1e17632)(See 21.2)    
        [rules](#Bookmark78_idd1e17653)(See 21.2)    
        [sorting results](#Bookmark78_idd1e18010)(See 21.2)  [2nd](#Bookmark78_idd1e18102)(See 21.2)    
        [WHERE clauses](#Bookmark77_idd1e17162)(See 21.1)    
    [combining](#Bookmark63_idd1e13930)(See 18.2)    
    [data formatting](#Bookmark18_idd1e2535)(See 9.3)    
    [defined](#Bookmark62_idd1e13700)(See 18.1)    
    [filtering results](#Bookmark28_idd1e3644)(See 11.1)  [2nd](#Bookmark28_idd1e3706)(See 11.1)  [3rd](#Bookmark28_idd1e3744)(See 11.1)    
        [AND operator](#Bookmark32_idd1e4999)(See 12.1)  [2nd](#Bookmark32_idd1e5081)(See 12.1)  [3rd](#Bookmark32_idd1e5149)(See 12.1)    
        [IN operator](#Bookmark33_idd1e5714)(See 12.2)  [2nd](#Bookmark33_idd1e5784)(See 12.2)  [3rd](#Bookmark33_idd1e5854)(See 12.2)  [4th](#Bookmark33_idd1e5963)(See 12.2)    
        [multiple criteria](#Bookmark32_idd1e4927)(See 12.1)    
        [NOT operator](#Bookmark34_idd1e6024)(See 12.3)  [2nd](#Bookmark34_idd1e6144)(See 12.3)  [3rd](#Bookmark34_idd1e6226)(See 12.3)    
        [OR operator](#Bookmark32_idd1e5207)(See 12.1)  [2nd](#Bookmark32_idd1e5279)(See 12.1)  [3rd](#Bookmark32_idd1e5347)(See 12.1)    
        [order of evaluation](#Bookmark32_idd1e5398)(See 12.1)  [2nd](#Bookmark32_idd1e5512)(See 12.1)  [3rd](#Bookmark32_idd1e5632)(See 12.1)    
        [WHERE clause operators](#Bookmark29_idd1e3914)(See 11.2)  [2nd](#Bookmark29_idd1e4127)(See 11.2)  [3rd](#Bookmark29_idd1e4214)(See 11.2)  [4th](#Bookmark29_idd1e4271)(See 11.2)  [5th](#Bookmark29_idd1e4325)(See 11.2)  [6th](#Bookmark29_idd1e4425)(See 11.2)  [7th](#Bookmark29_idd1e4531)(See 11.2)  [8th](#Bookmark29_idd1e4619)(See 11.2)  [9th](#Bookmark29_idd1e4664)(See 11.2)  [10th](#Bookmark29_idd1e4795)(See 11.2)    
    [INSERT statement and](#Bookmark81_idd1e18823)(See 22.1)  [2nd](#Bookmark81_idd1e18940)(See 22.1)  [3rd](#Bookmark81_idd1e19017)(See 22.1)    
    [multiple WHERE clauses](#Bookmark78_idd1e17504)(See 21.2)    
    [result sets](#Bookmark110_idd1e24381)(See 28.1)    
    [sorting results](#Bookmark22_idd1e2745)(See 10.1)  [2nd](#Bookmark22_idd1e2787)(See 10.1)  [3rd](#Bookmark22_idd1e2870)(See 10.1)    
        [ascending/desccending order](#Bookmark25_idd1e3267)(See 10.4)  [2nd](#Bookmark25_idd1e3323)(See 10.4)  [3rd](#Bookmark25_idd1e3397)(See 10.4)  [4th](#Bookmark25_idd1e3482)(See 10.4)    
        [by column position](#Bookmark24_idd1e3063)(See 10.3)  [2nd](#Bookmark24_idd1e3135)(See 10.3)  [3rd](#Bookmark24_idd1e3173)(See 10.3)    
        [by multiple columns](#Bookmark23_idd1e2964)(See 10.2)  [2nd](#Bookmark23_idd1e3027)(See 10.2)    
        [by nonselected columns](#Bookmark24_idd1e3216)(See 10.3)    
        [case sensitivity](#Bookmark25_idd1e3550)(See 10.4)    
        [nonselected columns and](#Bookmark22_idd1e2950)(See 10.1)    
    subqueries  
        [as calculated fields](#Bookmark64_idd1e14229)(See 18.3)  [2nd](#Bookmark64_idd1e14310)(See 18.3)  [3rd](#Bookmark64_idd1e14374)(See 18.3)  [4th](#Bookmark64_idd1e14478)(See 18.3)    
        [filtering by](#Bookmark63_idd1e13767)(See 18.2)  [2nd](#Bookmark63_idd1e13837)(See 18.2)  [3rd](#Bookmark63_idd1e13913)(See 18.2)  [4th](#Bookmark63_idd1e14074)(See 18.2)  [5th](#Bookmark63_idd1e14147)(See 18.2)    
        [overview](#Bookmark62_idd1e13668)(See 18.1)  [2nd](#Bookmark62_idd1e13713)(See 18.1)    
        [processing](#Bookmark63_idd1e13976)(See 18.2)    
        [self joins and](#Bookmark72_idd1e15958)(See 20.2)    
    [table aliases](#Bookmark71_idd1e15841)(See 20.1)    
    [unsorted results](#Bookmark17_idd1e2235)(See 9.2)    
    [views](#Bookmark96_idd1e21682)(See 25.1)    
    [wild cards (\*)](#Bookmark19_idd1e2579)(See 9.4)  [2nd](#Bookmark19_idd1e2653)(See 9.4)    
Query (Microsoft)  
    [running](#Bookmark129_idd1e28531)(See 31.7)  [2nd](#Bookmark129_idd1e28606)(See 31.7)    
Query Tool  
    [running](#Bookmark135_idd1e28964)(See 31.13)  [2nd](#Bookmark135_idd1e29039)(See 31.13)    
[Query Tool Web site](#Bookmark122_idd1e27766)(See 31.)    
[quotation marks, single (')](#Bookmark29_idd1e4382)(See 11.2)    
quotes  
    [numeric values](#Bookmark154_idd1e30500)(See 33.2)    
    [string values](#Bookmark153_idd1e30304)(See 33.1)

## 35.19 index\_R

[RAW datatype](#Bookmark156_idd1e30782)(See 33.4)    
[REAL datatype](#Bookmark154_idd1e30452)(See 33.2)    
records  
    [compared to rows](#Bookmark11_idd1e1659)(See 8.1)    
[REFERENCES keyword](#Bookmark114_idd1e25424)(See 29.1)    
referential integrity  
    [cascading deletes](#Bookmark114_idd1e25521)(See 29.1)    
    constrainte  
        [primary keys](#Bookmark114_idd1e25168)(See 29.1)  [2nd](#Bookmark114_idd1e25238)(See 29.1)  [3rd](#Bookmark114_idd1e25284)(See 29.1)    
    constraints  
        [check constraints](#Bookmark114_idd1e25649)(See 29.1)  [2nd](#Bookmark114_idd1e25746)(See 29.1)  [3rd](#Bookmark114_idd1e25783)(See 29.1)    
        [foreign keys](#Bookmark114_idd1e25313)(See 29.1)  [2nd](#Bookmark114_idd1e25380)(See 29.1)  [3rd](#Bookmark114_idd1e25446)(See 29.1)    
        [overview](#Bookmark114_idd1e24977)(See 29.1)  [2nd](#Bookmark114_idd1e25057)(See 29.1)  [3rd](#Bookmark114_idd1e25105)(See 29.1)    
        [unique constraints](#Bookmark114_idd1e25541)(See 29.1)  [2nd](#Bookmark114_idd1e25620)(See 29.1)    
    [natural joins](#Bookmark72_idd1e16198)(See 20.2)  [2nd](#Bookmark72_idd1e16264)(See 20.2)  [3rd](#Bookmark72_idd1e16295)(See 20.2)    
    [outer joins](#Bookmark72_idd1e16325)(See 20.2)  [2nd](#Bookmark72_idd1e16404)(See 20.2)  [3rd](#Bookmark72_idd1e16500)(See 20.2)  [4th](#Bookmark72_idd1e16543)(See 20.2)  [5th](#Bookmark72_idd1e16697)(See 20.2)  [6th](#Bookmark72_idd1e16779)(See 20.2)    
    [self joins](" \l "Bookmark72_idd1e15891)(See 20.2)  [2nd](#Bookmark72_idd1e15970)(See 20.2)  [3rd](#Bookmark72_idd1e16067)(See 20.2)  [4th](#Bookmark72_idd1e16135)(See 20.2)    
reformatting  
    [retrieved data with views](#Bookmark97_idd1e22186)(See 25.2)  [2nd](#Bookmark97_idd1e22227)(See 25.2)  [3rd](#Bookmark97_idd1e22276)(See 25.2)  [4th](#Bookmark97_idd1e22309)(See 25.2)    
relational databases  
    [sort order and](#Bookmark22_idd1e2782)(See 10.1)    
relational DBMS  
    [nonrelational behavior, inducing](#Bookmark110_idd1e24479)(See 28.1)    
[relational tables](#Bookmark67_idd1e14593)(See 19.1)  [2nd](#Bookmark67_idd1e14627)(See 19.1)  [3rd](#Bookmark67_idd1e14685)(See 19.1)    
relationships  
    constrainte  
        [overview](#Bookmark114_idd1e24984)(See 29.1)  [2nd](#Bookmark114_idd1e25064)(See 29.1)  [3rd](#Bookmark114_idd1e25112)(See 29.1)    
    constraints  
        [check constraints](#Bookmark114_idd1e25656)(See 29.1)  [2nd](#Bookmark114_idd1e25753)(See 29.1)  [3rd](#Bookmark114_idd1e25790)(See 29.1)    
        [foreign keys](#Bookmark114_idd1e25320)(See 29.1)  [2nd](#Bookmark114_idd1e25387)(See 29.1)  [3rd](#Bookmark114_idd1e25453)(See 29.1)    
        [primary keys](#Bookmark114_idd1e25175)(See 29.1)  [2nd](#Bookmark114_idd1e25245)(See 29.1)  [3rd](#Bookmark114_idd1e25291)(See 29.1)    
        [unique constraints](#Bookmark114_idd1e25548)(See 29.1)  [2nd](#Bookmark114_idd1e25627)(See 29.1)    
    [natural joins](#Bookmark72_idd1e16203)(See 20.2)  [2nd](#Bookmark72_idd1e16269)(See 20.2)  [3rd](#Bookmark72_idd1e16300)(See 20.2)    
    [outer joins](#Bookmark72_idd1e16330)(See 20.2)  [2nd](#Bookmark72_idd1e16409)(See 20.2)  [3rd](#Bookmark72_idd1e16505)(See 20.2)  [4th](#Bookmark72_idd1e16548)(See 20.2)  [5th](#Bookmark72_idd1e16702)(See 20.2)  [6th](#Bookmark72_idd1e16784)(See 20.2)    
    [self joins](#Bookmark72_idd1e15896)(See 20.2)  [2nd](#Bookmark72_idd1e15975)(See 20.2)  [3rd](#Bookmark72_idd1e16072)(See 20.2)  [4th](#Bookmark72_idd1e16140)(See 20.2)    
[RENAME statement](#Bookmark93_idd1e21532)(See 24.4)    
renaming  
    [tables](#Bookmark93_idd1e21545)(See 24.4)    
[reserved words](#Bookmark16_idd1e2067)(See 9.1)  [2nd](#Bookmark157_idd1e30831)(See 34.)  [3rd](#Bookmark157_idd1e30863)(See 34.)    
    [list of](#Bookmark157_idd1e31043)(See 34.)  [2nd](#Bookmark157_idd1e31417)(See 34.)  [3rd](#Bookmark157_idd1e31852)(See 34.)  [4th](#Bookmark157_idd1e32362)(See 34.)  [5th](#Bookmark157_idd1e32989)(See 34.)    
restrictions  
    [views](#Bookmark96_idd1e21822)(See 25.1)  [2nd](#Bookmark96_idd1e21918)(See 25.1)    
[result sets](#Bookmark110_idd1e24386)(See 28.1)    
reusable views  
    [creating](#Bookmark97_idd1e22160)(See 25.2)    
revisiting  
    [indexes](#Bookmark115_idd1e26150)(See 29.2)    
[REVOKE statements](#Bookmark117_idd1e26576)(See 29.4)    
[RIGHT keyword (outer joins)](#Bookmark72_idd1e16515)(See 20.2)    
[right outer joins](#Bookmark72_idd1e16612)(See 20.2)    
[RIGHT() function](#Bookmark47_idd1e9895)(See 15.2)    
[ROLLBACK command (transaction processing)](#Bookmark107_idd1e23911)(See 27.2)  [2nd](#Bookmark107_idd1e23959)(See 27.2)    
ROLLBACK statement  
    [syntax](#Bookmark149_idd1e29903)(See 32.11)    
[rollbacks](#Bookmark106_idd1e23765)(See 27.1)    
    [COMMIT statement](#Bookmark107_idd1e23982)(See 27.2)  [2nd](#Bookmark107_idd1e24059)(See 27.2)    
    [ROLLBACK command](#Bookmark107_idd1e23906)(See 27.2)  [2nd](#Bookmark107_idd1e23954)(See 27.2)    
    [savebacks and](#Bookmark107_idd1e24107)(See 27.2)  [2nd](#Bookmark107_idd1e24197)(See 27.2)  [3rd](#Bookmark107_idd1e24284)(See 27.2)    
    [statements](#Bookmark107_idd1e24311)(See 27.2)    
rollbacks (transaction processing)  
    [defined](#Bookmark106_idd1e23646)(See 27.1)    
rows  
    [adding to tables](#Bookmark147_idd1e29796)(See 32.9)    
    [compared to records](#Bookmark11_idd1e1664)(See 8.1)    
    [concepts](#Bookmark11_idd1e1613)(See 8.1)    
    [cursors](#Bookmark110_idd1e24398)(See 28.1)    
    [deleting](#Bookmark145_idd1e29674)(See 32.7)    
    [INSERT statement](#Bookmark81_idd1e18348)(See 22.1)  [2nd](#Bookmark81_idd1e18400)(See 22.1)  [3rd](#Bookmark81_idd1e18508)(See 22.1)  [4th](#Bookmark81_idd1e18550)(See 22.1)    
        [partial rows](#Bookmark81_idd1e18660)(See 22.1)  [2nd](#Bookmark81_idd1e18714)(See 22.1)    
    [preventing accidental deletion](#Bookmark114_idd1e25504)(See 29.1)    
    [updating](#Bookmark151_idd1e30026)(See 32.13)    
[RTRIM() function](#Bookmark42_idd1e8483)(See 14.2)  [2nd](#Bookmark42_idd1e8549)(See 14.2)  [3rd](#Bookmark42_idd1e8566)(See 14.2)  [4th](#Bookmark47_idd1e9914)(See 15.2)    
rules  
    [combining queries](#Bookmark78_idd1e17686)(See 21.2)    
    [constraints](#Bookmark114_idd1e25085)(See 29.1)    
    [views](#Bookmark96_idd1e21827)(See 25.1)  [2nd](#Bookmark96_idd1e21923)(See 25.1)

## 35.20 index\_S

savepoints  
    [transaction processing](#Bookmark107_idd1e24112)(See 27.2)  [2nd](#Bookmark107_idd1e24189)(See 27.2)  [3rd](#Bookmark107_idd1e24276)(See 27.2)    
savepoints (transaction processing)  
    [defined](#Bookmark106_idd1e23686)(See 27.1)    
[scalablity](#Bookmark67_idd1e14710)(See 19.1)    
[schemas](#Bookmark11_idd1e1470)(See 8.1)    
scripting  
    [PHP](#Bookmark133_idd1e28862)(See 31.11)    
scripts  
    [example tables](#Bookmark121_idd1e27603)(See 30.2)    
search patterns  
    [defined](#Bookmark37_idd1e6404)(See 13.1)    
    [wildcards](#Bookmark37_idd1e6351)(See 13.1)  [2nd](#Bookmark37_idd1e6429)(See 13.1)  [3rd](#Bookmark37_idd1e6515)(See 13.1)    
        [% (percent sign) wildcard](#Bookmark37_idd1e6593)(See 13.1)  [2nd](#Bookmark37_idd1e6681)(See 13.1)  [3rd](#Bookmark37_idd1e6780)(See 13.1)  [4th](#Bookmark37_idd1e6878)(See 13.1)  [5th](#Bookmark37_idd1e6949)(See 13.1)    
        [[] (square brackets) wildcard](#Bookmark37_idd1e7357)(See 13.1)  [2nd](#Bookmark37_idd1e7479)(See 13.1)  [3rd](#Bookmark37_idd1e7559)(See 13.1)  [4th](#Bookmark37_idd1e7664)(See 13.1)    
        [\_ (underscore) wildcard](#Bookmark37_idd1e7088)(See 13.1)  [2nd](#Bookmark37_idd1e7180)(See 13.1)  [3rd](#Bookmark37_idd1e7291)(See 13.1)    
        [cautions](#Bookmark37_idd1e7725)(See 13.1)    
searching  
    indexes  
        [overview](#Bookmark115_idd1e25877)(See 29.2)  [2nd](#Bookmark115_idd1e25928)(See 29.2)  [3rd](#Bookmark115_idd1e26032)(See 29.2)  [4th](#Bookmark115_idd1e26100)(See 29.2)    
    [trailing spaces and](#Bookmark37_idd1e7034)(See 13.1)    
    wildcards  
        [% character](#Bookmark37_idd1e6606)(See 13.1)  [2nd](#Bookmark37_idd1e6694)(See 13.1)  [3rd](#Bookmark37_idd1e6793)(See 13.1)  [4th](#Bookmark37_idd1e6891)(See 13.1)  [5th](#Bookmark37_idd1e6962)(See 13.1)    
        [[] (square brackets)](#Bookmark37_idd1e7370)(See 13.1)  [2nd](#Bookmark37_idd1e7492)(See 13.1)  [3rd](#Bookmark37_idd1e7572)(See 13.1)  [4th](#Bookmark37_idd1e7677)(See 13.1)    
        [^ (caret) character](#Bookmark37_idd1e7526)(See 13.1)    
        [\_ (underscore)](#Bookmark37_idd1e7101)(See 13.1)  [2nd](#Bookmark37_idd1e7193)(See 13.1)  [3rd](#Bookmark37_idd1e7304)(See 13.1)    
security  
    [data](#Bookmark117_idd1e26487)(See 29.4)    
    [DELETE statement](#Bookmark86_idd1e19849)(See 23.2)    
    [INSERT statements](#Bookmark81_idd1e18304)(See 22.1)    
    [UPDATE statement](#Bookmark85_idd1e19434)(See 23.1)    
[SELECT INTO statements](#Bookmark82_idd1e19135)(See 22.2)    
    [INSERT SELECT statement comparison](#Bookmark82_idd1e19143)(See 22.2)    
[SELECT statement](#Bookmark16_idd1e2036)(See 9.1)    
    aggregate functions  
        [combining](#Bookmark52_idd1e12218)(See 16.3)  [2nd](#Bookmark52_idd1e12272)(See 16.3)    
    [AVG() function](#Bookmark50_idd1e10988)(See 16.1)    
    clauses  
        [ordering of](#Bookmark59_idd1e13471)(See 17.5)    
    columns  
        [retrieving all](#Bookmark19_idd1e2558)(See 9.4)  [2nd](#Bookmark19_idd1e2615)(See 9.4)    
        [retrieving individual](#Bookmark17_idd1e2148)(See 9.2)  [2nd](#Bookmark17_idd1e2246)(See 9.2)    
        [retrieving multiple](#Bookmark18_idd1e2408)(See 9.3)  [2nd](#Bookmark18_idd1e2488)(See 9.3)    
        [retrieving unknown](#Bookmark19_idd1e2682)(See 9.4)    
    combining  
        [creating](#Bookmark78_idd1e17204)(See 21.2)  [2nd](#Bookmark78_idd1e17258)(See 21.2)  [3rd](#Bookmark78_idd1e17338)(See 21.2)  [4th](#Bookmark78_idd1e17400)(See 21.2)  [5th](#Bookmark78_idd1e17476)(See 21.2)  [6th](#Bookmark78_idd1e17547)(See 21.2)    
        [duplicate rows and](#Bookmark78_idd1e17771)(See 21.2)  [2nd](#Bookmark78_idd1e17851)(See 21.2)  [3rd](#Bookmark78_idd1e17909)(See 21.2)    
        [overview](#Bookmark77_idd1e17095)(See 21.1)    
        [rules](#Bookmark78_idd1e17665)(See 21.2)    
        [sorting results](#Bookmark78_idd1e18022)(See 21.2)  [2nd](#Bookmark78_idd1e18114)(See 21.2)    
    [COUNT() function](#Bookmark50_idd1e11295)(See 16.1)    
    [syntax](#Bookmark150_idd1e29979)(See 32.12)    
SELECT statements  
    [AS keyword](#Bookmark42_idd1e8730)(See 14.2)  [2nd](#Bookmark42_idd1e8802)(See 14.2)    
    [concatenating fields](#Bookmark42_idd1e8105)(See 14.2)  [2nd](#Bookmark42_idd1e8323)(See 14.2)    
    FROM clause  
        [creating joins](#Bookmark68_idd1e14908)(See 19.2)    
    [grouping data](#Bookmark56_idd1e12433)(See 17.2)  [2nd](#Bookmark56_idd1e12525)(See 17.2)  [3rd](#Bookmark56_idd1e12655)(See 17.2)    
    [IS NULL clause](#Bookmark29_idd1e4731)(See 11.2)    
    [ORDER BY clause](#Bookmark22_idd1e2839)(See 10.1)    
        [positioning](#Bookmark22_idd1e2919)(See 10.1)    
    subqueries  
        [formatting](#Bookmark63_idd1e14043)(See 18.2)    
    [WHERE clause](#Bookmark28_idd1e3636)(See 11.1)  [2nd](#Bookmark28_idd1e3698)(See 11.1)  [3rd](#Bookmark28_idd1e3736)(See 11.1)    
    WHERE clauses  
        [combined queries](#Bookmark77_idd1e17150)(See 21.1)    
        [combining](#Bookmark32_idd1e5067)(See 12.1)    
        [NOT operator](#Bookmark34_idd1e6053)(See 12.3)    
[self joins](#Bookmark72_idd1e15883)(See 20.2)  [2nd](#Bookmark72_idd1e15994)(See 20.2)  [3rd](#Bookmark72_idd1e16059)(See 20.2)  [4th](#Bookmark72_idd1e16127)(See 20.2)    
    [compared to subqueries](#Bookmark72_idd1e16173)(See 20.2)    
semicolonCharacter (semicolons)  
    [multiple statements](#Bookmark17_idd1e2334)(See 9.2)    
semicolons (semicolonCharacter)  
    [multiple statements](#Bookmark17_idd1e2329)(See 9.2)    
[sequence (SELECT statement clauses)](#Bookmark59_idd1e13468)(See 17.5)    
server-based results fomatting  
    [compared to client-based](#Bookmark41_idd1e7970)(See 14.1)    
SET command  
    [updating tables](#Bookmark85_idd1e19515)(See 23.1)    
[SIN() function](#Bookmark47_idd1e10602)(See 15.2)    
single quotation marks (')  
    [WHERE clause operators and](#Bookmark29_idd1e4390)(See 11.2)    
[SMALLDATETIME datatype](#Bookmark155_idd1e30622)(See 33.3)    
[SMALLINT datatype](#Bookmark154_idd1e30465)(See 33.2)    
sorting  
    [combined query results](#Bookmark78_idd1e18043)(See 21.2)  [2nd](#Bookmark78_idd1e18135)(See 21.2)    
    [datatype functionality](#Bookmark152_idd1e30112)(See 33.)    
    indexes  
        [overview](#Bookmark115_idd1e25870)(See 29.2)  [2nd](#Bookmark115_idd1e25921)(See 29.2)  [3rd](#Bookmark115_idd1e26025)(See 29.2)  [4th](#Bookmark115_idd1e26093)(See 29.2)    
    [query results](#Bookmark22_idd1e2750)(See 10.1)  [2nd](#Bookmark22_idd1e2792)(See 10.1)  [3rd](#Bookmark22_idd1e2875)(See 10.1)    
        [ascending/desccending order](#Bookmark25_idd1e3274)(See 10.4)  [2nd](#Bookmark25_idd1e3330)(See 10.4)  [3rd](#Bookmark25_idd1e3404)(See 10.4)  [4th](#Bookmark25_idd1e3489)(See 10.4)    
        [by column position](#Bookmark24_idd1e3070)(See 10.3)  [2nd](#Bookmark24_idd1e3142)(See 10.3)  [3rd](#Bookmark24_idd1e3180)(See 10.3)    
        [by multiple columns](#Bookmark23_idd1e2971)(See 10.2)  [2nd](#Bookmark23_idd1e3034)(See 10.2)    
        [by nonselected columns](#Bookmark24_idd1e3223)(See 10.3)    
        [case sensitivity](#Bookmark25_idd1e3557)(See 10.4)    
        [nonselected columns and](#Bookmark22_idd1e2943)(See 10.1)    
sorting data  
    [compared to grouping](#Bookmark58_idd1e13164)(See 17.4)  [2nd](#Bookmark58_idd1e13310)(See 17.4)  [3rd](#Bookmark58_idd1e13352)(See 17.4)  [4th](#Bookmark58_idd1e13447)(See 17.4)    
[SOUNDEX() function](#Bookmark47_idd1e9936)(See 15.2)  [2nd](#Bookmark47_idd1e10070)(See 15.2)    
    [support for](#Bookmark47_idd1e10015)(See 15.2)    
spaces  
    removing  
        [RTRIM function](#Bookmark42_idd1e8476)(See 14.2)  [2nd](#Bookmark42_idd1e8559)(See 14.2)    
    [search results and](#Bookmark37_idd1e7029)(See 13.1)    
specifying  
    [dates](#Bookmark155_idd1e30664)(See 33.3)    
speed  
    [constraints versus triggers](#Bookmark116_idd1e26460)(See 29.3)    
SQL  
    [deleting/updating data](#Bookmark87_idd1e20256)(See 23.3)    
    [extensions](#Bookmark12_idd1e1903)(See 8.2)    
    [overview](#Bookmark12_idd1e1812)(See 8.2)  [2nd](#Bookmark12_idd1e1870)(See 8.2)    
SQL scripts  
    [example tables](#Bookmark121_idd1e27598)(See 30.2)    
SQL Server  
    cursors  
        [closing](#Bookmark111_idd1e24893)(See 28.2)    
    [Identity fields](#Bookmark103_idd1e23353)(See 26.4)    
    local variables  
        [@ character](#Bookmark103_idd1e23180)(See 26.4)    
    [savepoints](#Bookmark107_idd1e24166)(See 27.2)    
    [stored procedures](#Bookmark103_idd1e23120)(See 26.4)    
    [triggers](#Bookmark116_idd1e26398)(See 29.3)    
SQL Server (Microsoft)  
    [running](#Bookmark130_idd1e28648)(See 31.8)  [2nd](#Bookmark130_idd1e28706)(See 31.8)    
[SQRT() function](#Bookmark47_idd1e10621)(See 15.2)    
[square brackets ([]) wildcard](#Bookmark37_idd1e7364)(See 13.1)  [2nd](#Bookmark37_idd1e7486)(See 13.1)  [3rd](#Bookmark37_idd1e7566)(See 13.1)  [4th](#Bookmark37_idd1e7671)(See 13.1)    
statement  
    [CREATE VIEW](#Bookmark97_idd1e21974)(See 25.2)    
statements  
    [ALTER TABLE](#Bookmark91_idd1e21201)(See 24.2)  [2nd](#Bookmark91_idd1e21272)(See 24.2)  [3rd](#Bookmark91_idd1e21329)(See 24.2)    
        [syntax](#Bookmark139_idd1e29345)(See 32.1)    
    [case sensitivity](#Bookmark17_idd1e2385)(See 9.2)    
    [clauses](#Bookmark22_idd1e2819)(See 10.1)    
    [COMMIT](#Bookmark107_idd1e23995)(See 27.2)  [2nd](#Bookmark107_idd1e24072)(See 27.2)    
        [syntax](#Bookmark140_idd1e29402)(See 32.2)    
    [CREATE INDEX](#Bookmark115_idd1e26054)(See 29.2)    
        [syntax](#Bookmark141_idd1e29454)(See 32.3)  [2nd](#Bookmark142_idd1e29516)(See 32.4)    
    [CREATE TABLE](#Bookmark90_idd1e20345)(See 24.1)  [2nd](#Bookmark90_idd1e20440)(See 24.1)  [3rd](#Bookmark90_idd1e20511)(See 24.1)  [4th](#Bookmark90_idd1e20550)(See 24.1)    
        [syntax](#Bookmark143_idd1e29576)(See 32.5)    
    CREATE VIEW  
        [syntax](#Bookmark144_idd1e29642)(See 32.6)    
    [DELETE](#Bookmark86_idd1e19774)(See 23.2)  [2nd](#Bookmark86_idd1e19888)(See 23.2)  [3rd](#Bookmark86_idd1e19996)(See 23.2)  [4th](#Bookmark87_idd1e20169)(See 23.3)    
        [FROM keyword](#Bookmark86_idd1e19961)(See 23.2)    
        [syntax](#Bookmark145_idd1e29696)(See 32.7)    
        [transaction processing](#Bookmark106_idd1e23746)(See 27.1)    
    DROP  
        [syntax](#Bookmark146_idd1e29754)(See 32.8)    
    [DROP TABLE](#Bookmark92_idd1e21414)(See 24.3)  [2nd](#Bookmark92_idd1e21454)(See 24.3)    
    [formatting](#Bookmark90_idd1e20591)(See 24.1)    
    [GRANT](#Bookmark117_idd1e26571)(See 29.4)    
    [grouping related operators](#Bookmark32_idd1e5559)(See 12.1)    
    INSERT  
        [completing rows](#Bookmark81_idd1e18336)(See 22.1)  [2nd](#Bookmark81_idd1e18388)(See 22.1)  [3rd](#Bookmark81_idd1e18496)(See 22.1)  [4th](#Bookmark81_idd1e18538)(See 22.1)    
        [omitting columns](#Bookmark81_idd1e18741)(See 22.1)    
        [overview](#Bookmark81_idd1e18252)(See 22.1)    
        [partial rows](#Bookmark81_idd1e18646)(See 22.1)  [2nd](#Bookmark81_idd1e18700)(See 22.1)    
        [query data](#Bookmark81_idd1e18809)(See 22.1)  [2nd](#Bookmark81_idd1e18926)(See 22.1)  [3rd](#Bookmark81_idd1e19003)(See 22.1)    
        [security privileges](#Bookmark81_idd1e18314)(See 22.1)    
        [syntax](#Bookmark147_idd1e29823)(See 32.9)    
        [transaction processing](#Bookmark106_idd1e23739)(See 27.1)    
        [VALUES](#Bookmark81_idd1e18624)(See 22.1)    
    INSERT SELECT  
        [syntax](#Bookmark148_idd1e29861)(See 32.10)    
    multiple  
        [separating](#Bookmark17_idd1e2339)(See 9.2)    
    [OPEN CURSOR](#Bookmark111_idd1e24682)(See 28.2)    
    [RENAME](#Bookmark93_idd1e21535)(See 24.4)    
    [REVOKE](#Bookmark117_idd1e26579)(See 29.4)    
    ROLLBACK  
        [syntax](#Bookmark149_idd1e29913)(See 32.11)    
    [rollbacks](#Bookmark106_idd1e23760)(See 27.1)  [2nd](#Bookmark107_idd1e24306)(See 27.2)    
        [defined](#Bookmark106_idd1e23651)(See 27.1)    
    [SELECT](#Bookmark16_idd1e2039)(See 9.1)    
        [AVG() function](#Bookmark50_idd1e10993)(See 16.1)    
        [combining](#Bookmark77_idd1e17102)(See 21.1)  [2nd](#Bookmark78_idd1e17211)(See 21.2)  [3rd](#Bookmark78_idd1e17265)(See 21.2)  [4th](#Bookmark78_idd1e17345)(See 21.2)  [5th](#Bookmark78_idd1e17407)(See 21.2)  [6th](#Bookmark78_idd1e17483)(See 21.2)  [7th](#Bookmark78_idd1e17554)(See 21.2)  [8th](#Bookmark78_idd1e17672)(See 21.2)  [9th](#Bookmark78_idd1e17778)(See 21.2)  [10th](#Bookmark78_idd1e17858)(See 21.2)  [11th](#Bookmark78_idd1e17916)(See 21.2)  [12th](#Bookmark78_idd1e18029)(See 21.2)  [13th](#Bookmark78_idd1e18121)(See 21.2)    
        [combining aggregate functions](#Bookmark52_idd1e12225)(See 16.3)  [2nd](#Bookmark52_idd1e12279)(See 16.3)    
        [contenating fields](#Bookmark42_idd1e8110)(See 14.2)  [2nd](#Bookmark42_idd1e8328)(See 14.2)    
        [COUNT() function](#Bookmark50_idd1e11300)(See 16.1)    
        [grouping data](#Bookmark56_idd1e12438)(See 17.2)  [2nd](#Bookmark56_idd1e12530)(See 17.2)  [3rd](#Bookmark56_idd1e12660)(See 17.2)    
        [retrieving all columns](#Bookmark19_idd1e2565)(See 9.4)  [2nd](#Bookmark19_idd1e2622)(See 9.4)    
        [retrieving individual columns](#Bookmark17_idd1e2155)(See 9.2)  [2nd](#Bookmark17_idd1e2253)(See 9.2)    
        [retrieving multiple columns](#Bookmark18_idd1e2415)(See 9.3)  [2nd](#Bookmark18_idd1e2495)(See 9.3)    
        [retrieving unknown columns](#Bookmark19_idd1e2689)(See 9.4)    
        [syntax](#Bookmark150_idd1e29984)(See 32.12)    
    stored procedures  
        [creating](#Bookmark103_idd1e23025)(See 26.4)  [2nd](#Bookmark103_idd1e23097)(See 26.4)  [3rd](#Bookmark103_idd1e23196)(See 26.4)  [4th](#Bookmark103_idd1e23246)(See 26.4)  [5th](#Bookmark103_idd1e23377)(See 26.4)    
        [disadvantages of](#Bookmark101_idd1e22793)(See 26.2)  [2nd](#Bookmark101_idd1e22835)(See 26.2)    
        [executing](#Bookmark102_idd1e22877)(See 26.3)  [2nd](#Bookmark102_idd1e22933)(See 26.3)  [3rd](#Bookmark102_idd1e23001)(See 26.3)    
        [overview](#Bookmark100_idd1e22613)(See 26.1)  [2nd](#Bookmark100_idd1e22664)(See 26.1)    
        [usefulness of](#Bookmark101_idd1e22729)(See 26.2)  [2nd](#Bookmark101_idd1e22775)(See 26.2)    
    [syntax](#Bookmark140_idd1e29382)(See 32.2)  [2nd](#Bookmark142_idd1e29496)(See 32.4)  [3rd](#Bookmark144_idd1e29608)(See 32.6)  [4th](#Bookmark147_idd1e29786)(See 32.9)  [5th](#Bookmark151_idd1e30031)(See 32.13)  [6th](#Bookmark138_idd1e29255)(See 32.)  [7th](#Bookmark138_idd1e29306)(See 32.)    
    [UPDATE](#Bookmark85_idd1e19364)(See 23.1)  [2nd](#Bookmark85_idd1e19486)(See 23.1)  [3rd](#Bookmark85_idd1e19564)(See 23.1)  [4th](#Bookmark85_idd1e19704)(See 23.1)  [5th](#Bookmark87_idd1e20159)(See 23.3)    
        [syntax](#Bookmark151_idd1e30051)(See 32.13)    
        [transaction processing](#Bookmark106_idd1e23753)(See 27.1)    
    [white space](#Bookmark17_idd1e2295)(See 9.2)    
stored procedures  
    [commenting code](#Bookmark103_idd1e23289)(See 26.4)    
    [creating](#Bookmark103_idd1e23032)(See 26.4)  [2nd](#Bookmark103_idd1e23104)(See 26.4)  [3rd](#Bookmark103_idd1e23203)(See 26.4)  [4th](#Bookmark103_idd1e23253)(See 26.4)  [5th](#Bookmark103_idd1e23384)(See 26.4)  [6th](#Bookmark142_idd1e29486)(See 32.4)    
    [disadvantages of](#Bookmark101_idd1e22800)(See 26.2)  [2nd](#Bookmark101_idd1e22842)(See 26.2)    
    [executing](#Bookmark102_idd1e22884)(See 26.3)  [2nd](#Bookmark102_idd1e22940)(See 26.3)  [3rd](#Bookmark102_idd1e23008)(See 26.3)    
    [Identity fields](#Bookmark103_idd1e23358)(See 26.4)    
    [Oracle](#Bookmark103_idd1e23050)(See 26.4)    
    [overview](#Bookmark100_idd1e22620)(See 26.1)  [2nd](#Bookmark100_idd1e22671)(See 26.1)    
    [triggers](#Bookmark116_idd1e26199)(See 29.3)    
    [usefulness of](#Bookmark101_idd1e22736)(See 26.2)  [2nd](#Bookmark101_idd1e22782)(See 26.2)    
storing  
    [date and time values](#Bookmark155_idd1e30547)(See 33.3)    
    numeric values  
        [cautions](#Bookmark153_idd1e30328)(See 33.1)    
    [strings](#Bookmark153_idd1e30159)(See 33.1)    
[string datatypes](#Bookmark153_idd1e30164)(See 33.1)    
[strings](#Bookmark47_idd1e9778)(See 15.2)  [See also [text functions](#Bookmark47_idd1e9581)(See 15.2)]  
    empty  
        [compared to NULL values](#Bookmark90_idd1e20886)(See 24.1)    
    [fixed length](#Bookmark153_idd1e30181)(See 33.1)    
    [quotes](#Bookmark153_idd1e30309)(See 33.1)    
    [TRIM functions](#Bookmark42_idd1e8641)(See 14.2)    
    [variable-length](#Bookmark153_idd1e30195)(See 33.1)    
    [wildcard searching and](#Bookmark37_idd1e6613)(See 13.1)    
subqueries  
    [as calculated fields](#Bookmark64_idd1e14236)(See 18.3)  [2nd](#Bookmark64_idd1e14317)(See 18.3)  [3rd](#Bookmark64_idd1e14381)(See 18.3)  [4th](#Bookmark64_idd1e14485)(See 18.3)    
    [compared to self joins](#Bookmark72_idd1e16178)(See 20.2)    
    [COUNT\*](#Bookmark64_idd1e14305)(See 18.3)    
    [filtering by](#Bookmark63_idd1e13774)(See 18.2)  [2nd](#Bookmark63_idd1e13844)(See 18.2)  [3rd](#Bookmark63_idd1e13920)(See 18.2)  [4th](#Bookmark63_idd1e14081)(See 18.2)  [5th](#Bookmark63_idd1e14154)(See 18.2)    
    [formatting](#Bookmark63_idd1e14038)(See 18.2)    
    [overview](#Bookmark62_idd1e13675)(See 18.1)  [2nd](#Bookmark62_idd1e13720)(See 18.1)    
    [performance](#Bookmark63_idd1e14211)(See 18.2)    
    [processing](#Bookmark63_idd1e13971)(See 18.2)    
    [self joins and](#Bookmark72_idd1e15953)(See 20.2)    
    [UPDATE statement](#Bookmark85_idd1e19637)(See 23.1)    
    [WHERE lauses](#Bookmark63_idd1e14142)(See 18.2)    
[SUM() function](#Bookmark50_idd1e10893)(See 16.1)  [2nd](#Bookmark50_idd1e11694)(See 16.1)  [3rd](#Bookmark50_idd1e11777)(See 16.1)  [4th](#Bookmark50_idd1e11827)(See 16.1)    
    [multiple columns](#Bookmark50_idd1e11854)(See 16.1)    
    [NULL values](#Bookmark50_idd1e11882)(See 16.1)    
support  
    [DBMS function support](#Bookmark46_idd1e9346)(See 15.1)  [2nd](#Bookmark46_idd1e9477)(See 15.1)    
Sybase Adaptive Server  
    [running](#Bookmark136_idd1e29077)(See 31.14)  [2nd](#Bookmark136_idd1e29121)(See 31.14)    
    statements  
        [ending](#Bookmark17_idd1e2346)(See 9.2)    
syntax  
    [ALTER TABLE statements](#Bookmark139_idd1e29340)(See 32.1)    
    [column aliases](#Bookmark71_idd1e15674)(See 20.1)    
    [COMMIT statement](#Bookmark140_idd1e29397)(See 32.2)    
    [CREATE INDEX statement](#Bookmark141_idd1e29449)(See 32.3)  [2nd](#Bookmark142_idd1e29511)(See 32.4)    
    [CREATE TABLE statement](#Bookmark90_idd1e20376)(See 24.1)  [2nd](#Bookmark143_idd1e29571)(See 32.5)    
    [CREATE VIEW statement](#Bookmark144_idd1e29637)(See 32.6)    
    [DELETE statement](#Bookmark145_idd1e29703)(See 32.7)    
    [DROP statement](#Bookmark146_idd1e29749)(See 32.8)    
    [INERT statement](#Bookmark148_idd1e29868)(See 32.10)    
    [INSERT statement](#Bookmark147_idd1e29818)(See 32.9)    
    [outer joins](#Bookmark72_idd1e16385)(See 20.2)    
    [ROLLBACK statement](#Bookmark149_idd1e29908)(See 32.11)    
    [SELECT statement](#Bookmark150_idd1e29991)(See 32.12)    
    [statements](#Bookmark140_idd1e29387)(See 32.2)  [2nd](#Bookmark142_idd1e29501)(See 32.4)  [3rd](#Bookmark144_idd1e29613)(See 32.6)  [4th](#Bookmark147_idd1e29791)(See 32.9)  [5th](#Bookmark151_idd1e30036)(See 32.13)  [6th](#Bookmark138_idd1e29260)(See 32.)  [7th](#Bookmark138_idd1e29311)(See 32.)    
    [transaction processing](#Bookmark107_idd1e23800)(See 27.2)    
    [triggers](#Bookmark116_idd1e26367)(See 29.3)    
    [UPDATE statement](#Bookmark151_idd1e30046)(See 32.13)    
system date  
    [default value syntax](#Bookmark90_idd1e21037)(See 24.1)    
[system functions](#Bookmark47_idd1e9628)(See 15.2)

## 35.21 index\_T

tables  
    calculated fields  
        [concatenating fields](#Bookmark42_idd1e7987)(See 14.2)  [2nd](#Bookmark42_idd1e8079)(See 14.2)  [3rd](#Bookmark42_idd1e8213)(See 14.2)  [4th](#Bookmark42_idd1e8297)(See 14.2)  [5th](#Bookmark42_idd1e8443)(See 14.2)  [6th](#Bookmark42_idd1e8582)(See 14.2)  [7th](#Bookmark42_idd1e8677)(See 14.2)  [8th](#Bookmark42_idd1e8822)(See 14.2)    
        [mathematical calculations](#Bookmark43_idd1e8973)(See 14.3)  [2nd](#Bookmark43_idd1e9031)(See 14.3)  [3rd](#Bookmark43_idd1e9095)(See 14.3)  [4th](#Bookmark44_idd1e9231)(See 14.4)    
        [overview](#Bookmark41_idd1e7790)(See 14.1)  [2nd](#Bookmark41_idd1e7850)(See 14.1)  [3rd](#Bookmark41_idd1e7922)(See 14.1)    
    column aliases  
        [creating](#Bookmark71_idd1e15667)(See 20.1)    
    [columns](#Bookmark11_idd1e1490)(See 8.1)  [2nd](#Bookmark11_idd1e1544)(See 8.1)    
        [NULL value, checking for](#Bookmark29_idd1e4678)(See 11.2)    
        [primary keys](#Bookmark11_idd1e1745)(See 8.1)    
    [concepts](#Bookmark11_idd1e1386)(See 8.1)  [2nd](#Bookmark11_idd1e1446)(See 8.1)    
    [copying](#Bookmark82_idd1e19268)(See 22.2)    
    [copying data into tables](#Bookmark82_idd1e19073)(See 22.2)  [2nd](#Bookmark82_idd1e19190)(See 22.2)  [3rd](#Bookmark82_idd1e19236)(See 22.2)    
    [creating](#Bookmark143_idd1e29561)(See 32.5)    
        [CREATE TABLE statement](#Bookmark90_idd1e20430)(See 24.1)  [2nd](#Bookmark90_idd1e20501)(See 24.1)  [3rd](#Bookmark90_idd1e20555)(See 24.1)    
        [overview](#Bookmark90_idd1e20304)(See 24.1)  [2nd](#Bookmark90_idd1e20387)(See 24.1)    
    [datatypes](#Bookmark11_idd1e1566)(See 8.1)    
    [default values](#Bookmark90_idd1e20913)(See 24.1)  [2nd](#Bookmark90_idd1e20971)(See 24.1)  [3rd](#Bookmark90_idd1e21015)(See 24.1)    
    [deleting](#Bookmark92_idd1e21419)(See 24.3)  [2nd](#Bookmark92_idd1e21459)(See 24.3)    
        [preventing accidental deletion](#Bookmark92_idd1e21506)(See 24.3)    
    examples  
        [Customers table](#Bookmark120_idd1e27004)(See 30.1)    
        [downloading](#Bookmark121_idd1e27498)(See 30.2)    
        [downloading;Microsoft Access MDB file](#Bookmark121_idd1e27525)(See 30.2)    
        [downloading;SQL scripts](#Bookmark121_idd1e27579)(See 30.2)    
        [functions of](#Bookmark120_idd1e26624)(See 30.1)    
        [OrderItems table](#Bookmark120_idd1e27329)(See 30.1)    
        [Orders table](#Bookmark120_idd1e27187)(See 30.1)    
        [Products table](#Bookmark120_idd1e26852)(See 30.1)    
        [Vendors table](#Bookmark120_idd1e26694)(See 30.1)    
    indexes  
        [cautions](#Bookmark115_idd1e26003)(See 29.2)    
        [creating](#Bookmark115_idd1e26129)(See 29.2)    
        [searching](#Bookmark115_idd1e25944)(See 29.2)    
    INSERT statement  
        [multiple rows](#Bookmark81_idd1e19053)(See 22.1)    
    [inserting data](#Bookmark81_idd1e18343)(See 22.1)  [2nd](#Bookmark81_idd1e18395)(See 22.1)  [3rd](#Bookmark81_idd1e18503)(See 22.1)  [4th](#Bookmark81_idd1e18545)(See 22.1)    
        [from queries](#Bookmark81_idd1e18816)(See 22.1)  [2nd](#Bookmark81_idd1e18933)(See 22.1)  [3rd](#Bookmark81_idd1e19010)(See 22.1)    
        [partial rows](#Bookmark81_idd1e18653)(See 22.1)  [2nd](#Bookmark81_idd1e18707)(See 22.1)    
    joins  
        [Cartesian Product](#Bookmark68_idd1e15028)(See 19.2)  [2nd](#Bookmark68_idd1e15092)(See 19.2)  [3rd](#Bookmark68_idd1e15135)(See 19.2)  [4th](#Bookmark68_idd1e15183)(See 19.2)    
        [creating](#Bookmark68_idd1e14806)(See 19.2)  [2nd](#Bookmark68_idd1e14852)(See 19.2)    
        [cross joins](#Bookmark68_idd1e15260)(See 19.2)    
        [inner joins](#Bookmark68_idd1e15280)(See 19.2)  [2nd](#Bookmark68_idd1e15337)(See 19.2)    
        [multiple tables](#Bookmark68_idd1e15390)(See 19.2)  [2nd](#Bookmark68_idd1e15448)(See 19.2)  [3rd](#Bookmark68_idd1e15545)(See 19.2)  [4th](#Bookmark68_idd1e15589)(See 19.2)    
        [overview](#Bookmark67_idd1e14559)(See 19.1)  [2nd](#Bookmark67_idd1e14574)(See 19.1)    
        [performance considerations](#Bookmark68_idd1e15474)(See 19.2)    
        [usefulness of](#Bookmark67_idd1e14725)(See 19.1)    
        [WHERE clause](#Bookmark68_idd1e14990)(See 19.2)  [2nd](#Bookmark68_idd1e15067)(See 19.2)  [3rd](#Bookmark68_idd1e15110)(See 19.2)  [4th](#Bookmark68_idd1e15159)(See 19.2)    
    [naming](#Bookmark11_idd1e1433)(See 8.1)    
        [reserved words and](#Bookmark16_idd1e2070)(See 9.1)    
    [natural joins](#Bookmark72_idd1e16208)(See 20.2)  [2nd](#Bookmark72_idd1e16274)(See 20.2)  [3rd](#Bookmark72_idd1e16305)(See 20.2)    
    [NULL value columns](#Bookmark90_idd1e20661)(See 24.1)  [2nd](#Bookmark90_idd1e20699)(See 24.1)  [3rd](#Bookmark90_idd1e20759)(See 24.1)    
    [outer joins](#Bookmark72_idd1e16335)(See 20.2)  [2nd](#Bookmark72_idd1e16414)(See 20.2)  [3rd](#Bookmark72_idd1e16510)(See 20.2)  [4th](#Bookmark72_idd1e16553)(See 20.2)  [5th](#Bookmark72_idd1e16707)(See 20.2)  [6th](#Bookmark72_idd1e16789)(See 20.2)    
    [relational](#Bookmark67_idd1e14596)(See 19.1)  [2nd](#Bookmark67_idd1e14630)(See 19.1)  [3rd](#Bookmark67_idd1e14688)(See 19.1)    
    [renaming](#Bookmark93_idd1e21540)(See 24.4)    
    [replacing](#Bookmark90_idd1e20621)(See 24.1)    
    [rows](#Bookmark11_idd1e1608)(See 8.1)    
        [adding](#Bookmark147_idd1e29801)(See 32.9)    
        [deleting](#Bookmark145_idd1e29684)(See 32.7)    
        [updating](#Bookmark151_idd1e30019)(See 32.13)    
    [schemas](#Bookmark11_idd1e1473)(See 8.1)    
    [security](#Bookmark117_idd1e26502)(See 29.4)    
    [table name aliases](#Bookmark71_idd1e15699)(See 20.1)  [2nd](#Bookmark71_idd1e15783)(See 20.1)  [3rd](#Bookmark71_idd1e15851)(See 20.1)    
        [self joins](#Bookmark72_idd1e15908)(See 20.2)  [2nd](#Bookmark72_idd1e15987)(See 20.2)  [3rd](#Bookmark72_idd1e16084)(See 20.2)  [4th](#Bookmark72_idd1e16152)(See 20.2)    
    [triggers](#Bookmark116_idd1e26242)(See 29.3)    
        [creating](#Bookmark116_idd1e26420)(See 29.3)    
        [functionality](#Bookmark116_idd1e26255)(See 29.3)    
    [updating](#Bookmark85_idd1e19351)(See 23.1)  [2nd](#Bookmark85_idd1e19473)(See 23.1)  [3rd](#Bookmark85_idd1e19551)(See 23.1)  [4th](#Bookmark85_idd1e19691)(See 23.1)  [5th](#Bookmark91_idd1e21206)(See 24.2)  [6th](#Bookmark91_idd1e21277)(See 24.2)  [7th](#Bookmark91_idd1e21334)(See 24.2)    
        [deleting data](#Bookmark86_idd1e19757)(See 23.2)  [2nd](#Bookmark86_idd1e19871)(See 23.2)  [3rd](#Bookmark86_idd1e19979)(See 23.2)    
    views  
        [creating](#Bookmark144_idd1e29625)(See 32.6)    
    [virtual.](#Bookmark96_idd1e21606)(See 25.1)  [See [views](#Bookmark181_idd1e21618)(See 35.23)]  
[TAN() function](#Bookmark47_idd1e10640)(See 15.2)    
testing  
    [Query Tool and](#Bookmark135_idd1e28969)(See 31.13)  [2nd](#Bookmark135_idd1e29044)(See 31.13)    
[text functions](#Bookmark47_idd1e9581)(See 15.2)  [2nd](#Bookmark47_idd1e9659)(See 15.2)  [3rd](#Bookmark47_idd1e9706)(See 15.2)    
    [list of common](#Bookmark47_idd1e9728)(See 15.2)    
[TEXT string datatype](#Bookmark153_idd1e30277)(See 33.1)    
[time functions](#Bookmark47_idd1e9613)(See 15.2)  [2nd](#Bookmark47_idd1e10154)(See 15.2)  [3rd](#Bookmark47_idd1e10202)(See 15.2)  [4th](#Bookmark47_idd1e10304)(See 15.2)  [5th](#Bookmark47_idd1e10464)(See 15.2)    
[TINYINT datatype](#Bookmark154_idd1e30478)(See 33.2)    
[to\_char() function](#Bookmark47_idd1e10336)(See 15.2)    
[to\_number() function](#Bookmark47_idd1e10339)(See 15.2)    
tools  
    DBMS  
        [interactive](#Bookmark67_idd1e14771)(See 19.1)    
[TOP argument](#Bookmark51_idd1e12163)(See 16.2)    
[TOP PERCENT argument](#Bookmark51_idd1e12166)(See 16.2)    
totaling  
    [calculated values](#Bookmark50_idd1e11760)(See 16.1)    
totaling values  
    [SUM() function](#Bookmark50_idd1e11702)(See 16.1)  [2nd](#Bookmark50_idd1e11785)(See 16.1)  [3rd](#Bookmark50_idd1e11835)(See 16.1)    
[transaction processing](#Bookmark107_idd1e24117)(See 27.2)  [2nd](#Bookmark107_idd1e24194)(See 27.2)  [3rd](#Bookmark107_idd1e24281)(See 27.2)    
    [COMMIT command](#Bookmark107_idd1e23990)(See 27.2)  [2nd](#Bookmark107_idd1e24067)(See 27.2)    
    [explicit commits](#Bookmark107_idd1e24015)(See 27.2)    
    [managing](#Bookmark107_idd1e23775)(See 27.2)  [2nd](#Bookmark107_idd1e23848)(See 27.2)  [3rd](#Bookmark107_idd1e23883)(See 27.2)    
    [overview](" \l "Bookmark106_idd1e23426)(See 27.1)  [2nd](#Bookmark106_idd1e23471)(See 27.1)  [3rd](#Bookmark106_idd1e23531)(See 27.1)  [4th](#Bookmark106_idd1e23545)(See 27.1)    
    [ROLLBACK command](#Bookmark107_idd1e23914)(See 27.2)  [2nd](#Bookmark107_idd1e23962)(See 27.2)    
    [terminology](#Bookmark106_idd1e23608)(See 27.1)    
transactions  
    blocks  
        [ROLLBACK statements](#Bookmark149_idd1e29896)(See 32.11)    
    [defined](#Bookmark106_idd1e23628)(See 27.1)    
    [writing to databases](#Bookmark140_idd1e29377)(See 32.2)    
[triggers](#Bookmark116_idd1e26196)(See 29.3)    
    [creating](#Bookmark116_idd1e26415)(See 29.3)    
    [functionality](#Bookmark116_idd1e26250)(See 29.3)    
    [overview](#Bookmark116_idd1e26176)(See 29.3)  [2nd](#Bookmark116_idd1e26298)(See 29.3)  [3rd](#Bookmark116_idd1e26387)(See 29.3)  [4th](#Bookmark116_idd1e26475)(See 29.3)    
    [speed](#Bookmark116_idd1e26470)(See 29.3)    
    [syntax examples](#Bookmark116_idd1e26362)(See 29.3)    
[TRIM() function](#Bookmark42_idd1e8654)(See 14.2)    
[trimming padded spaces](#Bookmark42_idd1e8491)(See 14.2)  [2nd](#Bookmark42_idd1e8574)(See 14.2)    
troubleshooting  
    [accidental table deletion](#Bookmark92_idd1e21494)(See 24.3)    
    [Query Tool and](#Bookmark135_idd1e28974)(See 31.13)  [2nd](#Bookmark135_idd1e29049)(See 31.13)    
[TRUNCATE TABLE statement](#Bookmark86_idd1e20046)(See 23.2)

## 35.22 index\_U

[UCASE() function](#Bookmark47_idd1e9967)(See 15.2)    
[underscore (\_) wildcard](#Bookmark37_idd1e7095)(See 13.1)  [2nd](#Bookmark37_idd1e7187)(See 13.1)  [3rd](#Bookmark37_idd1e7298)(See 13.1)    
UNION operator  
    [combined queries](#Bookmark78_idd1e17218)(See 21.2)  [2nd](#Bookmark78_idd1e17272)(See 21.2)  [3rd](#Bookmark78_idd1e17352)(See 21.2)  [4th](#Bookmark78_idd1e17414)(See 21.2)  [5th](#Bookmark78_idd1e17490)(See 21.2)  [6th](#Bookmark78_idd1e17561)(See 21.2)    
        [duplicate rows and](#Bookmark78_idd1e17785)(See 21.2)  [2nd](#Bookmark78_idd1e17865)(See 21.2)  [3rd](#Bookmark78_idd1e17923)(See 21.2)    
        [rules](#Bookmark78_idd1e17679)(See 21.2)    
        [sorting results](#Bookmark78_idd1e18036)(See 21.2)  [2nd](#Bookmark78_idd1e18128)(See 21.2)    
    [compared to WHERE clauses](#Bookmark78_idd1e17971)(See 21.2)    
    [limits](#Bookmark78_idd1e17594)(See 21.2)    
UNION statements  
    [types](#Bookmark78_idd1e18185)(See 21.2)    
unions (queries)  
    [creating](#Bookmark78_idd1e17199)(See 21.2)  [2nd](#Bookmark78_idd1e17253)(See 21.2)  [3rd](#Bookmark78_idd1e17333)(See 21.2)  [4th](#Bookmark78_idd1e17395)(See 21.2)  [5th](#Bookmark78_idd1e17471)(See 21.2)  [6th](#Bookmark78_idd1e17542)(See 21.2)    
    [duplicate rows and](#Bookmark78_idd1e17766)(See 21.2)  [2nd](#Bookmark78_idd1e17846)(See 21.2)  [3rd](#Bookmark78_idd1e17904)(See 21.2)    
    [overview](#Bookmark77_idd1e17090)(See 21.1)    
    [rules](#Bookmark78_idd1e17660)(See 21.2)    
    [sorting results](#Bookmark78_idd1e18017)(See 21.2)  [2nd](#Bookmark78_idd1e18109)(See 21.2)    
[unique constraints](#Bookmark114_idd1e25533)(See 29.1)  [2nd](#Bookmark114_idd1e25612)(See 29.1)    
[UNIQUE keyword](#Bookmark114_idd1e25595)(See 29.1)    
unsorted data  
    [query results](#Bookmark17_idd1e2230)(See 9.2)    
[UPDATE statement](#Bookmark85_idd1e19361)(See 23.1)  [2nd](#Bookmark85_idd1e19483)(See 23.1)  [3rd](#Bookmark85_idd1e19561)(See 23.1)  [4th](#Bookmark85_idd1e19701)(See 23.1)    
    [FROM keyword](#Bookmark85_idd1e19673)(See 23.1)    
    [guidelines](#Bookmark87_idd1e20154)(See 23.3)    
    [security privileges](#Bookmark85_idd1e19439)(See 23.1)    
    [subqueries](#Bookmark85_idd1e19632)(See 23.1)    
    [transaction processing](#Bookmark106_idd1e23729)(See 27.1)    
UPDATE statements  
    [syntax](#Bookmark151_idd1e30041)(See 32.13)    
    [triggers](#Bookmark116_idd1e26186)(See 29.3)    
updating  
    data  
        [guidelines](#Bookmark87_idd1e20105)(See 23.3)    
    [table data](#Bookmark85_idd1e19356)(See 23.1)  [2nd](#Bookmark85_idd1e19478)(See 23.1)  [3rd](#Bookmark85_idd1e19556)(See 23.1)  [4th](#Bookmark85_idd1e19696)(See 23.1)    
        [deleting data](#Bookmark86_idd1e19764)(See 23.2)  [2nd](#Bookmark86_idd1e19878)(See 23.2)  [3rd](#Bookmark86_idd1e19986)(See 23.2)    
    [tables](#Bookmark91_idd1e21211)(See 24.2)  [2nd](#Bookmark91_idd1e21282)(See 24.2)  [3rd](#Bookmark91_idd1e21339)(See 24.2)    
[UPPER() function](#Bookmark47_idd1e9667)(See 15.2)  [2nd](#Bookmark47_idd1e9714)(See 15.2)  [3rd](#Bookmark47_idd1e9959)(See 15.2)    
[user-defined datatypes](#Bookmark114_idd1e25840)(See 29.1)

## 35.23 index\_V

values  
    [concatenation](#Bookmark42_idd1e8051)(See 14.2)    
    [searching for (indexes)](#Bookmark115_idd1e25911)(See 29.2)    
    [trimming padded space](#Bookmark42_idd1e8544)(See 14.2)    
[VARBINARY datatype](#Bookmark156_idd1e30795)(See 33.4)    
[variable-length strings](#Bookmark153_idd1e30192)(See 33.1)    
[Vendors table](#Bookmark120_idd1e26706)(See 30.1)    
views  
    (tables)  
        [creating](#Bookmark144_idd1e29618)(See 32.6)    
    [calculated fields](#Bookmark97_idd1e22482)(See 25.2)  [2nd](#Bookmark97_idd1e22533)(See 25.2)  [3rd](#Bookmark97_idd1e22569)(See 25.2)    
    [creating](#Bookmark96_idd1e21856)(See 25.1)    
        [overview](#Bookmark97_idd1e21952)(See 25.2)    
    [DBMS consistency](#Bookmark96_idd1e21721)(See 25.1)    
    [filtering data](#Bookmark97_idd1e22373)(See 25.2)  [2nd](#Bookmark97_idd1e22413)(See 25.2)    
    joins  
        [simplifying](#Bookmark97_idd1e22012)(See 25.2)  [2nd](#Bookmark97_idd1e22076)(See 25.2)  [3rd](#Bookmark97_idd1e22131)(See 25.2)    
    [overview](" \l "Bookmark96_idd1e21618)(See 25.1)  [2nd](#Bookmark96_idd1e21677)(See 25.1)    
    [performance concerns](#Bookmark96_idd1e21794)(See 25.1)    
    [reformatting retrieved data](#Bookmark97_idd1e22191)(See 25.2)  [2nd](#Bookmark97_idd1e22232)(See 25.2)  [3rd](#Bookmark97_idd1e22281)(See 25.2)  [4th](#Bookmark97_idd1e22314)(See 25.2)    
    [reusable](#Bookmark97_idd1e22155)(See 25.2)    
    [rules and restrictions](#Bookmark96_idd1e21817)(See 25.1)  [2nd](#Bookmark96_idd1e21913)(See 25.1)    
    [usefulness of](#Bookmark96_idd1e21733)(See 25.1)  [2nd](#Bookmark96_idd1e21775)(See 25.1)    
[virtual tables.](#Bookmark96_idd1e21613)(See 25.1)  [See [views](#Bookmark181_idd1e21618)(See 35.23)]

## 35.24 index\_W

Web sites  
    [Aqua Data Studio](#Bookmark122_idd1e27786)(See 31.)    
    [example table download site](#Bookmark121_idd1e27493)(See 30.2)    
    [Query Tool](#Bookmark135_idd1e28996)(See 31.13)  [2nd](#Bookmark122_idd1e27769)(See 31.)    
Web-based applications  
    [cursors](#Bookmark110_idd1e24516)(See 28.1)    
[WHERE clause](#Bookmark28_idd1e3641)(See 11.1)  [2nd](#Bookmark28_idd1e3703)(See 11.1)  [3rd](#Bookmark28_idd1e3741)(See 11.1)  [4th](#Bookmark57_idd1e12839)(See 17.3)  [See also [HAVING clause](#Bookmark57_idd1e12844)(See 17.3)]  
    [BETWEEN operator](#Bookmark29_idd1e4548)(See 11.2)    
    [compared to UNION statement](#Bookmark78_idd1e17976)(See 21.2)    
    [filtering groups](#Bookmark57_idd1e12951)(See 17.3)    
    [joins](#Bookmark68_idd1e15231)(See 19.2)    
    [joins and](#Bookmark68_idd1e15002)(See 19.2)  [2nd](#Bookmark68_idd1e15079)(See 19.2)  [3rd](#Bookmark68_idd1e15122)(See 19.2)  [4th](#Bookmark68_idd1e15171)(See 19.2)    
    [multiple query criteria](#Bookmark32_idd1e4934)(See 12.1)    
        [AND operator](#Bookmark32_idd1e5006)(See 12.1)  [2nd](#Bookmark32_idd1e5088)(See 12.1)  [3rd](#Bookmark32_idd1e5156)(See 12.1)    
        [IN operator](#Bookmark33_idd1e5721)(See 12.2)  [2nd](#Bookmark33_idd1e5791)(See 12.2)  [3rd](#Bookmark33_idd1e5861)(See 12.2)  [4th](#Bookmark33_idd1e5970)(See 12.2)    
        [NOT operator](#Bookmark34_idd1e6031)(See 12.3)  [2nd](#Bookmark34_idd1e6151)(See 12.3)  [3rd](#Bookmark34_idd1e6233)(See 12.3)    
        [OR operator](#Bookmark32_idd1e5214)(See 12.1)  [2nd](#Bookmark32_idd1e5286)(See 12.1)  [3rd](#Bookmark32_idd1e5354)(See 12.1)    
        [order of evaluation](#Bookmark32_idd1e5405)(See 12.1)  [2nd](#Bookmark32_idd1e5519)(See 12.1)  [3rd](#Bookmark32_idd1e5639)(See 12.1)    
    [operator support by DBMS](#Bookmark29_idd1e4482)(See 11.2)    
    [operators](#Bookmark29_idd1e3897)(See 11.2)  [2nd](#Bookmark29_idd1e4110)(See 11.2)    
        [checking against single value](#Bookmark29_idd1e4193)(See 11.2)  [2nd](#Bookmark29_idd1e4250)(See 11.2)    
        [checking for nonmatches](#Bookmark29_idd1e4304)(See 11.2)  [2nd](#Bookmark29_idd1e4404)(See 11.2)    
        [checking for NULL value](#Bookmark29_idd1e4643)(See 11.2)  [2nd](#Bookmark29_idd1e4774)(See 11.2)    
        [checking for range of values](#Bookmark29_idd1e4510)(See 11.2)  [2nd](#Bookmark29_idd1e4598)(See 11.2)    
        [quotes and](#Bookmark29_idd1e4375)(See 11.2)    
    [parentheses and](#Bookmark32_idd1e5686)(See 12.1)    
    [positioning](#Bookmark28_idd1e3872)(See 11.1)    
    [SOUNDEX() function](#Bookmark47_idd1e10124)(See 15.2)    
    [UPDATE statements](#Bookmark85_idd1e19543)(See 23.1)    
    [wildcards](#Bookmark37_idd1e6449)(See 13.1)    
WHERE clauses  
    [combining in queries](#Bookmark77_idd1e17157)(See 21.1)    
    [DELETE statements](#Bookmark86_idd1e19817)(See 23.2)    
    [NOT operators](#Bookmark34_idd1e6060)(See 12.3)    
    [subqueries](#Bookmark63_idd1e14091)(See 18.2)    
    [UPDATE statements](#Bookmark85_idd1e19407)(See 23.1)    
white space  
    [SQL statements](#Bookmark17_idd1e2290)(See 9.2)    
wildcard character (\*)  
    [queries](#Bookmark19_idd1e2589)(See 9.4)  [2nd](#Bookmark19_idd1e2663)(See 9.4)    
wildcards  
    [^ (caret) character](#Bookmark37_idd1e7521)(See 13.1)    
    [cautions](#Bookmark37_idd1e7720)(See 13.1)    
    [defined](#Bookmark37_idd1e6385)(See 13.1)    
    [LIKE operator and](#Bookmark37_idd1e6356)(See 13.1)  [2nd](#Bookmark37_idd1e6434)(See 13.1)  [3rd](#Bookmark37_idd1e6520)(See 13.1)    
    [natural joins](#Bookmark72_idd1e16279)(See 20.2)    
writing  
    [stored procedures](#Bookmark101_idd1e22824)(See 26.2)

## 35.25 index\_Y

|  |
| --- |
| [YEAR() function](#Bookmark47_idd1e10273)(See 15.2) |