

# Murach's MySQL (3<sup>rd</sup> Edition)

Introduction xiii

## **Section 1 An introduction to MySQL**

---

Chapter 1	An introduction to relational databases	3
Chapter 2	How to use MySQL Workbench and other development tools	41
Chapter 3	How to retrieve data from a single table	73
Chapter 4	How to retrieve data from two or more tables	113
Chapter 5	How to insert, update, and delete data	149

## **Section 2 More SQL skills as you need them**

---

Chapter 6	How to code summary queries	169
Chapter 7	How to code subqueries	199
Chapter 8	How to work with data types	231
Chapter 9	How to use functions	257

## **Section 3 Database design and implementation**

---

Chapter 10	How to design a database	305
Chapter 11	How to create databases, tables, and indexes	341
Chapter 12	How to create views	381

## **Section 4 Stored program development**

---

Chapter 13	Language skills for writing stored programs	401
Chapter 14	How to use transactions and locking	429
Chapter 15	How to create stored procedures and functions	445
Chapter 16	How to create triggers and events	477

## **Section 5 Database administration**

---

Chapter 17	An introduction to database administration	493
Chapter 18	How to secure a database	523
Chapter 19	How to backup and restore a database	563

## **Appendixes**

---

Appendix A	How to install the software for this book on Windows	593
Appendix B	How to install the software for this book on macOS	601

# Expanded contents

## Section 1 An introduction to MySQL

---

### Chapter 1 An introduction to relational databases

<b>An introduction to client/server systems.....</b>	<b>4</b>
The hardware components of a client/server system.....	4
The software components of a client/server system.....	6
Other client/server architectures .....	8
<b>An introduction to the relational database model.....</b>	<b>10</b>
How a table is organized.....	10
How tables are related.....	12
How columns are defined .....	14
How to read a database diagram.....	16
<b>An introduction to SQL and SQL-based systems .....</b>	<b>18</b>
A brief history of SQL .....	18
A comparison of Oracle, DB2, Microsoft SQL Server, and MySQL.....	20
<b>The SQL statements .....</b>	<b>22</b>
An introduction to the SQL statements .....	22
How to work with database objects .....	24
How to query a single table.....	26
How to join data from two or more tables .....	28
How to add, update, and delete data in a table .....	30
SQL coding guidelines .....	32
<b>How to use SQL from an application program .....</b>	<b>34</b>
Common options for accessing MySQL data.....	34
PHP code that retrieves data from MySQL.....	36
Java code that retrieves data from MySQL.....	38

### Chapter 2 How to use MySQL Workbench and other development tools

<b>An introduction to MySQL Workbench.....</b>	<b>42</b>
The Home page of MySQL Workbench .....	42
How to open a database connection.....	44
How to start and stop the database server .....	46
How to navigate through the database objects .....	48
How to view and edit the data for a table .....	50
How to view and edit the column definitions for a table.....	52
<b>How to use MySQL Workbench to run SQL statements.....</b>	<b>54</b>
How to enter and execute a SQL statement .....	54
How to use snippets .....	56
How to handle syntax errors.....	58
How to open and save SQL scripts .....	60
How to enter and execute SQL scripts.....	62
<b>How to use the MySQL Reference Manual.....</b>	<b>64</b>
How to view the manual .....	64
How to look up information.....	64
<b>How to use the MySQL Command Line Client.....</b>	<b>66</b>
How to start and stop the MySQL Command Line Client.....	66
How to use the MySQL Command Line Client to work with a database .....	68

### **Chapter 3 How to retrieve data from a single table**

<b>An introduction to the SELECT statement.....</b>	<b>74</b>
The basic syntax of the SELECT statement .....	74
SELECT statement examples .....	76
<b>How to code the SELECT clause.....</b>	<b>78</b>
How to code column specifications .....	78
How to name the columns in a result set using aliases .....	80
How to code arithmetic expressions .....	82
How to use the CONCAT function to join strings.....	84
How to use functions with strings, dates, and numbers .....	86
How to test expressions by coding statements without FROM clauses .....	88
How to eliminate duplicate rows .....	90
<b>How to code the WHERE clause .....</b>	<b>92</b>
How to use the comparison operators.....	92
How to use the AND, OR, and NOT logical operators .....	94
How to use the IN operator.....	96
How to use the BETWEEN operator.....	98
How to use the LIKE and REGEXP operators .....	100
How to use the IS NULL clause.....	102
<b>How to code the ORDER BY clause .....</b>	<b>104</b>
How to sort by a column name .....	104
How to sort by an alias, expression, or column number.....	106
<b>How to code the LIMIT clause .....</b>	<b>108</b>
How to limit the number of rows.....	108
How to return a range of rows .....	108

### **Chapter 4 How to retrieve data from two or more tables**

<b>How to work with inner joins .....</b>	<b>114</b>
How to code an inner join.....	114
How to use table aliases.....	116
How to join to a table in another database.....	118
How to use compound join conditions.....	120
How to use a self-join.....	122
How to join more than two tables .....	124
How to use the implicit inner join syntax.....	126
<b>How to work with outer joins .....</b>	<b>128</b>
How to code an outer join.....	128
Outer join examples .....	130
<b>Other skills for working with joins .....</b>	<b>134</b>
How to join tables with the USING keyword.....	134
How to join tables with the NATURAL keyword.....	136
How to use cross joins .....	138
<b>How to work with unions.....</b>	<b>140</b>
How to code a union .....	140
A union that combines result sets from different tables.....	140
A union that combines result sets from the same tables .....	142
A union that simulates a full outer join .....	144

<b>Chapter 5</b>	<b>How to insert, update, and delete data</b>	
	<b>How to create test tables</b> .....	<b>150</b>
	How to create the tables for this book .....	150
	How to create a copy of a table .....	150
	<b>How to insert new rows</b> .....	<b>152</b>
	How to insert a single row .....	152
	How to insert multiple rows .....	152
	How to insert default values and null values .....	154
	How to use a subquery in an INSERT statement .....	156
	<b>How to update existing rows</b> .....	<b>158</b>
	How to update rows .....	158
	How to use a subquery in an UPDATE statement .....	160
	<b>How to delete existing rows</b> .....	<b>162</b>
	How to delete rows .....	162
	How to use a subquery in a DELETE statement .....	162

## **Section 2 More SQL skills as you need them**

---

<b>Chapter 6</b>	<b>How to code summary queries</b>	
	<b>How to work with aggregate functions</b> .....	<b>170</b>
	How to code aggregate functions .....	170
	Queries that use aggregate functions .....	172
	<b>How to group and summarize data</b> .....	<b>174</b>
	How to code the GROUP BY and HAVING clauses .....	174
	Queries that use the GROUP BY and HAVING clauses .....	176
	How the HAVING clause compares to the WHERE clause .....	178
	How to code compound search conditions .....	180
	How to use the WITH ROLLUP operator .....	182
	How to use the GROUPING function .....	184
	<b>How to code aggregate window functions</b> .....	<b>188</b>
	How the aggregate window functions work .....	188
	How to use frames .....	190
	How to use named windows .....	194
<b>Chapter 7</b>	<b>How to code subqueries</b>	
	<b>An introduction to subqueries</b> .....	<b>200</b>
	Where to code subqueries .....	200
	When to use subqueries .....	202
	<b>How to code subqueries in the WHERE clause</b> .....	<b>204</b>
	How to use the IN operator .....	204
	How to use the comparison operators .....	206
	<b>How to use the ALL keyword</b> .....	<b>208</b>
	How to use the ANY and SOME keywords .....	210
	How to code correlated subqueries .....	212
	How to use the EXISTS operator .....	214
	<b>How to code subqueries in other clauses</b> .....	<b>216</b>
	How to code subqueries in the HAVING clause .....	216
	How to code subqueries in the SELECT clause .....	216
	How to code subqueries in the FROM clause .....	218

	<b>How to work with complex queries</b> .....	<b>220</b>
	A complex query that uses subqueries.....	220
	A procedure for building complex queries .....	222
	<b>How to work with common table expressions</b> .....	<b>224</b>
	How to code a CTE.....	224
	How to code a recursive CTE .....	226
<b>Chapter 8</b>	<b>How to work with data types</b>	
	<b>The data types</b> .....	<b>232</b>
	Overview .....	232
	The character types.....	234
	The integer types.....	236
	The fixed-point and floating-point types .....	238
	The date and time types.....	240
	The ENUM and SET types.....	244
	The large object types.....	246
	<b>How to convert data</b> .....	<b>248</b>
	How implicit data conversion works.....	248
	How to convert data using the CAST and CONVERT functions .....	250
	How to convert data using the FORMAT and CHAR functions .....	252
<b>Chapter 9</b>	<b>How to use functions</b>	
	<b>How to work with string data</b> .....	<b>258</b>
	A summary of the string functions.....	258
	Examples that use string functions .....	260
	How to sort by a string column that contains numbers.....	262
	How to parse a string .....	264
	<b>How to work with numeric data</b> .....	<b>266</b>
	How to use the numeric functions .....	266
	How to search for floating-point numbers .....	268
	<b>How to work with date/time data</b> .....	<b>270</b>
	How to get the current date and time.....	270
	How to parse dates and times with date/time functions .....	272
	How to parse dates and times with the EXTRACT function.....	274
	How to format dates and times .....	276
	How to perform calculations on dates and times .....	278
	How to search for a date .....	280
	How to search for a time .....	282
	<b>Other functions you should know about</b> .....	<b>284</b>
	How to use the CASE function.....	284
	How to use the IF, IFNULL, and COALESCE functions.....	286
	How to use the regular expression functions.....	288
	How to use the ranking functions.....	292
	How to use the analytic functions.....	296
<hr/> <b>Section 3 Database design and implementation</b> <hr/>		
<b>Chapter 10</b>	<b>How to design a database</b>	
	<b>How to design a data structure</b> .....	<b>306</b>
	The basic steps for designing a data structure.....	306
	How to identify the data elements .....	308

How to subdivide the data elements .....	310
How to identify the tables and assign columns .....	312
How to identify the primary and foreign keys.....	314
How to enforce the relationships between tables .....	316
How normalization works.....	318
How to identify the columns to be indexed.....	320
<b>How to normalize a data structure .....</b>	<b>322</b>
The seven normal forms .....	322
How to apply the first normal form .....	324
How to apply the second normal form.....	326
How to apply the third normal form.....	328
When and how to denormalize a data structure.....	330
<b>How to use MySQL Workbench for database design .....</b>	<b>332</b>
How to open an existing EER model.....	332
How to create a new EER model .....	332
How to work with an EER model.....	334
How to work with an EER diagram.....	336
<b>Chapter 11 How to create databases, tables, and indexes</b>	
<b>How to work with databases.....</b>	<b>342</b>
How to create and drop a database .....	342
How to select a database .....	342
<b>How to work with tables .....</b>	<b>344</b>
How to create a table.....	344
How to code a primary key constraint.....	346
How to code a foreign key constraint .....	348
How to alter the columns of a table .....	350
How to alter the constraints of a table .....	352
How to rename, truncate, and drop a table.....	354
<b>How to work with indexes .....</b>	<b>356</b>
How to create an index .....	356
How to drop an index.....	356
<b>A script that creates a database.....</b>	<b>358</b>
<b>How to use MySQL Workbench.....</b>	<b>362</b>
How to work with the columns of a table .....	362
How to work with the indexes of a table.....	364
How to work with the foreign keys of a table .....	366
<b>How to work with character sets and collations.....</b>	<b>368</b>
An introduction to character sets and collations .....	368
How to view character sets and collations.....	370
How to specify a character set and a collation .....	372
<b>How to work with storage engines.....</b>	<b>374</b>
An introduction to storage engines .....	374
How to view storage engines .....	374
How to specify a storage engine.....	376

## **Chapter 12 How to create views**

<b>An introduction to views .....</b>	<b>382</b>
How views work .....	382
Benefits of using views .....	384
<b>How to work with views .....</b>	<b>386</b>
How to create a view .....	386
How to create an updatable view .....	390
How to use the WITH CHECK OPTION clause .....	392
How to insert or delete rows through a view .....	394
How to alter or drop a view .....	396

## **Section 4 Stored program development**

---

### **Chapter 13 Language skills for writing stored programs**

<b>An introduction to stored programs .....</b>	<b>402</b>
Four types of stored programs .....	402
A script that creates and calls a stored procedure .....	402
A summary of statements for coding stored programs .....	404
<b>How to write procedural code .....</b>	<b>406</b>
How to display data .....	406
How to declare and set variables .....	408
How to code IF statements .....	410
How to code CASE statements .....	412
How to code loops .....	414
How to use a cursor .....	416
How to declare a condition handler .....	418
How to use a condition handler .....	420
How to use multiple condition handlers .....	424

### **Chapter 14 How to use transactions and locking**

<b>How to work with transactions .....</b>	<b>430</b>
How to commit and rollback transactions .....	430
How to work with save points .....	432
<b>How to work with concurrency and locking .....</b>	<b>434</b>
How concurrency and locking are related .....	434
The four concurrency problems that locks can prevent .....	436
How to set the transaction isolation level .....	438
How to lock selected rows .....	440
How to prevent deadlocks .....	442

### **Chapter 15 How to create stored procedures and functions**

<b>How to code stored procedures .....</b>	<b>446</b>
How to create and call a stored procedure .....	446
How to code input and output parameters .....	448
How to set a default value for a parameter .....	450
How to validate parameters and raise errors .....	452
A stored procedure that inserts a row .....	454
How to work with user variables .....	458
How to work with dynamic SQL .....	460
How to drop a stored procedure .....	462
<b>How to code stored functions .....</b>	<b>464</b>
How to create and call a function .....	464

	How to use function characteristics.....	466
	A function that calculates balance due.....	468
	How to drop a function.....	470
	<b>How to use Workbench with procedures and functions .....</b>	<b>472</b>
	How to view and edit stored routines.....	472
	How to create stored routines.....	472
	How to drop stored routines.....	472
<b>Chapter 16</b>	<b>How to create triggers and events</b>	
	<b>How to work with triggers.....</b>	<b>478</b>
	How to create a BEFORE trigger.....	478
	How to use a trigger to enforce data consistency.....	480
	How to create an AFTER trigger.....	482
	How to view or drop triggers.....	484
	<b>How to work with events.....</b>	<b>486</b>
	How to turn the event scheduler on or off.....	486
	How to create an event.....	486
	How to view, alter, or drop events.....	488
<b>Section 5</b>	<b>Database administration</b>	
<b>Chapter 17</b>	<b>An introduction to database administration</b>	
	<b>Database administration concepts.....</b>	<b>494</b>
	Database administrator responsibilities.....	494
	Types of database files.....	496
	Types of log files.....	496
	<b>How to monitor the server.....</b>	<b>498</b>
	How to view the server status.....	498
	How to view and kill processes.....	500
	How to view the status variables.....	502
	How to view the system variables.....	504
	<b>How to configure the server.....</b>	<b>506</b>
	How to set system variables using MySQL Workbench.....	506
	How to set system variables using a text editor.....	508
	How to set system variables using the SET statement.....	510
	<b>How to work with logging.....</b>	<b>512</b>
	How to enable and disable logging.....	512
	How to configure logging.....	514
	How to view text-based logs.....	516
	How to manage logs.....	518
<b>Chapter 18</b>	<b>How to secure a database</b>	
	<b>An introduction to user accounts.....</b>	<b>524</b>
	An introduction to SQL statements for user accounts.....	524
	A summary of privileges.....	526
	The four privilege levels.....	530
	The grant tables in the mysql database.....	530
	<b>How to work with users and privileges.....</b>	<b>532</b>
	How to create, rename, and drop users.....	532
	How to specify user account names.....	534
	How to grant privileges.....	536



How to view privileges .....	538
How to revoke privileges .....	540
How to change passwords .....	542
A script that creates users .....	544
<b>How to work with roles .....</b>	<b>546</b>
How to create, manage, and drop roles.....	546
A script that creates users and roles .....	550
<b>How to use MySQL Workbench.....</b>	<b>552</b>
How to work with users and privileges.....	552
How to connect as a user for testing .....	556

## **Chapter 19 How to backup and restore a database**

<b>Strategies for backing up and restoring a database.....</b>	<b>564</b>
A backup strategy .....	564
A restore strategy .....	564
<b>How to back up a database.....</b>	<b>566</b>
How to use mysqldump to back up a database .....	566
A SQL script file for a database backup .....	568
How to set advanced options for a database backup .....	572
<b>How to restore a database .....</b>	<b>574</b>
How to use a SQL script file to restore a full backup.....	574
How to execute statements in the binary log .....	576
<b>How to import and export data.....</b>	<b>578</b>
How to export data to a file.....	578
How to import data from a file .....	580
<b>How to check and repair tables.....</b>	<b>582</b>
How to use the CHECK TABLE statement.....	582
How to repair a MyISAM table .....	584
How to repair an InnoDB table.....	584
How to use the mysqlcheck program.....	586
How to use the myisamchk program .....	588

## **Appendix A How to install the software for this book on Windows**

<b>How to install the software from mysql.com .....</b>	<b>594</b>
How to install the MySQL Community Server .....	594
How to install MySQL Workbench .....	594
<b>How to install the software from murach.com.....</b>	<b>596</b>
How to install the source files for this book .....	596
How to create the databases for this book .....	598
How to restore the databases .....	598

## **Appendix B How to install the software for this book on macOS**

<b>How to install the software from mysql.com .....</b>	<b>602</b>
How to install the MySQL Community Server .....	602
How to install MySQL Workbench .....	604
<b>How to install the software from murach.com.....</b>	<b>606</b>
How to install the source files for this book .....	606
How to create the databases for this book .....	608
How to restore the databases .....	608