



A Guide to

# SQL

10TH EDITION

SHELLMAN ▶ AFYOUNI ▶ PRATT ▶ LAST

# A GUIDE TO SQL

**Tenth Edition**

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Library of Congress Control Number: 2020911488

ISBN: 978-0-357-36168-9

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Printed in the United States of America

Print Number: 01

Print Year: 2020

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# PREFACE

Structured Query Language (or SQL, which is pronounced “se-quel,” or “ess-cue-ell”) is a popular computer language that is used by diverse groups such as home computer users, small businesses owners, end users in large organizations, and programmers. Although this text uses the MySQL Community Server 8.0.18 implementation as a vehicle for teaching SQL, its module material, examples, and exercises can be completed using any SQL implementation.

*A Guide to SQL, Tenth Edition* is written for a wide range of teaching levels, from students taking introductory computer science classes to those students in advanced information systems classes. This text can be used for a stand-alone course on SQL or in conjunction with a database concepts text where students are required to learn SQL.

The modules in this text should be covered in order. Students should complete the end-of-module exercises and the examples within the modules for maximum learning. Because the content of Module 8 assumes that the reader has had instruction or experience in at least one programming language, the instructor should determine whether students will understand its concepts. Students without a programming background might have difficulty understanding the topic of embedded SQL. Instructors can easily omit Module 8 from the text in situations where students are not comfortable with programming examples.

The Tenth Edition builds on the success of previous editions by presenting basic SQL commands in the context of a business that uses SQL to manage orders, items, customers, and sales reps. Like in previous editions, this edition uses MySQL 8.0, Oracle 19c, and MS SQL Server 2019 as the vehicle to present SQL commands. This edition also shows Oracle and SQL Server commands when they differ from the MySQL version. Differences for Oracle and SQL Server users are featured in “User” notes, which make it easy for students to identify differences for the SQL implementation they are using. Students can download the Oracle 19c Enterprise/Standard Edition or the Oracle 19c Express Edition from the Oracle Web site for free and use it to complete this text without having to purchase or install the full Oracle program.

The Tenth Edition includes an entire module on database design, showing students how to create an appropriate design that satisfies a given set of requirements, and includes coverage of the important topics of stored procedures and triggers. The text also contains updated case problems that feature pet supplier and student accommodation companies.

## **DISTINGUISHING FEATURES**

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### **Use of Examples**

Starting in Module 3, each module contains multiple examples that use SQL to solve a problem. Following each example, students will read about the commands that are used to solve the stated problem, and then they will see the SQL commands used to arrive at the solution. For most students, learning through examples is the most effective way to master material. For this reason, instructors should encourage students to read the modules at the computer and input the commands shown in the figures.

### **Case Studies**

A running case study—KimTay Pet Supplies—is presented in all the examples within the modules and in the first set of exercises at the end of each module. Although the database is small in order to be manageable, the examples and exercises for the KimTay Pet Supplies database simulate what a real business can accomplish using SQL commands. Using the same case study as examples within the module and in the end-of-module exercises ensures a high level of continuity to reinforce learning.

A second case study—the StayWell Student Accommodation database—is used in a second set of exercises at the end of each module. This case study gives students a chance to venture out “on their own” without the direct guidance of examples from the text.

### **Question and Answer Sections**

A special type of exercise, called a Q&A, is used throughout the text. These exercises drive students to consider special issues and understand important questions before continuing with their study. The answer to each Q&A appears after the question. Students are encouraged to formulate their own answers before reading the ones provided in the text to ensure that they understand new material before proceeding.

### **User Notes for Oracle and SQL Server Users**

When an SQL command has a different use or format in Oracle or SQL Server, it appears in a User note. When you encounter a User note for the SQL implementation you are using, be sure to read its contents. You might also review the User notes for other SQL implementations so you are aware of the differences that occur from one implementation of SQL to another.

### **Helpful Hints**

Helpful Hint boxes call out fundamental information and provide useful tips for the successful implementation of SQL. Students should pay careful attention to the advice within Helpful Hint boxes and are encouraged to review the hints as they are practicing SQL skills.

## Review Material

A Summary and Key Terms list appear at the end of each module, followed by Review Questions that test students' recall of the important points in the module and occasionally test their ability to apply what they have learned. Critical Thinking questions that reinforce problem-solving and analytical skills are included for review questions and hands-on exercises. Each module also contains exercises related to the KimTay Pet Supplies and StayWell Student Accommodation databases.

## Appendices

Three appendices appear at the end of this text. Appendix A is an SQL reference that describes the purpose and syntax for the major SQL commands featured in the text. Students can use Appendix A to identify how and when to use important commands quickly. The SQL reference appendix contains references to specific pages in the text where the command is discussed to make it easy for students to find additional information when they need to refer back to the section in the text where the topic is covered.

Appendix B includes a “How Do I” reference, which lets students cross-reference the appropriate section in Appendix A by searching for the answer to a question. Appendix C is the 10 Commandments of Writing Queries. This appendix presents summarized steps and rules for composing an SQL statement.

## Instructor Support

The Tenth Edition includes a package of proven supplements for instructors and students. The Instructor's Resources offer a detailed electronic Instructor's Manual, figure files, Microsoft® PowerPoint® presentations, and the Cognero Test Bank. The Instructor's Manual includes suggestions and strategies for using this text as well as answers to Review Questions and solutions to the end-of-module exercises. Figure files allow instructors to create their own presentations using figures appearing in the text. Instructors can also take advantage of lecture presentations provided on PowerPoint slides; these presentations follow each module's coverage precisely, include module figures, and can be customized.

The Instructor's Resources include the KimTay Pet Supplies and StayWell Student Accommodation cases script files to create the tables and data in these databases in MySQL, Oracle, and SQL Server. These files are provided so instructors have the choice of assigning exercises in which students create the databases used in this text and load them with data, or they can provide the MySQL, Oracle, or SQL Server script files to students to automate and simplify these tasks.

## ORGANIZATION OF THE TEXT

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The text contains eight modules and three appendices, which are described in the following sections.

**Module 1: Introduction to KimTay Pet Supplies and StayWell Student Accommodation Database**

Module 1 introduces the two database cases that are used throughout the text: KimTay Pet Supplies and StayWell Student Accommodation. Many Q&A exercises are provided throughout the module to ensure that students understand how to manipulate the database on paper before they begin working in SQL.

**Module 2: Database Design Fundamentals**

Module 2 covers important concepts and terminology associated with relational databases, functional dependence, and primary keys, followed by a method for designing a database to satisfy a given set of requirements. It also illustrates the normalization process for finding and correcting a variety of potential problems in database designs. Finally, it shows how to represent database designs graphically using entity-relationship diagrams.

**Module 3: Creating Tables**

In Module 3, students begin using a DBMS by creating and running SQL commands to create tables, use data types, and add rows to tables. Module 3 also discusses the role of and use of nulls.

**Module 4: Single-Table Queries**

Module 4 is the first of two modules on using SQL commands to query a database. The queries in Module 4 all involve single tables. Included in this module are discussions of simple and compound conditions; computed columns; the SQL BETWEEN, LIKE, and IN operators; using SQL aggregate functions; nesting queries; grouping data; and retrieving columns with null values.

**Module 5: Multiple-Table Queries**

Module 5 completes the discussion of querying a database by demonstrating queries that join more than one table. Included in this module are discussions of the SQL IN and EXISTS operators, nested subqueries, using aliases, joining a table to itself, SQL set operations, and the use of the ALL and ANY operators. The module also includes coverage of various types of joins.

**Module 6: Updating Data**

In Module 6, students learn how to use the SQL COMMIT, ROLLBACK, UPDATE, INSERT, and DELETE commands to update table data. Students also learn how to create a new table from an existing table and how to change the structure of a table. The module also includes coverage of transactions, including both their purpose and implementation.

## **Module 7: Database Administration**

Module 7 covers the database administration features of SQL, including the use of views; granting and revoking database privileges to users; creating, dropping, and using an index; using and obtaining information from the system catalog; and using integrity constraints to control data entry.

## **Module 8: SQL Functions, Procedures, and Triggers**

Module 8 begins with a discussion of some important SQL functions that act on single rows. Students also learn how to use PL/SQL and T-SQL to cover the process of embedding SQL commands in another language. Included in this module are discussions of using embedded SQL to insert new rows and change and delete existing rows. Also included is a discussion of how to retrieve single rows using embedded SQL commands and how to use cursors to retrieve multiple rows. The module concludes with a discussion of triggers.

## **Appendix A: SQL Reference**

Appendix A includes a command reference for all the major SQL clauses and operators that are featured in the modules. Students can use Appendix A as a quick reference when constructing commands. Each command includes a short description, a table that shows the required and optional clauses and operators, and an example and its results. It also contains a reference to the pages in the text where the command is covered.

## **Appendix B: How Do I Reference**

Appendix B provides students with an opportunity to ask a question, such as “How do I delete rows?” and to identify the appropriate section in Appendix A to use to find the answer. Appendix B is extremely valuable when students know what task they want to accomplish but cannot remember the exact SQL command they need.

## **Appendix C: The 10 Commandments of Writing Queries**

Appendix C provides students with a one-page guide (cheat sheet) on the Dos and Don'ts of writing query statements. The 10 commandments in Appendix C covers all the SQL rules presented in this text.

# **GENERAL NOTES TO THE STUDENT**

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For details on running script files in Oracle or SQL Server, check with your instructor. You can also refer to Module 3 in the text for information about creating and using scripts.

For information about downloading MySQL and Oracle 19c software, please visit the Oracle Web site. For information about SQL Server Express, please visit the Microsoft Web site.

### **Embedded Questions**

In many places, you'll find Q&A sections to ensure that you understand some crucial material before you proceed. In some cases, the questions are designed to give you the chance to consider some special concept in advance of its actual presentation. In all cases, the answer to each question appears immediately after the question. You can simply read the question and its answer, but you will benefit from taking time to determine the answer to the question before checking your answer against the one given in the text.

### **End-of-Module Material**

The end-of-module material consists of a Summary, a Key Terms list, Review Questions, Critical Thinking questions, and exercises for the KimTay Pet Supplies and StayWell Student Accommodation databases. The Summary briefly describes the material covered in the module. The Review Questions require you to recall and apply the important material in the module. The KimTay Pet Supplies and StayWell Student Accommodation exercises test your knowledge of the module material; your instructor will assign one or more of these exercises for you to complete. Critical-thinking questions that reinforce problem-solving and analytical skills are included for review questions and hands-on exercises.



# ABOUT THE AUTHORS

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Dr. Mark Shellman is an instructor and the Chair of the Information Technology Department at Gaston College in Dallas, North Carolina. Dr. Mark, as his students refer to him, prides himself on being student-centered and loves learning himself. His favorite subjects in the information technology realm include databases and programming languages. Dr. Mark has been teaching information technology for more than thirty years and has co-authored several texts in the New Perspectives Series on Microsoft® Access databases.

## **Hassan Afyouni**, e-conn (Chief Information Officer)

Dr. Hassan Afyouni has been working in the information technology field for more than thirty years. He is a database expert, Oracle® specialist, an enterprise architect, technical advisor, and educator. He has been an instructor for several colleges and universities in Canada, the United States, and Lebanon. He is a respected author of several leading books in the database field.

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Philip J. Pratt is Professor Emeritus of Mathematics and Computer Science at Grand Valley State University, where he taught for 33 years. His teaching interests include database management, systems analysis, complex analysis, and discrete mathematics. He has authored more than 75 textbooks and has co-authored three levels of Microsoft® Office Access books for the popular Shelly Cashman Series, in addition to the popular A GUIDE TO SQL.

## **Mary Z. Last**

Mary Z. Last has taught computer information systems since 1984. She retired from the University of Mary Hardin-Baylor, Belton, Texas, where she was an associate professor and the Director of the Center for Effectiveness in Learning and Teaching. Ms. Last is actively involved in the Computing Educator's Oral History Project that encourages young women to pursue careers in math and science. She has been a contributing author to the Shelly Cashman Series since 1992. She also authors many instructor resources for leading database texts.

## **ACKNOWLEDGMENTS**

---

### **From Mark Shellman:**

I would first like to dedicate this text to the memory of parents, Mickey and Shelba Shellman, that passed away during the writing of this text. No child has ever been more loved and supported in their life than I. I would also like to thank my wife Donna Sue, and

children, Taylor and Kimberly, for their support and patience during this project. Last, but certainly not least, I would like to thank the entire development team of Amy Savino, Michele Stulga, and Joy Dark, along with my co-author Hassan Afyouni. Thank you all from the bottom of my heart for all of your support and caring during this project. It means more than you will ever know. You are truly the best!

**From Hassan Afyouni:**

I dedicate this text to my beautiful and patient wife, Rouba, for her everlasting love and support. I devote every letter of this text to my precious children, Aya, Wissam, Sammy, and Luna.

Special thanks to my co-author Mark Shellman and Cengage development team Amy Savino, Michele Stulga, Joy Dark, and to the whole production team. Also, thanks to Jennifer Bowes for giving me the opportunity to work on this project.

# MODULE 1

# INTRODUCTION TO KIMTAY PET SUPPLIES AND STAYWELL STUDENT ACCOMMODATION DATABASES

## OBJECTIVES

- Introduce KimTay Pet Supplies, a company whose database is used to manage a pet supplies business. The KimTay database is used as the basis for many of the examples throughout the text.
- Introduce StayWell, a Seattle-based company whose database is used to manage accommodation for university students on behalf of property owners. The StayWell database is used as an additional case that runs throughout the text.

## INTRODUCTION

---

In this module, you examine the database requirements of KimTay Pet Supplies—a company that is used in the examples throughout the text. Then, you examine the database requirements for StayWell, whose database is featured in the exercises that appear at the end of each module.

## WHAT IS A DATABASE?

---

Throughout this text, you will work with databases for two organizations: KimTay Pet Supplies and StayWell. A **database** is a structure that contains different categories of information and the relationships between these categories. For example, the KimTay Pet Supplies database contains information about categories such as sales representatives (sales reps), customers, invoices, and items. The StayWell database contains information about the offices that manage the accommodation, the owners of the accommodation, the residents, and the services (such as cleaning and maintenance) offered for the properties.

Each database also contains relationships between categories. For example, the KimTay Pet Supplies database contains information that relates sales reps to the customers they represent and customers to the invoices they have placed. The StayWell database contains information that relates the two main company offices to the properties that they manage, the owners, the different services to the service request, and to the resident renting a property.

As you work through the modules in this text, you will learn more about these databases and how to view and update the information they contain. As you read each module, you will see examples from the KimTay Pet Supplies database. At the end of each module, your instructor might assign the exercises for the KimTay Pet Supplies or StayWell databases.

## THE KIMTAY PET SUPPLIES DATABASE

---

The management of KimTay Pet Supplies (a supplier of pet supplies, food, and accessories located in Cody, Wyoming) has determined that the company's recent growth no longer makes it feasible to maintain customer, invoice, and inventory data using its manual systems. In addition, KimTay Pet Supplies wants to build an Internet presence. With the data stored in a database, management will be able to ensure that the data is up-to-date and more accurate than in the current manual systems. In addition, managers will be able to obtain answers to their questions concerning the data in the database easily and quickly, with the option of producing a variety of useful reports.

Management has determined that KimTay Pet Supplies must maintain the following information about its sales reps, customers, and inventory in the new database:

- The sales rep ID, first name, last name, full address, cell phone number, total commission, and commission rate for each sales rep
- The customer ID, first name, last name, full address, e-mail address, current balance, and credit limit for each customer, as well as the ID of the sales rep who represents the customer
- The item ID, description, number of units on hand, category, storage location, and unit price for each item in inventory

KimTay Pet Supplies also must store information about invoices. Figure 1-1 shows a sample invoice.

The sample invoice shown in Figure 1-1 has three sections:

- The heading (top) of the invoice contains the company name and contact information; the invoice number and date; the customer's ID, name, and full address; and the sales rep's ID and full name.
- The body of the invoice contains one or more invoice lines, sometimes called line items. Each invoice line contains an item ID, an item description, the number of units of the item ordered, and the quoted price for the item. Each invoice line also contains a total, usually called an extension, which is the result of multiplying the number ordered by the quoted price.
- Finally, the footing (bottom) of the invoice contains the invoice total.

ITEM ID	DESCRIPTION	QUANTITY ORDERED	PRICE	TOTAL
AD72	Dog Feeding Station	2	79.99	159.98
DT12	Dog Toy Gift Set	4	39.99	159.96
<b>TOTAL</b>				<b>319.94</b>

**KimTay Pet Supplies**  
 1212 Main Street  
 Cody, WY 82414  
 Phone: (307) 824-2762  
 Fax: (307) 824-2763

**INVOICE**  
 Invoice# 14219  
 Date: November 15, 2021

**TO:**  
 CUSTOMER: 227  
 Sandra Pincher  
 53 Verde Ln  
 Powell, WY 82440

SALES REP: 15  
 Donna Smith

Make all checks payable to KimTay Pet Supplies  
 Total due in 15 days. Overdue accounts subject to a service charge of 1.5% per month.

**Thank you for your business!**

**FIGURE 1-1** Sample invoice

KimTay Pet Supplies also must store the following items in the database for each customer's invoice:

- The invoice number, the date the invoice was placed, and the ID of the customer that placed the invoice. The customer's name, full address, and the ID of the sales rep who represents the customer are stored with the customer information. The name of the sales rep is stored with the sales rep information.
- The invoice number, the item ID, the quantity ordered, and the quoted price for each invoice line. The item description is stored with the information about items. The result of multiplying the number of units ordered by the quoted price is not stored because the database can calculate it when needed.

The overall invoice total is not stored. Instead, the database calculates the total whenever an invoice is printed or displayed on the screen.

Figure 1-2 shows sample data for KimTay Pet Supplies.

## CUSTOMER

CUST_ID	FIRST_NAME	LAST_NAME	ADDRESS	CITY	STATE	POSTAL	EMAIL	BALANCE	CREDIT_LIMIT	REP_ID
126	Joey	Smith	17 Fourth St	Cody	WY	82414	jsmith17@example.com	\$80.68	\$500.00	05
182	Billy	Rufton	21 Simple Cir	Garland	WY	82435	billyruff@example.com	\$43.13	\$750.00	10
227	Sandra	Pincher	53 Verde Ln	Powell	WY	82440	spinch2@example.com	\$156.38	\$500.00	15
294	Samantha	Smith	14 Rock Ln	Ralston	WY	82440	ssmith5@example.com	\$58.60	\$500.00	10
314	Tom	Rascal	1 Rascal Farm Rd	Cody	WY	82414	trascal3@example.com	\$17.25	\$250.00	15
375	Melanie	Jackson	42 Blackwater Way	Elk Butte	WY	82433	mjackson5@example.com	\$252.25	\$250.00	05
435	James	Gonzalez	16 Rockway Rd	Wapiti	WY	82450	jgonzo@example.com	\$230.40	\$1,000.00	15
492	Elmer	Jackson	22 Jackson Farm Rd	Garland	WY	82435	ejackson4@example.com	\$45.20	\$500.00	10
543	Angie	Hendricks	27 Locklear Ln	Powell	WY	82440	ahendricks7@example.com	\$315.00	\$750.00	05
616	Sally	Cruz	199 18th Ave	Ralston	WY	82440	scruz5@example.com	\$8.33	\$500.00	15
721	Leslie	Smith	123 Sheepland Rd	Elk Butte	WY	82433	lsmith12@example.com	\$166.65	\$1,000.00	10
795	Randy	Blacksmith	75 Stream Rd	Cody	WY	82414	rblacksmith6@example.com	\$61.50	\$500.00	05

## SALES\_REP

REP_ID	FIRST_NAME	LAST_NAME	ADDRESS	CITY	STATE	POSTAL	CELL_PHONE	COMMISSION	RATE
05	Susan	Garcia	42 Mountain Ln	Cody	WY	82414	307-824-1245	\$12,743.16	0.04
10	Richard	Miller	87 Pikes Dr	Ralston	WY	82440	307-406-4321	\$20,872.11	0.06
15	Donna	Smith	312 Oak Rd	Powell	WY	82440	307-982-8401	\$14,912.92	0.04
20	Daniel	Jackson	19 Lookout Dr	Elk Butte	WY	82433	307-883-9481	\$0.00	0.04

## ITEM

ITEM_ID	DESCRIPTION	ON_HAND	CATEGORY	LOCATION	PRICE
AD72	Dog Feeding Station	12	DOG	B	\$79.99
BC33	Feathers Bird Cage (12x24x18)	10	BRD	B	\$79.99
CA75	Enclosed Cat Litter Station	15	CAT	C	\$39.99
DT12	Dog Toy Gift Set	27	DOG	B	\$39.99
FM23	Fly Mask with Ears	41	HOR	C	\$24.95
FS39	Folding Saddle Stand	12	HOR	C	\$39.99
FS42	Aquarium (55 Gallon)	5	FSH	A	\$124.99
KH81	Wild Bird Food (25 lb)	24	BRD	C	\$19.99
LD14	Locking Small Dog Door	14	DOG	A	\$49.99
LP73	Large Pet Carrier	23	DOG	B	\$59.99
PF19	Pump & Filter Kit	5	FSH	A	\$74.99
QB92	Quilted Stable Blanket	32	HOR	C	\$119.99
SP91	Small Pet Carrier	18	CAT	B	\$39.99
UF39	Underground Fence System	7	DOG	A	\$199.99
WB49	Insulated Water Bucket	34	HOR	C	\$79.99

FIGURE 1-2 Sample data for KimTay Pet Supplies

INVOICES

INVOICE_NUM	INVOICE_DATE	CUST_ID
14216	11/15/2021	125
14219	11/15/2021	227
14222	11/16/2021	294
14224	11/16/2021	182
14228	11/18/2021	435
14231	11/18/2021	125
14233	11/18/2021	435
14237	11/19/2021	616

INVOICE\_LINE

INVOICE_NUM	ITEM_ID	QUANTITY	QUOTED_PRICE
14216	CA75	3	\$37.99
14219	AD72	2	\$79.99
14219	DT12	4	\$39.99
14222	LD14	1	\$47.99
14224	KH81	4	\$18.99
14228	FS42	1	\$124.99
14228	PF19	1	\$74.99
14231	UF39	2	\$189.99
14233	KH81	1	\$19.99
14233	QB92	4	\$109.95
14233	WB49	4	\$74.95
14237	LP73	3	\$54.95

**FIGURE 1-2** Sample data for KimTay Pet Supplies (Continued)

In the SALES\_REP table, you see that there are four reps, whose ID values are 05, 10, 15, and 20. The name of sales rep 05 is Susan Garcia. Her street address is 42 Mountain Ln. She lives in Cody, WY, and her postal code is 82414. Her cell phone number is 307-824-1245. Her total commission is \$12,743.16, and her commission rate is 0.04 (four percent).

In the CUSTOMER table, 12 KimTay Pet Supplies customers are identified with the ID values of 126, 182, 227, 294, 314, 375, 435, 492, 543, 616, 721, and 795. The name of customer number 126 is Joey Smith. This customer's address is 17 Fourth St in Cody, WY, with a postal code of 82414. The e-mail address of the customer is jsmith17@example.com. The customer's current balance is \$80.68, and their credit limit is \$500.00. The value 05 in the REP\_ID column indicates that Joey Smith is represented by sales rep 05 (Susan Garcia).

In the table named ITEM, you see that there are 15 items, whose item ID values are AD72, BC33, CA75, DT12, FM23, FS39, FS42, KH81, LD14, LP73, PF19, QB92, SP91, UF39, and WB49. Item AD72 is a Dog Feeding Station, and KimTay Pet Supplies has 12 units of this item on hand. The Dog Feeding Station item is in the DOG category, and it is located in area B. The price of the Dog Feeding Station is \$79.99. Other categories are BRD (bird), CAT, FSH (fish), and HOR (horse).

In the table named INVOICES, you see that there are eight invoices which are identified with the numbers 14216, 14219, 14222, 14224, 14228, 14231, 14233, and 14237. Invoice number 14216 was placed on November 15, 2021, by customer 125 (Joey Smith).

The table named INVOICE\_LINE might seem strange at first glance. Why do you need a separate table for the invoice lines? Could they be included in the INVOICES table? The answer is technically yes. You could structure the table named INVOICES as shown in Figure 1-3. Notice that this table contains the same invoices as shown in Figure 1-2, with the same dates and customer ID numbers. In addition, each table row in Figure 1-3 contains all the invoice lines for a given invoice. Examining the second row, for example, you see that invoice 14219 has two invoice lines. One of the invoice lines is for 2 units of item AD72 at \$79.99 each, and the other invoice line is for 4 units of item DT12 at \$39.99 each.

## Q & A

**Question:** How is the information from Figure 1-2 represented in Figure 1-3?

**Answer:** Examine the INVOICE\_LINE table shown in Figure 1-2 and note the second and third rows. The second row indicates that there is an invoice line on invoice 14219 for 2 units of item AD72 at \$79.99 each. The third row indicates that there is an invoice line on invoice 14219 for 4 units of item DT12 at \$39.99 each. Thus, the information that you find in Figure 1-3 is represented in Figure 1-2 in two separate rows rather than in one row.

It might seem inefficient to use two rows to store information that could be represented in one row. There is a problem, however, with the arrangement shown in Figure 1-3—the table is more complicated. In Figure 1-2, there is a single entry at each

### INVOICES

INVOICE_NUM	INVOICE_DATE	CUST_ID	ITEM_ID	QUANTITY	QUOTED_PRICE
14216	11/15/2021	125	CA75	3	\$37.99
14219	11/15/2021	227	AD72	2	\$79.99
			DT12	4	\$39.99
14222	11/16/2021	294	LD14	1	\$47.99
14224	11/16/2021	182	KH81	4	\$18.99
14228	11/18/2021	435	FS42	1	\$124.99
			PF19	1	\$74.99
14231	11/18/2021	125	UF39	2	\$189.99
14233	11/18/2021	435	KH81	1	\$19.99
			QB92	4	\$109.95
			WB49	4	\$74.95
14237	11/19/2021	616	LP73	3	\$54.95

**FIGURE 1-3** Alternative INVOICES table structure

location in the table. In Figure 1-3, some of the individual positions within the table contain multiple entries, making it difficult to track the information between columns. In the row for invoice number 14219, for example, it is crucial to know that the AD72 corresponds to the 2 in the QUANTITY column (not to the 4) and that it corresponds to the \$79.99 in the QUOTED\_PRICE column (not to the \$39.99). In addition, a more complex table raises practical issues, such as the following:

- How much room do you allow for these multiple entries?
- What happens when an invoice has more invoice lines than you have allowed room for?
- For a given item, how do you determine which invoices contain invoice lines for that item?

Although none of these problems is unsolvable, they do add a level of complexity that is not present in the arrangement shown in Figure 1-2. In Figure 1-2, there are no multiple entries to worry about, it does not matter how many invoice lines exist for any invoice, and finding every invoice that contains an invoice line for a given item is easy (just look



for all invoice lines with the given item number in the ITEM\_ID column). In general, this simpler structure is preferable, and that is why invoice lines appear in a separate table.

To test your understanding of the KimTay Pet Supplies data, use Figure 1-2 to answer the following questions.

### Q & A

**Question:** What are the customer ID values of the customers represented by Susan Garcia?

**Answer:** 125, 375, 543, and 795. (Look up the REP\_ID value of Susan Garcia in the SALES\_REP table and obtain the value 05. Then find all customers in the CUSTOMER table that have the value 05 in the REP\_ID field.)

### Q & A

**Question:** What is the name of the customer that placed invoice 14222, and what is the name of the sales rep who represents the customer?

**Answer:** Samantha Smith is the customer, and Richard Miller is the sales rep. (Look up the CUST\_ID value in the INVOICES table for invoice 14222 and obtain the ID value 294. Then find the customer in the CUSTOMER table with the CUST\_ID value of 294. Using the REP\_ID value, which is 10, find the name of the sales rep in the SALES\_REP table.)

### Q & A

**Question:** List all items that appear in invoice 14228. For each item, give the description, quantity ordered, and quoted price.

**Answer:** Item ID: FS42; description: Aquarium (55 Gallon); quantity ordered: 1; and quoted price: \$124.99. Also, item ID: PF19; description: Pump & Filter Kit; quantity ordered: 1; and quoted price: \$74.99. (Look up each INVOICE\_LINE table row on which the invoice number is 14228. Each of these rows contains an item ID, quantity ordered, and quoted price. Use the item ID to look up the corresponding item description in the ITEM table.)

### Q & A

**Question:** Why is the QUOTED\_PRICE column in the INVOICE\_LINE table? Can't you just use the item ID and look up the price in the ITEM table?

**Answer:** If the QUOTED\_PRICE column did not appear in the INVOICE\_LINE table, you would need to obtain the price for an item on an invoice line by looking up the price in the ITEM table. Although this approach is reasonable, it prevents KimTay Pet Supplies from charging different prices to different customers for the same item. Because KimTay Pet Supplies wants the flexibility to quote and charge different prices to different customers, the QUOTED\_PRICE column is included in the INVOICE\_LINE table. If you examine the INVOICE\_LINE table, you will see cases in which the quoted price matches the actual price in the ITEM table, and cases in which it differs. For example, in invoice number 14216, Joey Smith bought three Enclosed Cat Litter Stations, and KimTay Pet Supplies charged only \$37.99 each, not the regular price of \$39.99.

## STAYWELL STUDENT ACCOMMODATION DATABASE

StayWell finds and manages accommodation for owners of student accommodation in the Seattle area. The company rents out and helps to maintain 1–5-bedroom properties located in two main areas in the city, Columbia City and Georgetown. This is done on behalf of property owners based both in the local area and throughout the United States. Each location is administrated by a different office, StayWell-Columbia City and StayWell-Georgetown.

StayWell wishes to expand its business. The current model relies on advertisements in student and university publications in print and online, but prospective owners and renters need to contact the offices and speak to an administrator on all matters relating to renting of properties. The office organizes maintenance services for a fee, which is also currently done via email or direct communication.

StayWell has decided that the best way to increase efficiency and move toward an e-commerce-based business model is to store all the data about the properties, owners, tenants and services in databases. This will mean that the information can be easily accessed. StayWell hopes that these databases can then be used in future projects such as mobile apps and online booking systems.

The data is split into several tables as described below.

The OFFICE table shown in Figure 1-4 shows the office number, office location, address, area, city, state, and ZIP code.

### OFFICE

OFFICE_NUM	OFFICE_NAME	ADDRESS	AREA	CITY	STATE	ZIP_CODE
1	StayWell-Columbia City	1135 N. Wells Avenue	Columbia City	Seattle	WA	98118
2	StayWell-Georgetown	986 S. Madison Rd	Georgetown	Seattle	WA	98108

**FIGURE 1-4** Sample data for StayWell offices

StayWell is split into two offices to better manage the properties. This management includes communicating with owners about the status and upkeep of their properties. They also facilitate the payment from the properties, meaning that the owners get regular income without having to collect rent in arrears. Offices also advertise properties and place students in appropriate properties, facilitating initial visits and taking deposits. Lastly the office administers the maintenance of the properties, communicating with residents, owners, and maintenance services. This is discussed later.

StayWell stores information about the owners of each property in the OWNER table, as seen in Figure 1-5. Each owner is identified by a unique owner number that consists of two uppercase letters followed by a three-digit number. For each owner, the table also includes the last name, first name, address, city, state, and ZIP code. Notice the owners are from across the United States. Although some apartments may be owned by a couple or a family, only the primary contact is given.

Each property at each location is identified by a property ID, as seen in Figure 1-6. Each property also includes the office number that manages the property, address, floor size, the number of bedrooms, the number of floors, monthly rent per property, and the owner number. The property ID is an integer unique for each property.

## OWNER

OWNER_NUM	LAST_NAME	FIRST_NAME	ADDRESS	CITY	STATE	ZIP_CODE
MO100	Moore	Elle-May	8006 W. Newport Ave.	Reno	NV	89508
PA101	Patel	Makesh	7337 Sheffield St.	Seattle	WA	98119
AK102	Aksoy	Ceyda	411 Griffin Rd.	Seattle	WA	98131
CO103	Cole	Meerab	9486 Circle Ave.	Olympia	WA	98506
KO104	Kowalczyk	Jakub	7431 S. Bishop St.	Bellingham	WA	98226
SI105	Sims	Haydon	527 Primrose Rd.	Portland	OR	97203
BU106	Burke	Ernest	613 Old Pleasant St.	Twin Falls	ID	83303
RE107	Redman	Seth	7681 Fordham St.	Seattle	WA	98119
LO108	Lopez	Janine	9856 Pumpkin Hill Ln.	Everett	WA	98213
BI109	Bianchi	Nicole	7990 Willow Dr.	New York	NY	10005
JO110	Jones	Ammarah	730 Military Ave.	Seattle	WA	98126

**FIGURE 1-5** Sample data for the owners of StayWell properties

## PROPERTY

PROPERTY_ID	OFFICE_NUM	ADDRESS	SQR_FT	BDRMS	FLOORS	MONTHLY_RENT	OWNER_NUM
1	1	30 West Thomas Rd.	1,600	3	1	1,400	BU106
2	1	782 Queen Ln.	2,100	4	2	1,900	AK102
3	1	9800 Sunbeam Ave.	1,005	2	1	1,200	BI109
4	1	105 North Illinois Rd.	1,750	3	1	1,650	KO104
5	1	887 Vine Rd.	1,125	2	1	1,160	SI105
6	1	8 Laurel Dr.	2,125	4	2	2,050	MO100
7	2	447 Goldfield St.	1,675	3	2	1,700	CO103
8	2	594 Leatherwood Dr.	2,700	5	2	2,750	KO104
9	2	504 Windsor Ave.	700	2	1	1,050	PA101
10	2	891 Alton Dr.	1,300	3	1	1,600	LO108
11	2	9531 Sherwood Rd.	1,075	2	1	1,100	JO110
12	2	2 Bow Ridge Ave.	1,400	3	2	1,700	RE107

**FIGURE 1-6** Sample data for StayWell properties

It might at first seem reasonable to include property IDs in the OWNER table, as it would only add one more column. However, if you look at the tables, you notice that there are more properties than owners because some owners have more than one property managed by StayWell. If the OWNER table included the property codes, this would require some entries to have more than one property ID. This would either require multiple property columns or require single rows to contain multiple data entries, creating issues in cross-referencing.

StayWell provides maintenance services across the properties in the two areas; this is shown in Figure 1-7. The SERVICE\_CATEGORY table includes details of these services. The CATEGORY\_NUM provides a unique number for the service, and CATEGORY\_DESCRIPTION shows what the service is.

## SERVICE\_CATEGORY

CATEGORY_NUM	CATEGORY_DESCRIPTION
1	Plumbing
2	Heating
3	Painting
4	Electrical systems
5	Carpentry
6	Furniture replacement

**FIGURE 1-7** Sample category data for StayWell maintenance services