

Database Concepts

Ninth Edition



Chapter 1

Getting Started

Learning Objectives (1 of 2)

- Understand the importance of databases in Internet Web applications and mobile apps
- Understand the nature and characteristics of databases
- Understand the potential problems with lists
- Understand the reasons for using a database
- Understand how using related tables helps you avoid the problems of using lists
- Know the components of a database system
- Learn the elements of a database
- Learn the purpose of a database management system (DBMS)
- Understand the functions of a database application

Learning Objectives (2 of 2)

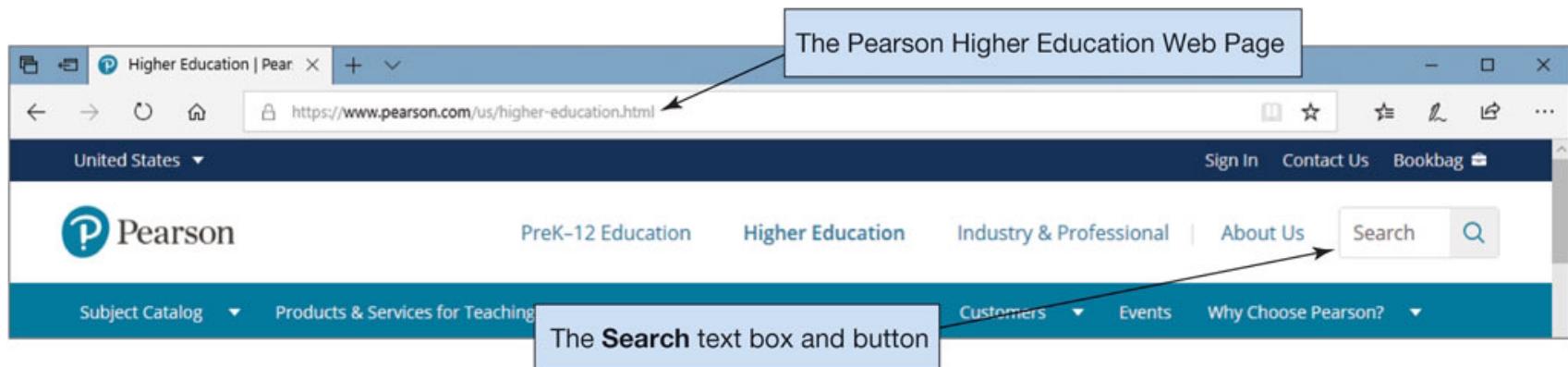
- Introduce Web database applications
- Introduce data warehouses and business intelligence (BI) systems
- Introduce Big Data and cloud computing

The Importance of Databases in the Internet and Mobile App World

Understand the importance of databases in Internet Web applications and mobile apps

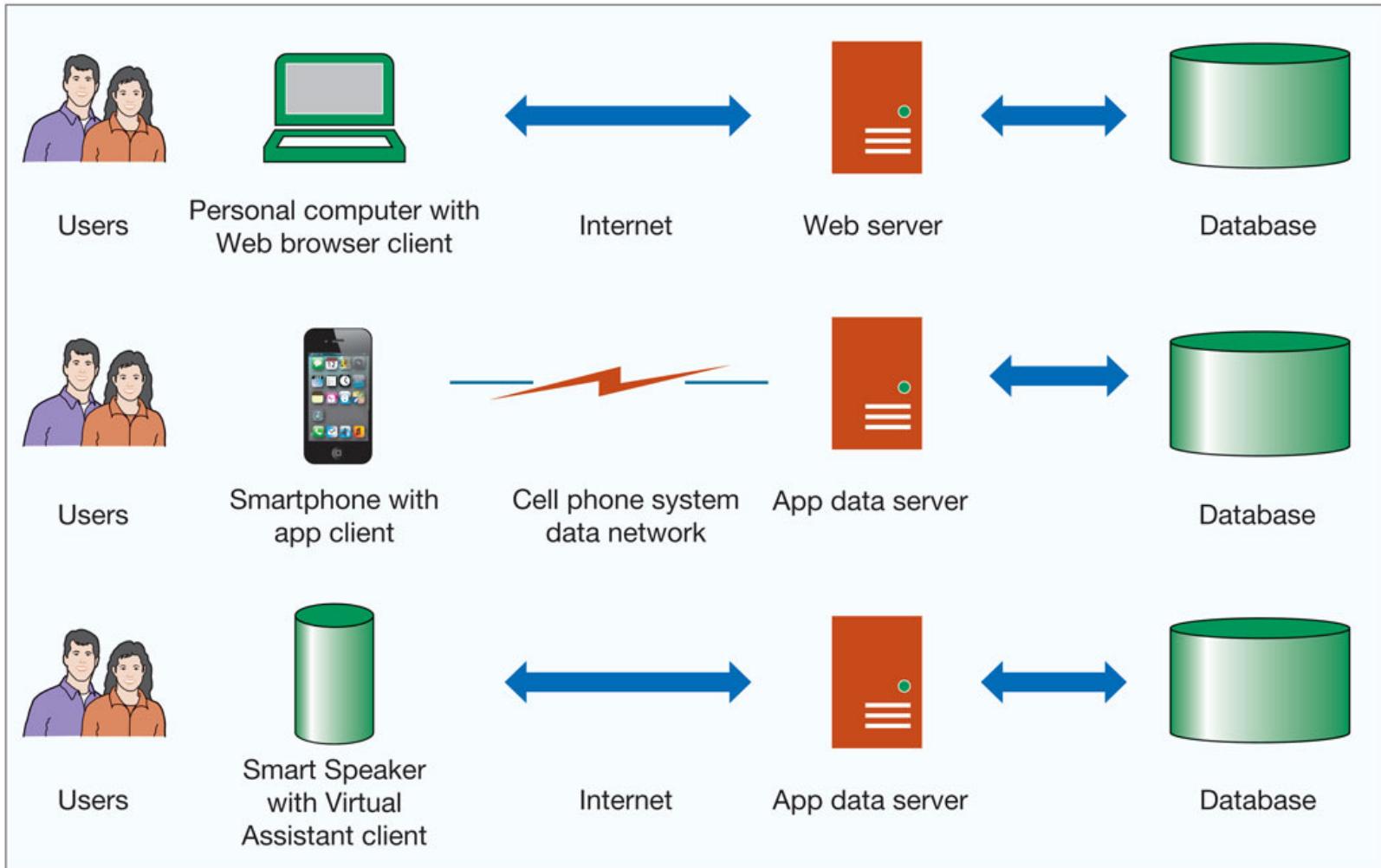
- The Internet was created as the ARPANET in 1969 and grew to connect LANs.
- It became known and used when the World Wide Web (Web) became accessible in 1993.
- In the early 2000s, Web 2.0 sites started to appear allowing users to add content.
- The Internet of Things (IoT) is the latest development which allows all types of devices to connect with each other.
- All of these items depend upon databases.

Figure 1.1(a) Searching a Database in a Web Browser



Courtesy of Pearson Education

Figure 1.2 The Internet and Mobile Device World



Why Use a Database?

Understand the nature and characteristics of databases

- The reason databases are used is to keep track of things.
- Databases store more complicated information than simple lists like a spreadsheet.

Figure 1.7 The Student with Advisor and Department List

Understand the potential problems with lists

- A major problem with using lists include:
 - **Modification problems:** Redundancy and multiple themes can create modification problems such as deleting, updating, and inserting records as seen in the figure below.

A	B	C	D	E	F	G	H	
1	SID	StudentLastName	StudentFirstName	StudentEmail	AdviserLastName	AdviserEmail	Department	AdminLastName
2	S0023	Andrews	Matthew	Matthew.Andrews@ourcampus.edu	Baker	Linda.Baker@ourcampus.edu	Accounting	Smith
3	S0065	Fischer	Douglas	Douglas.Fisher@ourcampus.edu	Baker	Linda.Baker@ourcampus.edu	Accounting	Smith
4	S0083	Hwang	Terry	Terry.Hwang@ourcampus.edu	Taing	Susan.Taing@ourcampus.edu	Accounting	Smith
5	S0132	Thompson	James	James.Thompson@ourcampus.edu	Taing	Susan.Taing@ourcampus.edu	InfoSystems	Rogers
6	S0154	Brisbon	Lisa	Lis.Brisbon@ourcampus.edu	Valdez	Richard.Valdez@ourcampus.edu	Chemistry	Chaplin
7	S0167	Lai	Tzu	Tzu.Lai@ourcampus.edu	Yeats	Bill.Yeats@ourcampus.edu	InfoSystems	Rogers
8	S0212	Marino	Chip	Chip.Marino@ourcampus.edu	Tran	Ken.Tran@ourcampus.edu	InfoSystems	Rogers
9	???	???	???	???	???	???	Biology	Kelly

If Adviser **Baker** is changed to **Taing**, we need to change *AdviserEmail* as well. If changed to **Valdez**, we need to change *AdviserEmail*, *Department*, and *AdminLastName*.

Deleted row—Student and Adviser data lost

Inserted row—both Student and Adviser data missing

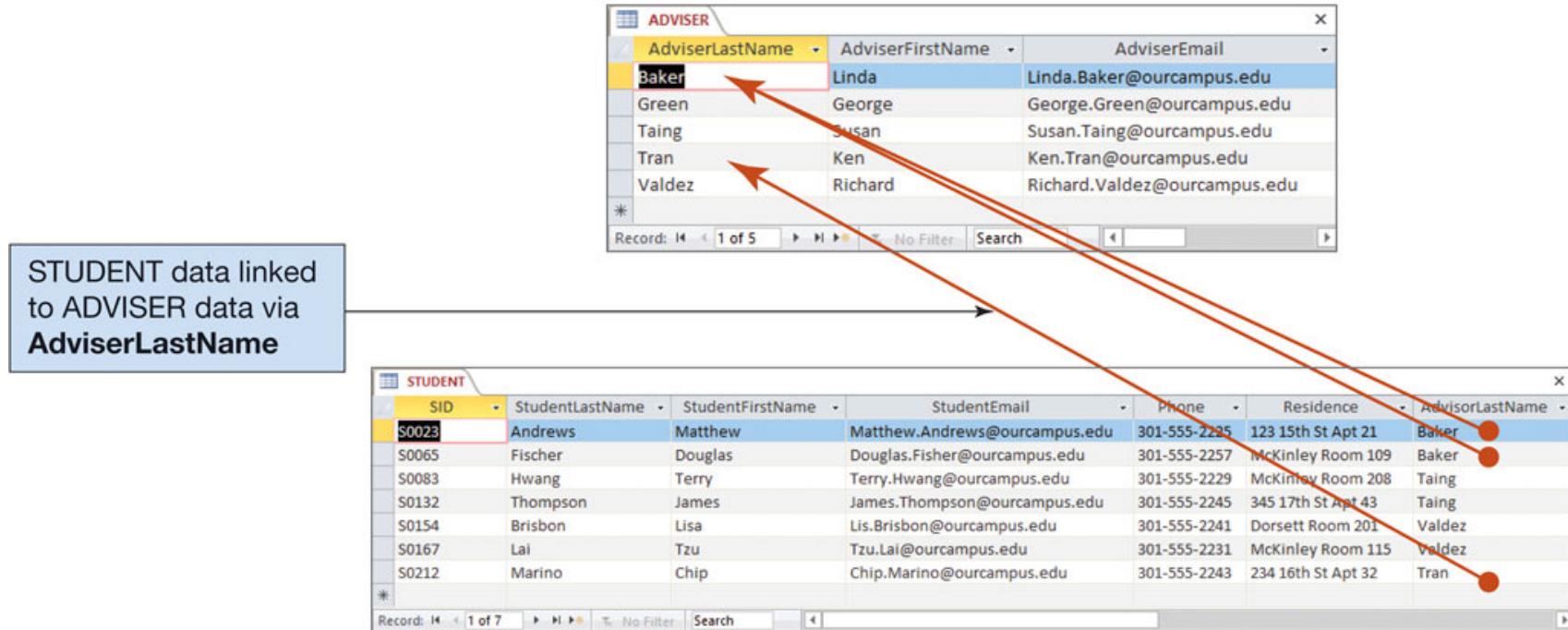
Excel 2019, Windows 10, Microsoft Corporation.

Using Relational Database Tables

Understand how using related tables helps you avoid the problems of using lists.

- **Relational model** is a methodology used as a solution for database design.
- A **relational database** contains a collection of separate tables.
- A **table** holds data about only one theme.
- Each **column**, also known as fields, in a table stores a characteristic common to all rows in a table. An example is StudentNumber.
- A **row** in a table, also known as a record, has data about an occurrence. An example would be all the information on one student.

Figure 1.8 The Advisor and Student Tables



Access 2019, Windows 10, Microsoft Corporation.

Figure 1.9 Modifying the Advisor and Student Tables

Changed data—data remains consistent

Inserted data—no STUDENT data required

Deleted data—no ADVISER data lost

AdviserLastName	AdviserFirstName	AdviserEmail
Baker	Linda	Linda.Baker@ourcampus.edu
Green	George	George.Green@ourcampus.edu
Taing	Susan	Sue.Taing@ourcampus.edu
Tran	Ken	Ken.Tran@ourcampus.edu
Valdez	Richard	Richard.Valdez@ourcampus.edu
Yeats	Bill	Bill.Yeats@ourcampus.edu
*		

SID	StudentLastName	StudentFirstName	StudentEmail	Phone	Residence	AdvisorLastName
S0023	Andrews	Matthew	Matthew.Andrews@ourcampus.edu	301-555-2225	123 15th St Apt 21	Baker
S0065	Fischer	Douglas	Douglas.Fisher@ourcampus.edu	301-555-2257	McKinley Room 109	Baker
S0083	Hwang	Terry	Terry.Hwang@ourcampus.edu	301-555-2229	McKinley Room 208	Taing
S0132	Thompson	James	James.Thompson@ourcampus.edu	301-555-2245	345 17th St Apt 43	Taing
S0154	Brisbon	Lisa	Lis.Brisbon@ourcampus.edu	301-555-2241	Dorsett Room 201	Valdez
S0167	Lai	Tzu	Tzu.Lai@ourcampus.edu	301-555-2231	McKinley Room 115	Valdez
S0212	Marino	Chip	Chip.Marino@ourcampus.edu	301-555-2243	234 16th St Apt 32	Tran
*						

Access 2019, Windows 10, Microsoft Corporation.

Figure 1.10 The Department, Advisor, and Student Tables

Can insert DEPARTMENT data as needed—no ADVISER or STUDENT data required

DepartmentName	DepartmentPhone	AdminLastName	AdminFirstName	AdminEmail
Accounting	301-557-1011	Smith	Shawna	Shawna.Smith@ourcampus.edu
Biology	301-557-1021	Kelly	Chris	Chris.Kelly@ourcampus.edu
Chemistry	301-557-1031	Chaplin	Robin	Robin.Chaplin@ourcampus.edu
InfoSystems	301-557-1041	Rogers	Aaron	Aaron.Rogers@ourcampus.edu

Can change STUDENT Adviser name as needed—new value is linked to its own data

AdviserLastName	AdviserFirstName	AdviserEmail	Department
Baker	Linda	Linda.Baker@ourcampus.edu	Accounting
Green	George	George.Green@ourcampus.edu	Biology
Taing	Susan	Sue.Taing@ourcampus.edu	Accounting
Tran	Ken	Ken.Tran@ourcampus.edu	InfoSystems
Valdez	Richard	Richard.Valdez@ourcampus.edu	Chemistry
Yeats	Bill	Bill.Yeats@ourcampus.edu	InfoSystems

Can delete STUDENT data as needed—no DEPARTMENT or ADVISER data lost

SID	StudentLastName	StudentFirstName	StudentEmail	Phone	Residence	AdvisorLastName
S0023	Andrews	Matthew	Matthew.Andrews@ourcampus.edu	301-555-2225	123 15th St Apt 21	Baker
S0065	Fischer	Douglas	Douglas.Fisher@ourcampus.edu	301-555-2257	McKinley Room 109	Baker
S0083	Hwang	Terry	Terry.Hwang@ourcampus.edu	301-555-2229	McKinley Room 208	Taing
S0132	Thompson	James	James.Thompson@ourcampus.edu	301-555-2245	345 17th St Apt 43	Taing
S0154	Brisbon	Lisa	Lis.Brisbon@ourcampus.edu	301-555-2241	Dorsett Room 201	Valdez
S0167	Lai	Tzu	Tzu.Lai@ourcampus.edu	301-555-2231	McKinley Room 115	Valdez
S0212	Marino	Chip	Chip.Marino@ourcampus.edu	301-555-2243	234 16th St Apt 32	Tran

Access 2019, Windows 10, Microsoft Corporation.

Figure 1.11 The Art Course List with Modification Problems

	A	B	C	D	E	F	G
1	CustomerLastName	CustomerFirstName	Phone	CourseDate	AmountPaid	Course	Fee
2	Johnson	Ariel	206-567-1234	10/1/2019	\$250.00	Adv Pastels	\$500.00
3	Green	Robin	425-678-8765	9/15/2019	\$350.00	Beg Oils	\$350.00
4	Jackson	Charles	360-789-3456	10/1/2019	\$500.00	Adv Pastels	\$500.00
5	Johnson	Ariel	206-567-1234	3/15/2019	\$350.00	Int Pastels	\$350.00
6	Pearson	Jeffery	206-567-2345	10/1/2019	\$500.00	Adv Pastels	\$500.00
7	Sears	Miguel	360-789-4567	9/15/2019	\$350.00	Beg Oils	\$350.00
8	Kyle	Leah	425-678-7654	11/15/2019	\$250.00	Adv Pastels	\$500.00
9	Myers	Lynda	360-789-5678	10/15/2019	\$0.00	Beg Oils	\$350.00

How to enter the fee for a new course?

Consequences of changing this date?

Consequences of deleting this row?

```
graph LR; A[How to enter the fee for a new course?] --> G9[Fee]; B[Consequences of changing this date?] --> D5[CourseDate]; C[Consequences of deleting this row?] --> R4[Row 4];
```

Excel 2019, Windows 10, Microsoft Corporation.

Figure 1.12 The Art Course Database Tables

The figure displays three Microsoft Access database tables: CUSTOMER, COURSE, and ENROLLMENT. Red arrows point from three callout boxes containing notes to specific fields in the tables.

- CUSTOMER Table:** Shows customer information with fields CustomerNumber, CustomerLastName, CustomerFirstName, and Phone. A red arrow points to the CustomerNumber field.
- COURSE Table:** Shows course offerings with fields CourseNumber, Course, CourseDate, and Fee. A red arrow points to the CourseNumber field.
- ENROLLMENT Table:** Shows enrollment details with fields CustomerNumber, CourseNumber, and AmountPaid. Two red arrows point to the CustomerNumber and CourseNumber fields.

Annotations:

- Can change COURSE CourseDate without problems
- Can insert new COURSE data as needed
- Can delete ENROLLMENT rows as needed—no adverse consequences

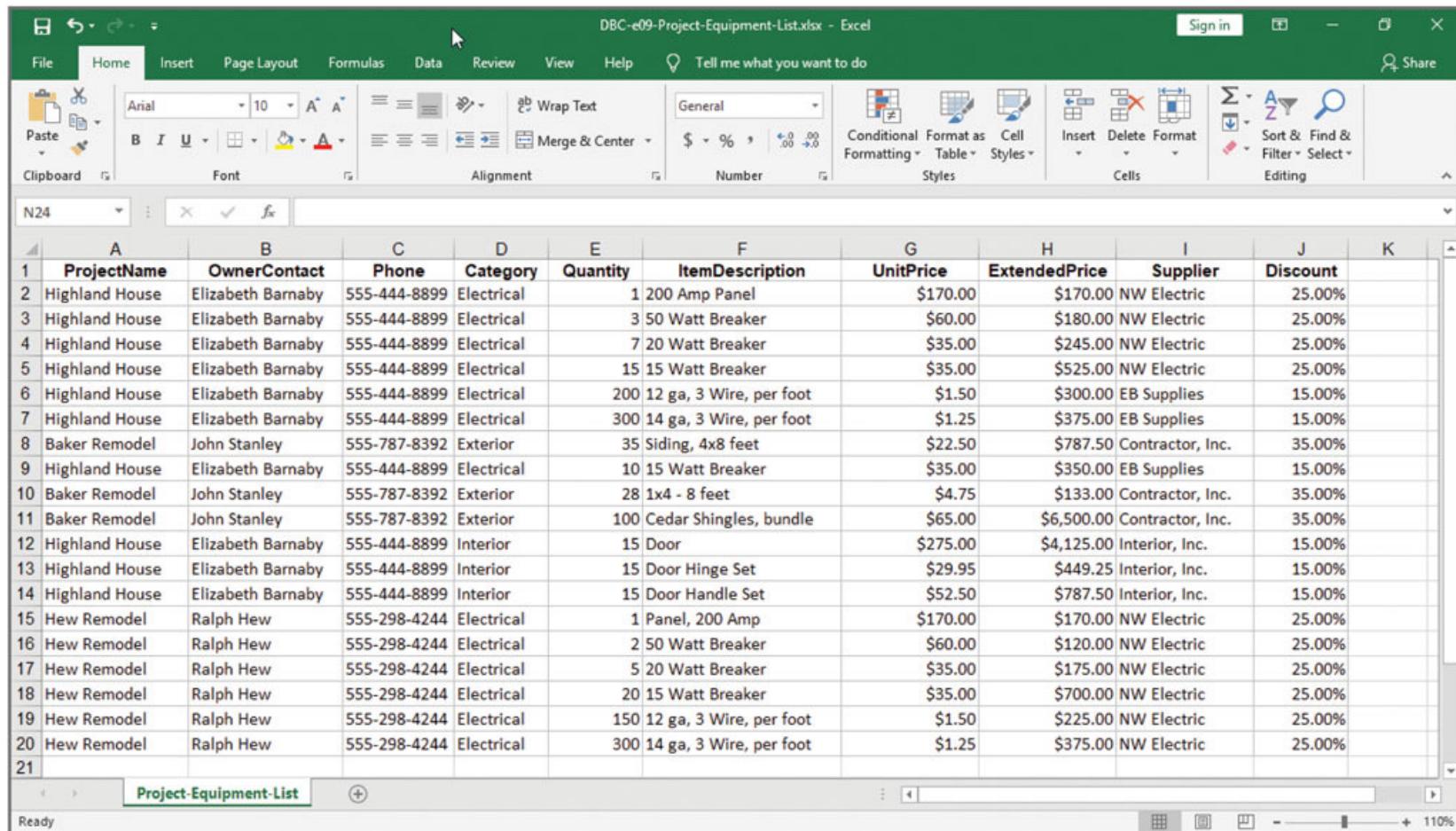
CustomerNumber	CustomerLastName	CustomerFirstName	Phone
1	Johnson	Ariel	206-567-1234
2	Green	Robin	425-678-8765
3	Jackson	Charles	360-789-3456
4	Pearson	Jeffery	206-567-2345
5	Sears	Miguel	360-789-4567
6	Kyle	Leah	425-678-7654
7	Myers	Lynda	360-789-5678

CourseNumber	Course	CourseDate	Fee
1	Adv Pastels	10/1/2019	\$500.00
2	Beg Oils	9/15/2019	\$350.00
3	Int Pastels	3/15/2019	\$350.00
4	Beg Oils	10/15/2019	\$350.00
5	Adv Pastels	11/15/2019	\$500.00

CustomerNumber	CourseNumber	AmountPaid
1	1	\$250.00
1	3	\$350.00
2	2	\$350.00
3	1	\$500.00
4	1	\$500.00
5	2	\$350.00
6	5	\$250.00
7	4	\$0.00
0	0	\$0.00

Access 2019, Windows 10, Microsoft Corporation.

Figure 1.13 The Project Equipment List as a Spreadsheet



The screenshot shows a Microsoft Excel 2019 window titled "DBC-e09-Project-Equipment-List.xlsx - Excel". The ribbon is visible at the top with tabs for File, Home, Insert, Page Layout, Formulas, Data, Review, View, and Help. The Home tab is selected. The Excel interface includes various toolbars for clipboard, font, alignment, number, styles, cells, and editing. The main area displays a data table with 21 rows and 11 columns. The columns are labeled A through K, and the rows are numbered 1 through 21. The data includes project names, owner contacts, phone numbers, categories, quantities, item descriptions, unit prices, extended prices, suppliers, and discounts.

	A	B	C	D	E	F	G	H	I	J	K
1	ProjectName	OwnerContact	Phone	Category	Quantity	ItemDescription	UnitPrice	ExtendedPrice	Supplier	Discount	
2	Highland House	Elizabeth Barnaby	555-444-8899	Electrical	1	200 Amp Panel	\$170.00	\$170.00	NW Electric	25.00%	
3	Highland House	Elizabeth Barnaby	555-444-8899	Electrical	3	50 Watt Breaker	\$60.00	\$180.00	NW Electric	25.00%	
4	Highland House	Elizabeth Barnaby	555-444-8899	Electrical	7	20 Watt Breaker	\$35.00	\$245.00	NW Electric	25.00%	
5	Highland House	Elizabeth Barnaby	555-444-8899	Electrical	15	15 Watt Breaker	\$35.00	\$525.00	NW Electric	25.00%	
6	Highland House	Elizabeth Barnaby	555-444-8899	Electrical	200	12 ga, 3 Wire, per foot	\$1.50	\$300.00	EB Supplies	15.00%	
7	Highland House	Elizabeth Barnaby	555-444-8899	Electrical	300	14 ga, 3 Wire, per foot	\$1.25	\$375.00	EB Supplies	15.00%	
8	Baker Remodel	John Stanley	555-787-8392	Exterior	35	Siding, 4x8 feet	\$22.50	\$787.50	Contractor, Inc.	35.00%	
9	Highland House	Elizabeth Barnaby	555-444-8899	Electrical	10	15 Watt Breaker	\$35.00	\$350.00	EB Supplies	15.00%	
10	Baker Remodel	John Stanley	555-787-8392	Exterior	28	1x4 - 8 feet	\$4.75	\$133.00	Contractor, Inc.	35.00%	
11	Baker Remodel	John Stanley	555-787-8392	Exterior	100	Cedar Shingles, bundle	\$65.00	\$6,500.00	Contractor, Inc.	35.00%	
12	Highland House	Elizabeth Barnaby	555-444-8899	Interior	15	Door	\$275.00	\$4,125.00	Interior, Inc.	15.00%	
13	Highland House	Elizabeth Barnaby	555-444-8899	Interior	15	Door Hinge Set	\$29.95	\$449.25	Interior, Inc.	15.00%	
14	Highland House	Elizabeth Barnaby	555-444-8899	Interior	15	Door Handle Set	\$52.50	\$787.50	Interior, Inc.	15.00%	
15	Hew Remodel	Ralph Hew	555-298-4244	Electrical	1	Panel, 200 Amp	\$170.00	\$170.00	NW Electric	25.00%	
16	Hew Remodel	Ralph Hew	555-298-4244	Electrical	2	50 Watt Breaker	\$60.00	\$120.00	NW Electric	25.00%	
17	Hew Remodel	Ralph Hew	555-298-4244	Electrical	5	20 Watt Breaker	\$35.00	\$175.00	NW Electric	25.00%	
18	Hew Remodel	Ralph Hew	555-298-4244	Electrical	20	15 Watt Breaker	\$35.00	\$700.00	NW Electric	25.00%	
19	Hew Remodel	Ralph Hew	555-298-4244	Electrical	150	12 ga, 3 Wire, per foot	\$1.50	\$225.00	NW Electric	25.00%	
20	Hew Remodel	Ralph Hew	555-298-4244	Electrical	300	14 ga, 3 Wire, per foot	\$1.25	\$375.00	NW Electric	25.00%	
21											

Excel 2019, Windows 10, Microsoft Corporation.

Figure 1.14 The Project Equipment Database Tables

The figure displays four Microsoft Access database tables:

- PROJECT**: Stores project information. Primary key is ProjectID.
- ITEM**: Stores item details. Primary key is ItemNumber.
- QUOTE**: Stores quote details. Primary key is QuoteID. It has foreign keys linking to ProjectID (from PROJECT) and ItemNumber (from ITEM).
- SUPPLIER**: Stores supplier information. Primary key is SupplierID.

Relationships shown by red arrows:

- A red arrow points from the ProjectID column in the PROJECT table to the ProjectID column in the QUOTE table, indicating a one-to-many relationship.
- A red arrow points from the ItemNumber column in the ITEM table to the ItemNumber column in the QUOTE table, indicating a many-to-many relationship.
- A red arrow points from the SupplierID column in the QUOTE table to the SupplierID column in the SUPPLIER table, indicating a many-to-one relationship.

PROJECT Table Data:

ProjectID	ProjectName	OwnerContact	Phone
1	Highland House	Elizabeth Barnaby	555-444-8899
2	Baker Remodel	John Stanley	555-787-8392
3	Hew Remodel	Ralph Hew	555-298-4244

ITEM Table Data:

ItemNumber	ItemDescription	Category
1100	200 Amp Panel	Electrical
1200	50 Watt Breaker	Electrical
1300	20 Watt Breaker	Electrical
1400	15 Watt Breaker	Electrical
1500	12 ga, 3 Wire, per foot	Electrical
1550	14 ga, 3 Wire, per foot	Electrical
1600	Siding, 4x8 feet	Exterior
1700	1x4 - 8 feet	Exterior
1800	Cedar Shingles, bundle	Exterior
2000	Door	Interior
2100	Door Hinge Set	Interior
2200	Door Handle Set	Interior

QUOTE Table Data:

QuoteID	ProjectID	ItemNumber	SupplierID	Quantity	UnitPrice	ExtendedPrice
1	1	1100	1	1	\$170.00	\$170.00
2	1	1200	1	3	\$60.00	\$180.00
3	1	1300	1	7	\$35.00	\$245.00
4	1	1400	1	15	\$35.00	\$525.00
5	1	1500	2	200	\$1.50	\$300.00
6	1	1500	2	300	\$1.25	\$375.00
7	2	1600	3	35	\$22.50	\$787.50
8	1	1400	2	10	\$35.00	\$350.00
9	2	1700	3	28	\$4.75	\$133.00
10	2	1800	3	100	\$65.00	\$6,500.00
11	1	2000	4	15	\$275.00	\$4,125.00
12	1	2100	4	15	\$29.95	\$449.25
13	1	2200	4	15	\$52.50	\$787.50
14	3	1100	1	1	\$170.00	\$170.00
15	3	1200	1	2	\$60.00	\$120.00
16	3	1300	1	5	\$35.00	\$175.00
17	3	1400	1	20	\$35.00	\$700.00
18	3	1500	1	150	\$1.50	\$225.00
19	3	1550	1	300	\$1.25	\$375.00

SUPPLIER Table Data:

SupplierID	Supplier	Discount
1	NW Electric	25.00%
2	EB Supplies	15.00%
3	Contractor, Inc.	35.00%
4	Interior, Inc.	15.00%

Access 2019, Windows 10, Microsoft Corporation.

How do I Process Relational Tables Using SQL?

- The leading technique for data definition and manipulation is **Structured Query Language (SQL)**.
- **SQL** is an international standard for creating, processing, and querying databases and their tables.
- Using **SQL** you can:
 - Reconstruct lists from their underlying tables,
 - Query for specific data conditions,
 - Perform calculations on data in tables, and
 - Insert, update, and delete data.

SQL Art Course Database Example

Understand how using related tables helps you avoid the problems of using lists

- Using SQL, the following code will combine the three tables in the Art Course Database as seen in Figure 1.12:

```
SELECT      CUSTOMER.CustomerLastName,  
            CUSTOMER.CustomerFirstName, CUSTOMER.Phone,  
            COURSE.CourseDate, ENROLLMENT.AmountPaid, COURSE.Course,  
            COURSE.Fee  
FROM        CUSTOMER, ENROLLMENT, COURSE  
WHERE       CUSTOMER.CustomerNumber = ENROLLMENT.CustomerNumber  
AND         COURSE.CourseNumber = ENROLLMENT.CourseNumber;
```

- The results of running the code above can be seen in Figure 1.15 on the next page.

Figure 1.15 Results of the SQL Query to Recreate the Art Course List Data

Art Course List							
CustomerLastName	CustomerFirstName	Phone	CourseDate	AmountPaid	Course	Fee	
Johnson	Ariel	206-567-1234	10/1/2019	\$250.00	Adv Pastels	\$500.00	
Johnson	Ariel	206-567-1234	3/15/2019	\$350.00	Int Pastels	\$350.00	
Green	Robin	425-678-8765	9/15/2019	\$350.00	Beg Oils	\$350.00	
Jackson	Charles	360-789-3456	10/1/2019	\$500.00	Adv Pastels	\$500.00	
Pearson	Jeffery	206-567-2345	10/1/2019	\$500.00	Adv Pastels	\$500.00	
Sears	Miguel	360-789-4567	9/15/2019	\$350.00	Beg Oils	\$350.00	
Kyle	Leah	425-678-7654	11/15/2019	\$250.00	Adv Pastels	\$500.00	
Myers	Lynda	360-789-5678	10/15/2019	\$0.00	Beg Oils	\$350.00	

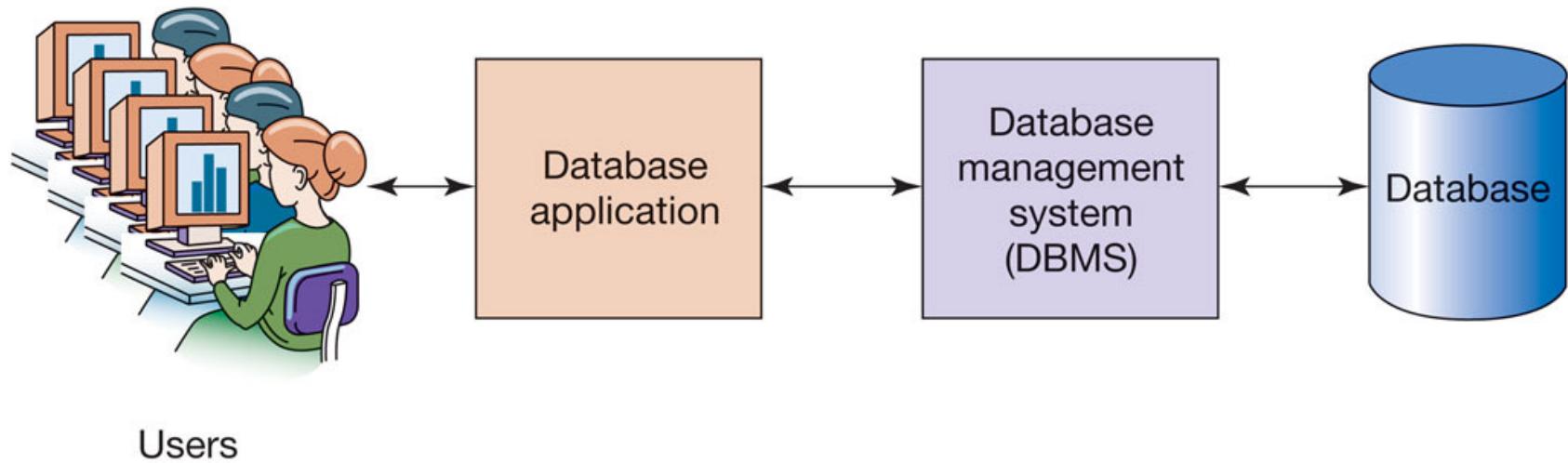
Access 2019, Windows 10, Microsoft Corporation

What is a Database System?

Know the components of a database system

- A **database system** has four components consisting of:
 1. Users,
 2. Database application
 3. Database management system (DBMS), and
 4. Database.

Figure 1.17 Components of a Database System

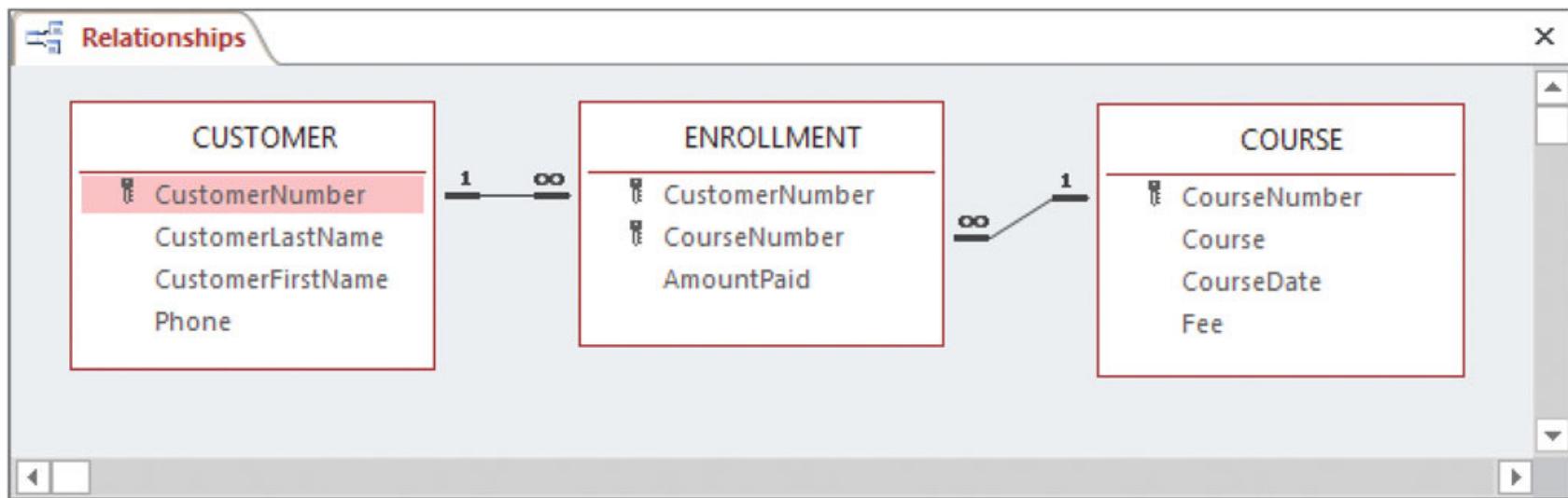


The Database

Know the components of a database system

- A **user** of a database system will:
 - Employ a database application to keep track of things
 - Use forms to read, enter, and query data
 - Produce reports
- A **database** is a self-describing collection of related tables:
 - **Self-describing** means a description of the structure of the database is contained with the database itself.
 - **Metadata** is data about the structure of the database.

Figure 1.18 Example Metadata: A Relationship Diagram for the Art Course Tables in Figure 1.12



Access 2019, Windows 10, Microsoft Corporation.

Figure 1.19 Database Contents

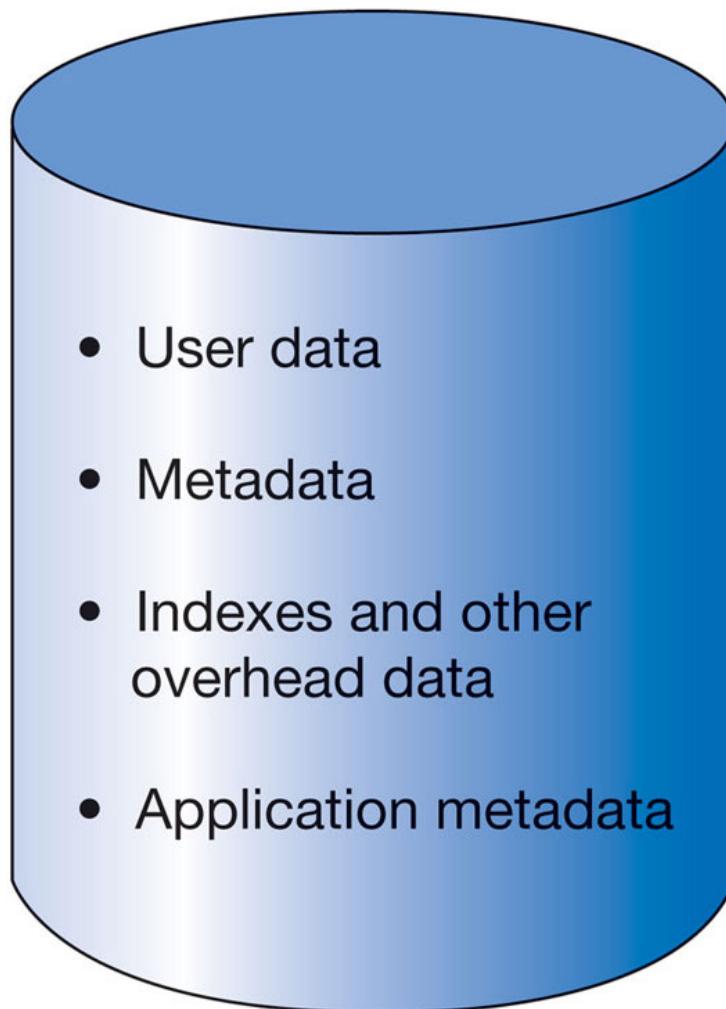


Figure 1.20 Functions of a DBMS

Learn to purpose of a database management system (DBMS)

- The purpose of a DBMS is to create, process, and administer databases and are licensed from a vendor.
- The functions of a DBMS are shown in the following slide:

- Create database
- Create tables
- Create supporting structures (e.g., indexes)
- Read database data
- Modify (insert, update, or delete) database data
- Maintain database structures
- Enforce rules
- Control concurrency
- Provide security
- Perform backup and recovery

Referential Integrity Constraints

Learn the purpose of a database management system (DBMS)

- **Referential integrity constraints** are rules enforced by the DBMS to ensure values of a column in one table are valid when compared to values in another table.
 - For example, in the Art Course database what would happen if a user mistakenly entered 9 for CustomerNumber in the ENROLLMENT table?
 - Since 9 does not exist in that table it would cause errors and not execute.
 - To prevent this situation, the DBMS enforces the rule that if a CustomerNumber is entered in the ENROLLMENT table, must also exist in the CUSTOMER table.

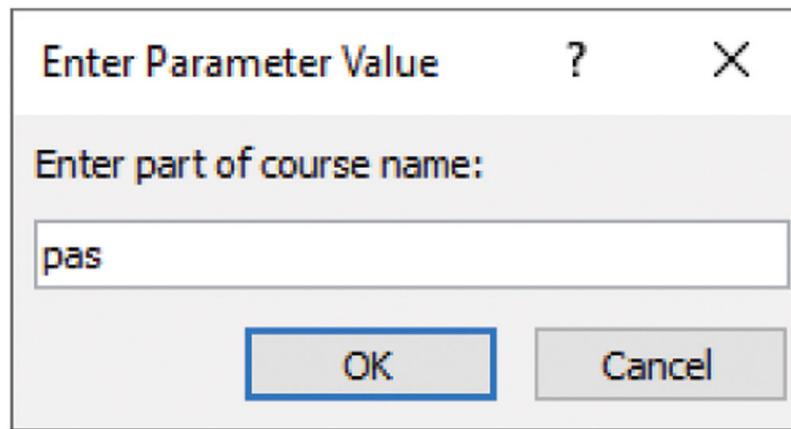
Figure 1.21 Functions of Database Application Programs

- Create and process forms
- Process user queries
- Create and process reports
- Execute application logic
- Control application

Figure 1.22 Example Data Entry Form

Access 2019, Windows 10, Microsoft Corporation.

Figure 1.23 (a) Query Parameter Form, and (b) Query Results



Course Parameter Query						
CustomerLastName	CustomerFirstName	Course	CourseDate	Fee	AmountPaid	Amount Due
Jackson	Charles	Adv Pastels	10/1/2019	\$500.00	\$500.00	\$0.00
Johnson	Ariel	Int Pastels	3/15/2019	\$350.00	\$350.00	\$0.00
Johnson	Ariel	Adv Pastels	10/1/2019	\$500.00	\$250.00	\$250.00
Kyle	Leah	Adv Pastels	11/15/2019	\$500.00	\$250.00	\$250.00
Pearson	Jeffery	Adv Pastels	10/1/2019	\$500.00	\$500.00	\$0.00
*						

Access 2019, Windows 10, Microsoft Corporation.

Figure 1.24 Example Report

Course Enrollment Report

Course	CourseDate	CustomerLastName	CustomerFirstName	Phone	Fee	AmountPaid	AmountDue
Adv Pastels							
	10/1/2019	Jackson	Charles	360-789-3456	\$500.00	\$500.00	\$0.00
		Johnson	Ariel	206-567-1234	\$500.00	\$250.00	\$250.00
		Pearson	Jeffery	206-567-2345	\$500.00	\$500.00	\$0.00
Beg Oils							
	11/15/2019	Kyle	Leah	425-678-7654	\$500.00	\$250.00	\$250.00
Int Pastels							
	9/15/2019	Green	Robin	425-678-8765	\$350.00	\$350.00	\$0.00
		Sears	Miguel	360-789-4567	\$350.00	\$350.00	\$0.00
	10/15/2019	Myers	Lynda	360-789-5678	\$350.00	\$0.00	\$350.00
	3/15/2019	Johnson	Ariel	206-567-1234	\$350.00	\$350.00	\$0.00

Access 2019, Windows 10, Microsoft Corporation.

Personal vs. Enterprise-Class Database Systems

- A **personal database system** is used by only one person and would include:
 - Only a few tables containing only a few hundred rows of data
 - Use only one computer with one user at a time
- An **enterprise database system is used international organizations with thousands** of concurrent users and would include:
 - Hundreds of tables with millions of rows of data
 - In use 24/7 24 hours a day

Figure 1.25 Personal Database System

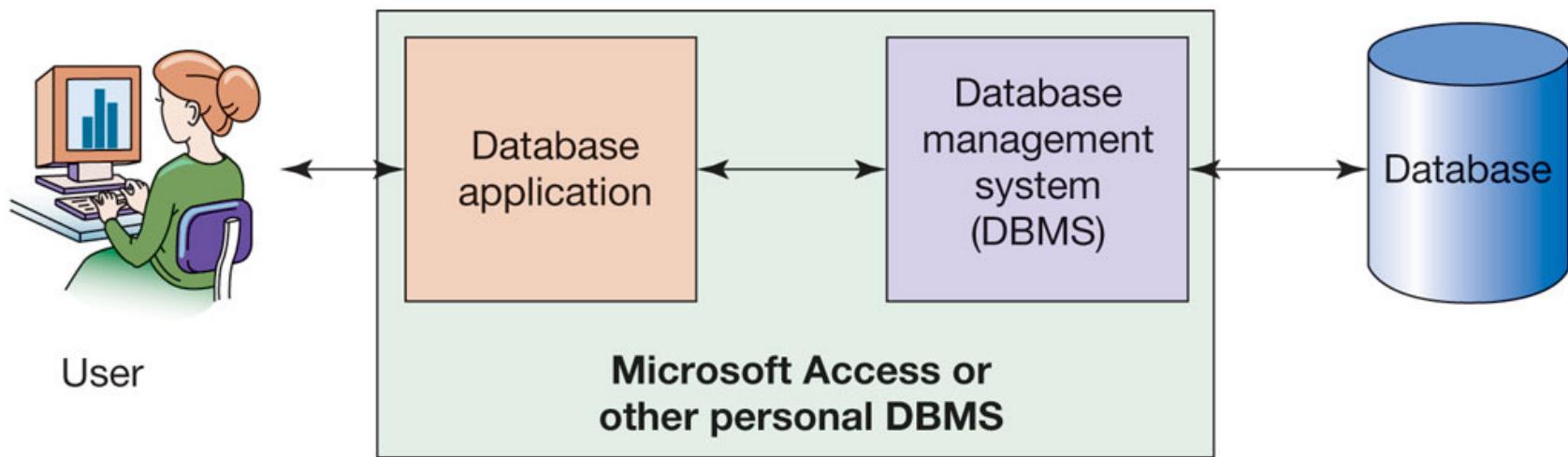


Figure 1.26 SQL Generated by Microsoft Access Query

The SQL has
been arranged to
make it easy to read

Art Course List

```
SELECT CUSTOMER.CustomerLastName,  
       CUSTOMER.CustomerFirstName,  
       CUSTOMER.Phone,  
       COURSE.CourseDate,  
       ENROLLMENT.AmountPaid,  
       COURSE.Course,  
       COURSE.Fee  
  FROM CUSTOMER, ENROLLMENT, COURSE  
 WHERE (((CUSTOMER.CustomerNumber)=[ENROLLMENT].[CustomerNumber]))  
   AND ((COURSE.CourseNumber)=[ENROLLMENT].[CourseNumber]));
```

Access 2019, Windows 10, Microsoft Corporation.

Figure 1.27 Microsoft Access 2019

The database name **Art-Course-Database**

The table object **CUSTOMER** is displayed under the **Tables** section of All Access Objects

The query object **Art Course List** stores the query itself

The query results in table format

CustomerLastName	CustomerFirstName	Phone	CourseDate	AmountPaid	Course	Fee
Johnson	Ariel	206-567-1234	10/1/2019	\$250.00	Adv Pastels	\$500.00
Johnson	Ariel	206-567-1234	3/15/2019	\$350.00	Int Pastels	\$350.00
Green	Robin	425-678-8765	9/15/2019	\$350.00	Beg Oils	\$350.00
Jackson	Charles	360-789-3456	10/1/2019	\$500.00	Adv Pastels	\$500.00
Pearson	Jeffery	206-567-2345	10/1/2019	\$500.00	Adv Pastels	\$500.00
Sears	Miguel	360-789-4567	9/15/2019	\$350.00	Beg Oils	\$350.00
Kyle	Leah	425-678-7654	11/15/2019	\$250.00	Adv Pastels	\$500.00
Myers	Lynda	360-789-5678	10/15/2019	\$0.00	Beg Oils	\$350.00

Access 2019, Windows 10, Microsoft Corporation.

Figure 1.28 Enterprise-Class Database System

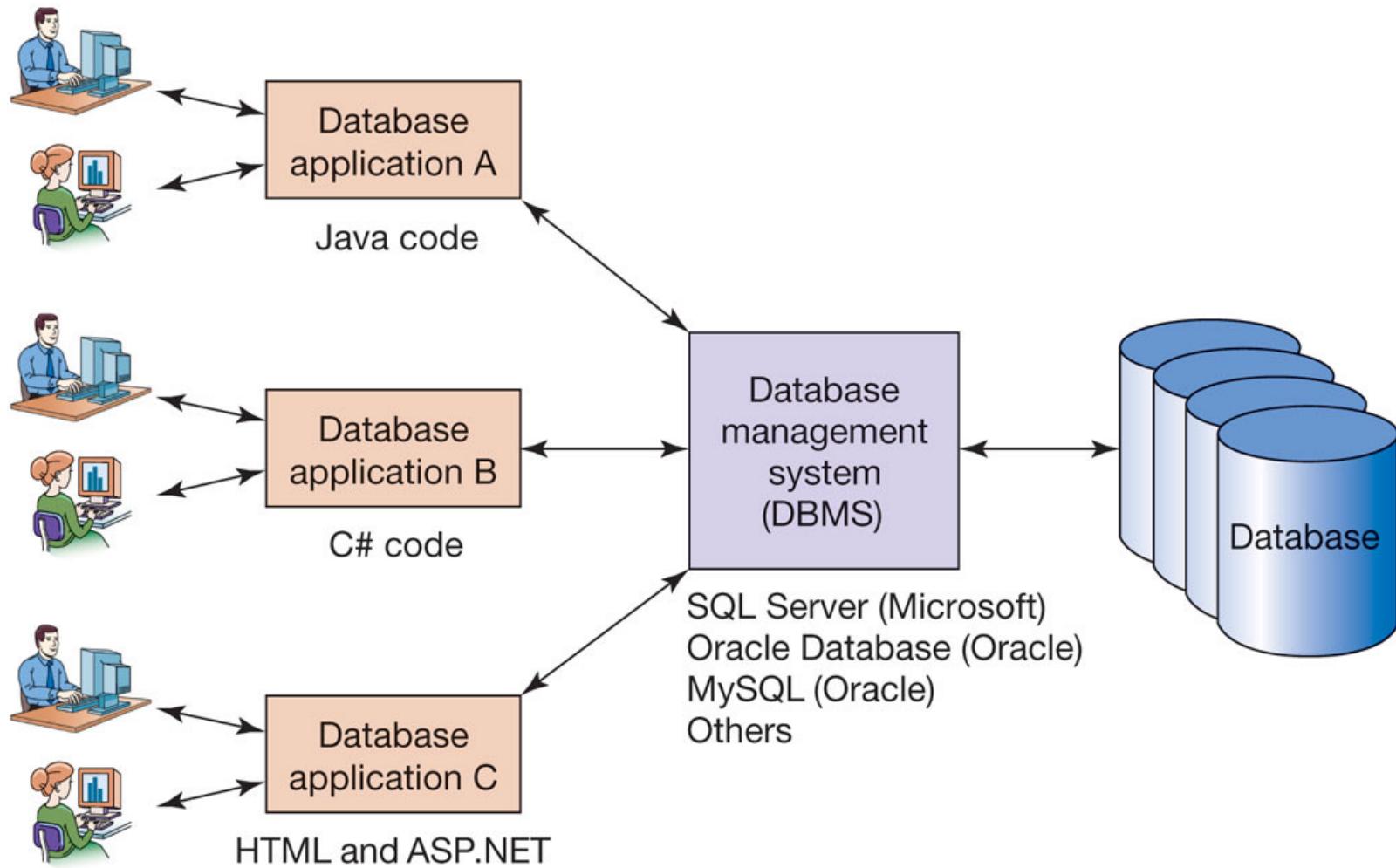


Figure 1.29 MySQL 8.0

Click this button to run the SQL query

The SQL query

The database object **art_course_database** is displayed in the Object Browser

The table object **CUSTOMER** is displayed under the **art_course_database** object

The query results in table format

The screenshot shows the MySQL Workbench interface. In the top left, there's a tooltip for the 'Run' button with the text 'Click this button to run the SQL query'. Below it, another tooltip says 'The SQL query'. In the center, a query editor window titled 'Query 1' contains the following SQL code:

```
SELECT CUSTOMER.CustomerLastName,  
       CUSTOMER.CustomerFirstName, CUSTOMER.Phone,  
       COURSE.CourseDate, ENROLLMENT.AmountPaid,  
       COURSE.Course, COURSE.Fee  
FROM CUSTOMER, ENROLLMENT, COURSE  
WHERE CUSTOMER.CustomerNumber=ENROLLMENT.CustomerNumber  
      AND COURSE.CourseNumber=ENROLLMENT.CourseNumber;
```

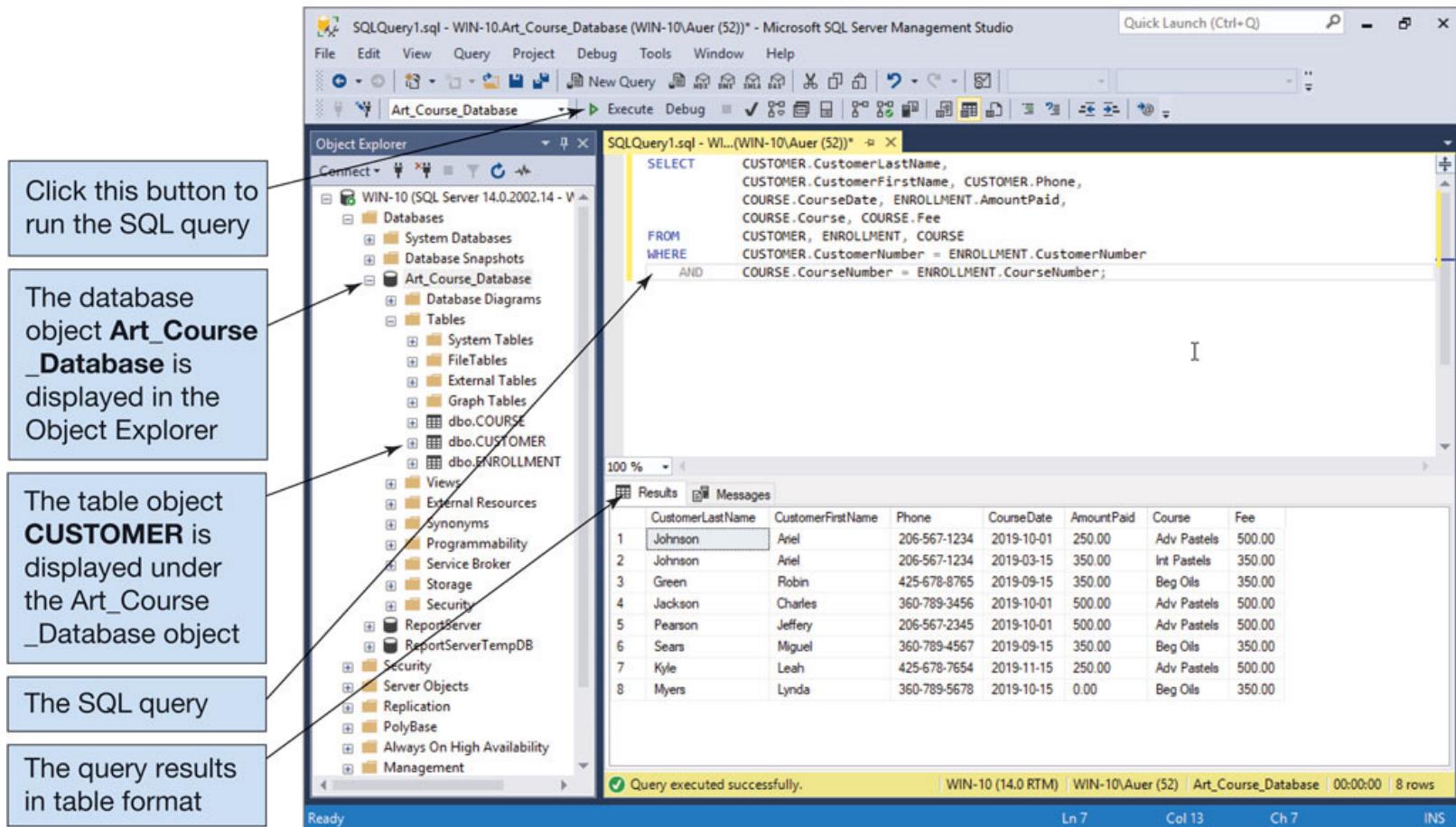
To the left of the query editor is the 'Object Browser' pane, which lists the 'art_course_database' schema. Under 'Tables', the 'CUSTOMER' table is listed. The bottom half of the screen shows the 'Result Grid' containing the query results:

	CustomerLastName	CustomerFirstName	Phone	CourseDate	AmountPaid	Course	Fee
1	Johnson	Ariel	206-567-1234	2019-10-01	250.00	Adv Pastels	500.00
2	Jackson	Charles	360-789-3456	2019-10-01	500.00	Adv Pastels	500.00
3	Pearson	Jeffery	206-567-2345	2019-10-01	500.00	Adv Pastels	500.00
4	Green	Robin	425-678-8765	2019-09-15	350.00	Beg Oils	350.00
5	Sears	Miguel	360-789-4567	2019-09-15	350.00	Beg Oils	350.00
6	Johnson	Ariel	206-567-1234	2019-03-15	350.00	Int Pastels	350.00
7	Myers	Lynda	360-789-5678	2019-10-15	0.00	Beg Oils	350.00
8	Kyle	Leah	425-678-7654	2019-11-15	250.00	Adv Pastels	500.00

The right side of the interface includes a sidebar with icons for 'Result Grid', 'Form Editor', 'Field Types', and 'Query Stats'. At the bottom right, there's a 'Read Only' status indicator.

MySQL Community Server 8.0, MySQL Workbench, Oracle Corporation.

Figure 1.30 Microsoft SQL Server 2017



SQL Server 2017, SQL Server Management Studio, Microsoft Corporation.

Figure 1.31 Oracle DatabaseXE

The database object **Art_Course_Database** is displayed in the Oracle Connections browser

Click this button to run the SQL query

The table object **CUSTOMER** is displayed in the Tables objects

The SQL query

The query results in table format

The screenshot shows the Oracle SQL Developer interface. On the left, the 'Connections' browser displays the 'Art_Course_Database' connection, with the 'Tables (Filtered)' node expanded to show 'COURSE', 'CUSTOMER', and 'ENROLLMENT'. A tooltip points to the 'CUSTOMER' table. The central area contains a 'Worksheet' tab with an SQL query:

```
SELECT CUSTOMER.CustomerLastName,
       CUSTOMER.CustomerFirstName, CUSTOMER.Phone,
       COURSE.CourseDate, ENROLLMENT.AmountPaid,
       COURSE.Course, COURSE.Fee
  FROM CUSTOMER, ENROLLMENT, COURSE
 WHERE CUSTOMER.CustomerNumber=ENROLLMENT.CustomerNumber
   AND COURSE.CourseNumber=ENROLLMENT.CourseNumber;
```

An arrow points from the 'Run' button in the toolbar to the 'Worksheet' tab. Below the worksheet is a 'Query Result' tab displaying the execution of the query, showing 8 rows of data:

	CUSTOMERLASTNAME	CUSTOMERFIRSTNAME	PHONE	COURSEDATE	AMOUNTPAID	COURSE	FEE
1	Johnson	Ariel	206-567-1234	15-MAR-19	350	Int Pastels	350
2	Johnson	Ariel	206-567-1234	01-OCT-19	250	Adv Pastels	500
3	Green	Robin	425-678-8765	15-SEP-19	350	Beg Oils	350
4	Jackson	Charles	360-789-3456	01-OCT-19	500	Adv Pastels	500
5	Pearson	Jeffery	206-567-2345	01-OCT-19	500	Adv Pastels	500
6	Sears	Miguel	360-789-4567	15-SEP-19	350	Beg Oils	350
7	Kyle	Leah	425-678-7654	15-NOV-19	250	Adv Pastels	500
8	Myers	Lynda	360-789-5678	15-OCT-19	0	Beg Oils	350

At the bottom, the status bar shows the file path 'Saved: C:\Users\Auer\Documents\Oracle Workspace\DBC-e09-Art-Course-Database Scripts\DBC-e09-ODB-Art-Course-Database-Insert-Data.sql' and the current line and column information.

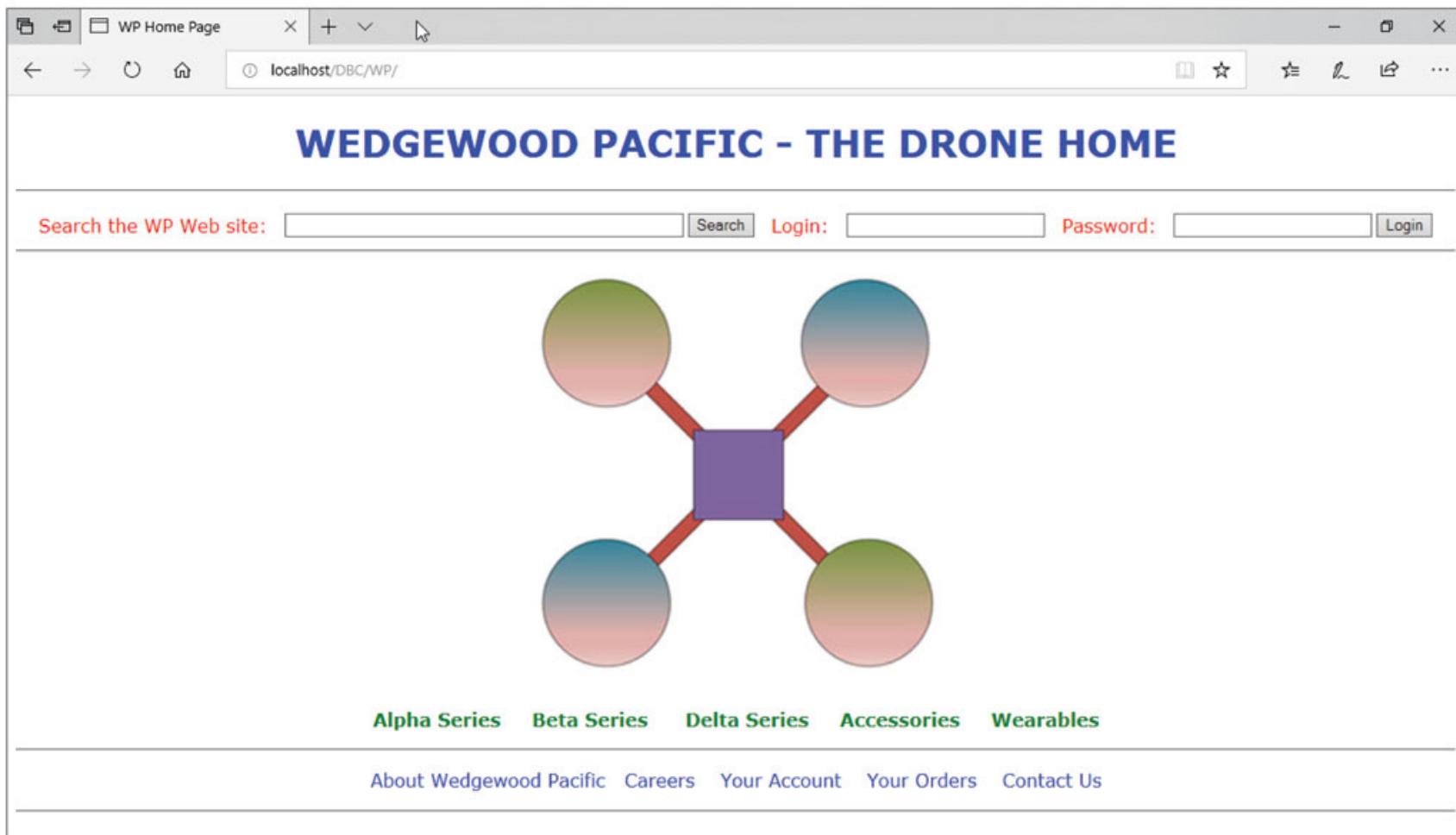
Oracle DatabaseXE, SQL Developer 18.4, Oracle Corporation.

What is a Web Database Application?

Introduce Web database applications

- A **Web database application** is an application with a Web user interface that is dependent on a database to store the data needed by the application (see Figure 1.32).
- An application programming interface (API) is a programming language such as PHP or JavaScript to connect to a DBMS allowing the sending of SQL commands to the DBMS and then to receive them back.

Figure 1.32 The WP Web Page



Microsoft Edge, Windows 10, Microsoft Corporation.

What are Data Warehouses and Business Intelligence (BI) Systems?

Introduce data warehouses and business intelligence (BI) systems

- **Transactions** are purchases bought online that are recorded in a company's database, also referred to as an **online transaction processing (OLTP)** database.
- Data analysis is done on an organization's **online analytical processing (OLAP)** database and is used for research.
- A **business intelligence system** consists of tools used to analyze and report on company data.

What is Big Data?

Introduce Big Data and cloud computing

- **Big Data** is the current term for the enormous datasets generated by Web and mobile applications.
- **Nonrelational databases** are used to store Big Data (also known as NoSQL).

Figure 1.33 ArangoDB

The screenshot shows the ArangoDB web interface. On the left, a sidebar lists 'COLLECTIONS', 'QUERIES' (selected), 'GRAPHS', 'SERVICES', 'LOGS', 'SUPPORT', 'HELP US', and 'GET ENTERPRISE'. The main area has tabs for 'Editor', 'Running Queries', and 'Slow Query History'. In the 'Editor' tab, there is a code editor with the following AQL query:

```
1 FOR c IN COURSES  
2 RETURN c
```

A callout box points to this code with the text: 'The query written in ArangoDB query language (AQL)'. Below the code editor is a table with the following data:

_key	_id	_rev	CourseNumber	Course	CourseDate	Fee	Enrollments
17183940	COURSES/17183940	_W8-BLay-B	2	Beg Oils	9/15/2019	350	[{"CustomerNumber":2,"CustomerLastName":"Green","CustomerFirstName":"Robin","Phone":"425-678-8765","AmountPaid":350}, {"CustomerNumber":5,"CustomerLastName":"Sears","CustomerFirstName":"Miguel","Phone":"360-789-4567","AmountPaid":350}]
17183944	COURSES/17183944	_W8-BLay-F	4	Beg Oils	10/15/2019	350	[{"CustomerNumber":7,"CustomerLastName":"Myers","CustomerFirstName":"Lynda","Phone":"360-789-5678","AmountPaid":0}]
17183936	COURSES/17183936	_W8-BLay_-	1	Adv Pastels	10/1/2019	500	[{"CustomerNumber":1,"CustomerLastName":"Johnson","CustomerFirstName":"Ariel","Phone":"206-567-1234","AmountPaid":250}, {"CustomerNumber":3,"CustomerLastName":"Jackson","CustomerFirstName":"Charles","Phone":"360-789-3456","AmountPaid":500}, {"CustomerNumber":4,"CustomerLastName":"Pearson","CustomerFirstName":"Jeffery","Phone":"206-567-2345","AmountPaid":500}]
17183942	COURSES/17183942	_W8-BLay-D	3	Int Pastels	3/15/2019	350	[{"CustomerNumber":1,"CustomerLastName":"Johnson","CustomerFirstName":"Ariel","Phone":"206-567-1234","AmountPaid":350}]
17183946	COURSES/17183946	_W8-BLay-H	5	Adv Pastels	11/15/2019	500	[{"CustomerNumber":6,"CustomerLastName":"Kyle","CustomerFirstName":"Leah","Phone":"425-678-7654","AmountPaid":250}]

A callout box points to the table with the text: 'The query results in table format—note the extra columns _key, _id, and _rev'. At the bottom right of the interface, there are buttons for 'Download', 'CSV', and 'Copy To Editor'.

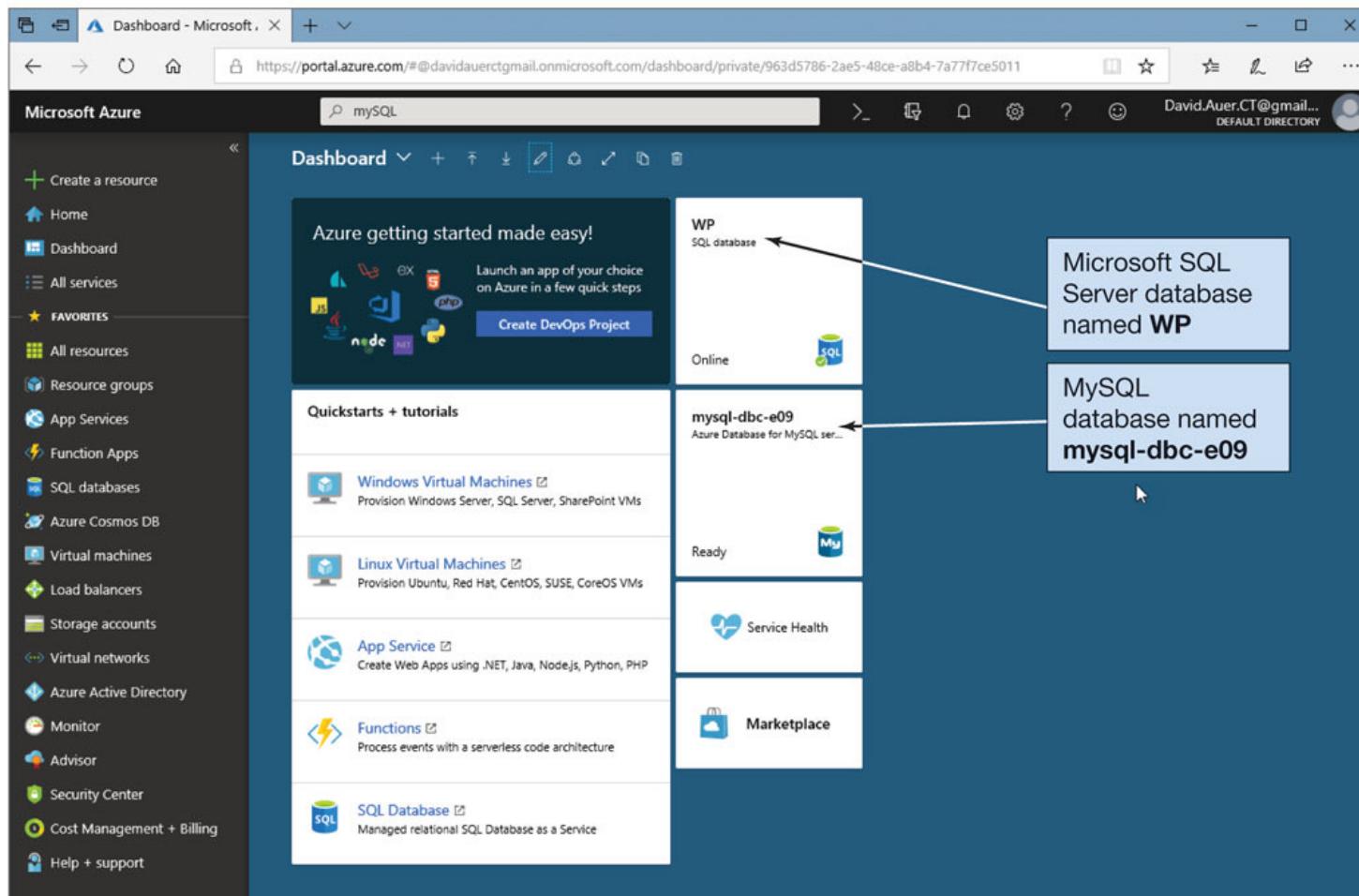
Courtesy of ArangoDB GmbH.

What is Cloud Computing?

Introduce Big Data and cloud computing

- **Cloud Computing** is the use of another company's hardware to conduct business via an Internet connection or through a Web server.
- Examples include:
 - Amazon Web Services (AWS)
 - Google Cloud Platform

Figure 1.34 Microsoft Azure Cloud Service



Azure, Microsoft Edge, Microsoft Corporation.

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