Chapter 35

Advanced Java Database Programming

Objectives

- To create a universal SQL client for accessing local or remote database (§35.2).
- To execute SQL statements in a batch mode (§35.3).
- To process updatable and scrollable result sets (§35.4).
- To simplify Java database programming using RowSet (§35.5).
- To store and retrieve images in JDBC (§35.6).

35.1 Introduction

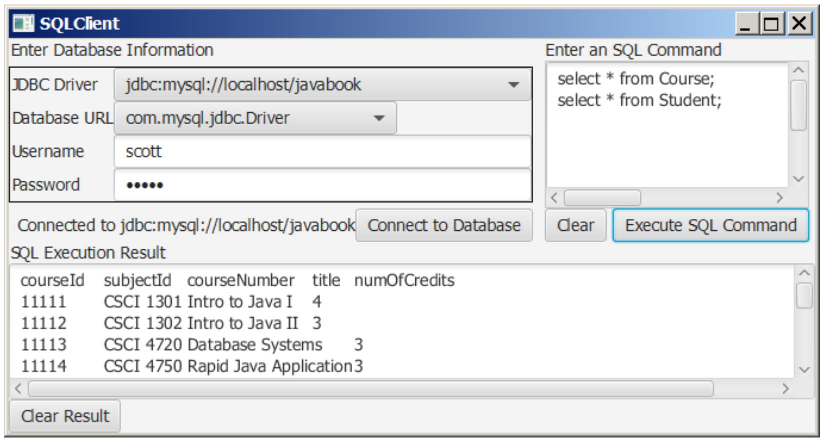
Key Point: This chapter introduces advanced features for Java database programming.

Chapter 32 introduced JDBC's basic features. This chapter covers its advanced features. You will learn how to develop a universal SQL client for accessing any local or remote relational database, learn how to execute statements in a batch mode to improve performance, learn scrollable result sets and how to update a database through result sets, learn how to use RowSet to simplify database access, and learn how to store and retrieve images.

35.2 A Universal SQL Client

Key Point: This section develops a universal SQL client for connecting and accessing any SQL database.

In Chapter 32, you used various drivers to connect to the database, created statements for executing SQL statements, and processed the results from SQL queries. This section presents a universal SQL client that enables you to connect to any relational database and execute SQL commands interactively, as shown in Figure 35.1. The client can connect to any JDBC data source and can submit SQL SELECT commands and non-SELECT commands for execution. The execution result is displayed for the SELECT queries, and the execution status is displayed for the non-SELECT commands. Listing 35.1 gives the program.



JDBC Driver: jdbc:mysql://localhost/javabook
Database URL: com.mysql.jdbc.Driver
Username: scott
Password: •••••

```
select * from Course;
select * from Student;
```

Connected to jdbc:mysql://localhost/javabook

```
courseId   subjectId   courseNumber   title   numOfCredits
11111      CSCI 1301 Intro to Java I   4
11112      CSCI 1302 Intro to Java II   3
11113      CSCI 4720 Database Systems     3
11114      CSCI 4750 Rapid Java Application3
```

Figure 35.1

You can connect to any JDBC data source and execute SQL commands interactively.

Listing 35.1 SQLClient.java

```java
import java.sql.*;
import javafx.application.Application;
import javafx.collections.FXCollections;
import javafx.geometry.Pos;
import javafx.scene.Scene;
import javafx.scene.control.Button;
import javafx.scene.control.ComboBox;
import javafx.scene.control.Label;
import javafx.scene.control.PasswordField;
import javafx.scene.control.ScrollPane;
import javafx.scene.control.TextArea;
import javafx.scene.control.TextField;
import javafx.scene.layout.BorderPane;
import javafx.scene.layout.GridPane;
import javafx.scene.layout.HBox;
import javafx.scene.layout.VBox;
import javafx.stage.Stage;

public class SQLClient extends Application {
  // Connection to the database
  private Connection connection;

  // Statement to execute SQL commands
  private Statement statement;

  // Text area to enter SQL commands
  private TextArea tasqlCommand = new TextArea();

  // Text area to display results from SQL commands
  private TextArea taSQLResult = new TextArea();

  // DBC info for a database connection
  private TextField tfUsername = new TextField();
  private PasswordField pfPassword = new PasswordField();
  private ComboBox<String> cboURL = new ComboBox<>();
  private ComboBox<String> cboDriver = new ComboBox<>();

  private Button btExecuteSQL = new Button("Execute SQL Command");
  private Button btClearSQLCommand = new Button("Clear");
  private Button btConnectDB = new Button("Connect to Database");
  private Button btClearSQLResult = new Button("Clear Result");
  private Label lblConnectionStatus
    = new Label("No connection now");

  @Override // Override the start method in the Application class
  public void start(Stage primaryStage) {
    cboURL.getItems().addAll(FXCollections.observableArrayList(
      "jdbc:mysql://localhost/javabook",
      "jdbc:mysql://liang.armstrong.edu/javabook",
      "jdbc:odbc:exampleMDBDataSource",
      "jdbc:oracle:thin:@liang.armstrong.edu:1521:orcl"));
    cboURL.getSelectionModel().selectFirst();

    cboDriver.getItems().addAll(FXCollections.observableArrayList(
      "com.mysql.jdbc.Driver", "sun.jdbc.odbc.dbcOdbcDriver",
      "oracle.jdbc.driver.OracleDriver"));
    cboDriver.getSelectionModel().selectFirst();

    // Create UI for connecting to the database
    GridPane gridPane = new GridPane();
    gridPane.add(cboURL, 1, 0);
    gridPane.add(cboDriver, 1, 1);
    gridPane.add(tfUsername, 1, 2);
    gridPane.add(pfPassword, 1, 3);
    gridPane.add(new Label("JDBC Driver"), 0, 0);
    gridPane.add(new Label("Database URL"), 0, 1);
    gridPane.add(new Label("Username"), 0, 2);
    gridPane.add(new Label("Password"), 0, 3);

    HBox hBoxConnection = new HBox();
    hBoxConnection.getChildren().addAll(
      lblConnectionStatus, btConnectDB);
    hBoxConnection.setAlignment(Pos.CENTER_RIGHT);

    VBox vBoxConnection = new VBox(5);
    vBoxConnection.getChildren().addAll(
      new Label("Enter Database Information"),
      gridPane, hBoxConnection);

    gridPane.setStyle("-fx-border-color: black;");

    HBox hBoxSQLCommand = new HBox(5);
    hBoxSQLCommand.getChildren().addAll(
      btClearSQLCommand, btExecuteSQL);
    hBoxSQLCommand.setAlignment(Pos.CENTER_RIGHT);

    BorderPane borderPaneSqlCommand = new BorderPane();
    borderPaneSqlCommand.setTop(
      new Label("Enter an SQL Command"));
    borderPaneSqlCommand.setCenter(
      new ScrollPane(tasqlCommand));
    borderPaneSqlCommand.setBottom(
      hBoxSQLCommand);

    HBox hBoxConnectionCommand = new HBox(10);
    hBoxConnectionCommand.getChildren().addAll(
      vBoxConnection, borderPaneSqlCommand);

    BorderPane borderPaneExecutionResult = new BorderPane();
    borderPaneExecutionResult.setTop(
      new Label("SQL Execution Result"));
    borderPaneExecutionResult.setCenter(taSQLResult);
    borderPaneExecutionResult.setBottom(btClearSQLResult);

    BorderPane borderPane = new BorderPane();
    borderPane.setTop(hBoxConnectionCommand);
    borderPane.setCenter(borderPaneExecutionResult);

    // Create a scene and place it in the stage
    Scene scene = new Scene(borderPane, 670, 400);
    primaryStage.setTitle("SQLClient"); // Set the stage title
    primaryStage.setScene(scene); // Place the scene in the stage
    primaryStage.show(); // Display the stage

    btConnectDB.setOnAction(e -> connectToDB());
    btExecuteSQL.setOnAction(e -> executeSQL());
    btClearSQLCommand.setOnAction(e -> tasqlCommand.setText(null));
    btClearSQLResult.setOnAction(e -> taSQLResult.setText(null));
  }

  /** Connect to DB */
  private void connectToDB() {
    // Get database information from the user input
    String driver = cboDriver
        .getSelectionModel().getSelectedItem();
    String url = cboURL.getSelectionModel().getSelectedItem();
    String username = tfUsername.getText().trim();
    String password = pfPassword.getText().trim();

    // Connection to the database
    try {
      Class.forName(driver);
      connection = DriverManager.getConnection(
        url, username, password);
      lblConnectionStatus.setText("Connected to " + url);
    }
    catch (java.lang.Exception ex) {
      ex.printStackTrace();
    }
  }

  /** Execute SQL commands */
  private void executeSQL() {
    if (connection == null) {
      taSQLResult.setText("Please connect to a database first");
      return;
    }
    else {
      String sqlCommands = tasqlCommand.getText().trim();
      String[] commands = sqlCommands.replace('\n', ' ').split(";");

      for (String aCommand: commands) {
        if (aCommand.trim().toUpperCase().startsWith("SELECT")) {
          processSQLSelect(aCommand);
        }
        else {
          processSQLNonSelect(aCommand);
        }
      }
    }
  }

  /** Execute SQL SELECT commands */
  private void processSQLSelect(String sqlCommand) {
    try {
      // Get a new statement for the current connection
      statement = connection.createStatement();

      // Execute a SELECT SQL command
      ResultSet resultSet = statement.executeQuery(sqlCommand);

      // Find the number of columns in the result set
      int columnCount = resultSet.getMetaData().getColumnCount();
      String row = "";

      // Display column names
      for (int i = 1; i <= columnCount; i++) {
        row += resultSet.getMetaData().getColumnName(i) + "\t";
      }

      taSQLResult.appendText(row + '\n');

      while (resultSet.next()) {
        // Reset row to empty
        row = "";

        for (int i = 1; i <= columnCount; i++) {
          // A non-String column is converted to a string
          row += resultSet.getString(i) + "\t";
        }

        taSQLResult.appendText(row + '\n');
```

```
193          }
194        }
195        catch (SQLException ex) {
196          taSQLResult.setText(ex.toString());
197        }
198      }
199
200      /** Execute SQL DDL, and modification commands */
201      private void processSQLNonSelect(String sqlCommand) {
202        try {
203          // Get a new statement for the current connection
204          statement = connection.createStatement();
205
206          // Execute a non-SELECT SQL command
207          statement.executeUpdate(sqlCommand);
208
209          taSQLResult.setText("SQL command executed");
210        }
211        catch (SQLException ex) {
212          taSQLResult.setText(ex.toString());
213        }
214      }
215    }
```

The user selects or enters the JDBC driver, database URL, username, and password, and clicks the *Connect to Database* button to connect to the specified database using the connectToDB() method (lines 130-147).

When the user clicks the *Execute SQL Command* button, the executeSQL() method is invoked (lines 150-168) to get the SQL commands from the text area (jtaSQLCommand) and extract each command separated by a semicolon (;). It then determines whether the command is a SELECT query or a DDL or data modification statement (lines 160-165). If the command is a SELECT query, the processSQLSelect method is invoked (lines 171-205). This method uses the executeQuery method (line 177) to obtain the query result. The result is displayed in the text area jtaSQLResult (line 188). If the command is a non-SELECT query, the processSQLNonSelect() method is invoked (lines 208-221). This method uses the executeUpdate method (line 214) to execute the SQL command.

The getMetaData method (lines 180, 185) in the ResultSet interface is used to obtain an instance of ResultSetMetaData. The getColumnCount method (line 180) returns the number of columns in the result set, and the getColumnName(i) method (line 185) returns the column name for the *i*th column.

35.3 Batch Processing

Key Point: You can send a batch of SQL statements to the database for execution at once to improve efficiency.

In all the preceding examples, SQL commands are submitted to the database for execution one at a time. This is inefficient for processing a large number of updates. For example, suppose you wanted to insert a thousand rows into a table. Submitting one INSERT command at a time would take nearly a thousand times longer than submitting all the INSERT commands in a batch at once. To improve performance, JDBC introduced the

batch update for processing nonselect SQL commands. A batch update consists of a sequence of nonselect SQL commands. These commands are collected in a batch and submitted to the database all together.
To use the batch update, you add nonselect commands to a batch using the addBatch method in the Statement interface. After all the SQL commands are added to the batch, use the executeBatch method to submit the batch to the database for execution.

For example, the following code adds a create table command, adds two insert statements in a batch, and executes the batch.

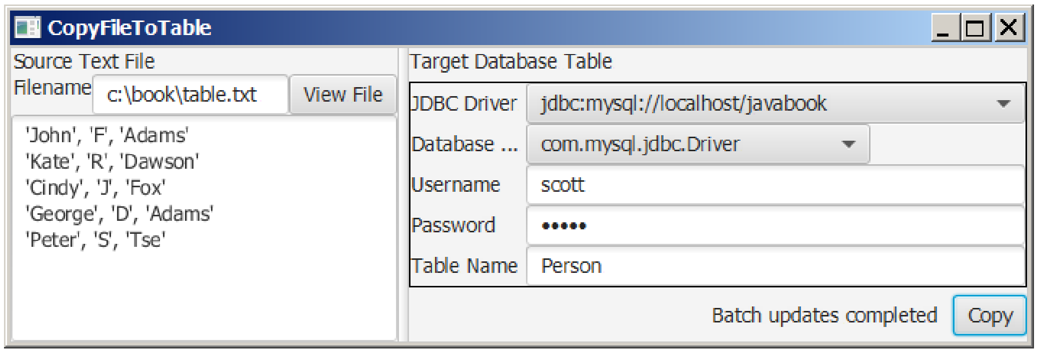
```
Statement statement = connection.createStatement();

// Add SQL commands to the batch
statement.addBatch("create table T (C1 integer, C2 varchar(15))");
statement.addBatch("insert into T values (100, 'Smith')");
statement.addBatch("insert into T values (200, 'Jones')");

// Execute the batch
int count[] = statement.executeBatch();
```

The executeBatch() method returns an array of counts, each of which counts the number of rows affected by the SQL command. The first count returns 0 because it is a DDL command. The other counts return 1 because only one row is affected.

> NOTE: To find out whether a driver supports batch updates, invoke supportsBatchUpdates() on a DatabaseMetaData instance. If the driver supports batch updates, it will return true. The JDBC drivers for MySQL, Access, and Oracle all support batch updates.

To demonstrate batch processing, consider writing a program that gets data from a text file and copies the data from the text file to a table, as shown in Figure 35.2. The text file consists of lines that each corresponds to a row in the table. The fields in a row are separated by commas. The string values in a row are enclosed in single quotes. You can view the text file by clicking the *View File* button and copy the text to the table by clicking the *Copy* button. The table must already be defined in the database. Figure 35.2 shows the text file table.txt copied to table Person. Person is created using the following statement:

```
create table Person (
  firstName varchar(20),
  mi char(1),
  lastName varchar(20)
)
```



Filename: c:\book\table.txt

```
'John', 'F', 'Adams'
'Kate', 'R', 'Dawson'
'Cindy', 'J', 'Fox'
'George', 'D', 'Adams'
'Peter', 'S', 'Tse'
```

JDBC Driver: jdbc:mysql://localhost/javabook
Database ...: com.mysql.jdbc.Driver
Username: scott
Password: •••••
Table Name: Person

Batch updates completed

Figure 35.2

The CopyFileToTable utility copies text files to database tables.

Listing 35.2 gives the solution to the problem.

Listing 35.2 CopyFileToTable.java

```
import java.io.File;
import java.io.FileNotFoundException;
import java.io.IOException;
import java.sql.*;
import java.util.Scanner;
import javafx.application.Application;
import javafx.collections.FXCollections;
import javafx.geometry.Pos;
import javafx.scene.Scene;
import javafx.scene.control.Button;
import javafx.scene.control.ComboBox;
import javafx.scene.control.Label;
import javafx.scene.control.PasswordField;
import javafx.scene.control.SplitPane;
import javafx.scene.control.TextArea;
import javafx.scene.control.TextField;
import javafx.scene.layout.BorderPane;
import javafx.scene.layout.GridPane;
import javafx.scene.layout.HBox;
import javafx.scene.layout.VBox;
import javafx.stage.Stage;

public class CopyFileToTable extends Application {
  // Text file info
  private TextField tfFilename = new TextField();
  private TextArea taFile = new TextArea();

  // JDBC and table info
  private ComboBox<String> cboURL = new ComboBox<>();
  private ComboBox<String> cboDriver = new ComboBox<>();
  private TextField tfUsername = new TextField();
  private PasswordField pfPassword = new PasswordField();
  private TextField tfTableName = new TextField();

  private Button btViewFile = new Button("View File");
  private Button btCopy = new Button("Copy");
  private Label lblStatus = new Label();

  @Override // Override the start method in the Application class
  public void start(Stage primaryStage) {
    cboURL.getItems().addAll(FXCollections.observableArrayList(
      "jdbc:mysql://localhost/javabook",
      "jdbc:mysql://liang.armstrong.edu/javabook",
      "jdbc:odbc:exampleMDBDataSource",
      "jdbc:oracle:thin:@liang.armstrong.edu:1521:orcl"));
    cboURL.getSelectionModel().selectFirst();

    cboDriver.getItems().addAll(FXCollections.observableArrayList(
      "com.mysql.jdbc.Driver", "sun.jdbc.odbc.dbcOdbcDriver",
      "oracle.jdbc.driver.OracleDriver"));
    cboDriver.getSelectionModel().selectFirst();

    // Create UI for connecting to the database
    GridPane gridPane = new GridPane();
    gridPane.add(new Label("JDBC Driver"), 0, 0);
    gridPane.add(new Label("Database URL"), 0, 1);
    gridPane.add(new Label("Username"), 0, 2);
    gridPane.add(new Label("Password"), 0, 3);
    gridPane.add(new Label("Table Name"), 0, 4);
    gridPane.add(cboURL, 1, 0);
    gridPane.add(cboDriver, 1, 1);
    gridPane.add(tfUsername, 1, 2);
    gridPane.add(pfPassword, 1, 3);
    gridPane.add(tfTableName, 1, 4);

    HBox hBoxConnection = new HBox(10);
    hBoxConnection.getChildren().addAll(lblStatus, btCopy);
    hBoxConnection.setAlignment(Pos.CENTER_RIGHT);

    VBox vBoxConnection = new VBox(5);
    vBoxConnection.getChildren().addAll(
      new Label("Target Database Table"),
      gridPane, hBoxConnection);

    gridPane.setStyle("-fx-border-color: black;");

    BorderPane borderPaneFileName = new BorderPane();
    borderPaneFileName.setLeft(new Label("Filename"));
    borderPaneFileName.setCenter(tfFilename);
    borderPaneFileName.setRight(btViewFile);

    BorderPane borderPaneFileContent = new BorderPane();
    borderPaneFileContent.setTop(borderPaneFileName);
    borderPaneFileContent.setCenter(taFile);

    BorderPane borderPaneFileSource = new BorderPane();
    borderPaneFileSource.setTop(new Label("Source Text File"));
    borderPaneFileSource.setCenter(borderPaneFileContent);

    SplitPane sp = new SplitPane();
    sp.getItems().addAll(borderPaneFileSource, vBoxConnection);

    // Create a scene and place it in the stage
    Scene scene = new Scene(sp, 680, 230);
    primaryStage.setTitle("CopyFileToTable"); // Set the stage title
    primaryStage.setScene(scene); // Place the scene in the stage
    primaryStage.show(); // Display the stage

    btViewFile.setOnAction(e -> showFile());
    btCopy.setOnAction(e -> {
        try {
          copyFile();
        }
        catch (Exception ex) {
          lblStatus.setText(ex.toString());
        }
    });
  }

  /** Display the file in the text area */
  private void showFile() {
    Scanner input = null;
    try {
      // Use a Scanner to read text from the file
      input = new Scanner(new File(tfFilename.getText().trim()));

      // Read a line and append the line to the text area
      while (input.hasNext())
        taFile.appendText(input.nextLine() + '\n');
    }
    catch (FileNotFoundException ex) {
      System.out.println("File not found: " + tfFilename.getText());
    }
    catch (IOException ex) {
      ex.printStackTrace();
    }
    finally {
      if (input != null) input.close();
    }
  }

  private void copyFile() throws Exception {
    // Load the JDBC driver
    Class.forName(cboDriver.getSelectionModel()
      .getSelectedItem().trim());
    System.out.println("Driver loaded");

    // Establish a connection
    Connection conn = DriverManager.getConnection(
      cboURL.getSelectionModel().getSelectedItem().trim(),
      tfUsername.getText().trim(),
      String.valueOf(pfPassword.getText()).trim());
    System.out.println("Database connected");

    // Read each line from the text file and insert it to the table
    insertRows(conn);
  }

  private void insertRows(Connection connection) {
    // Build the SQL INSERT statement
    String sqlInsert = "insert into " + tfTableName.getText()
      + " values (";

    // Use a Scanner to read text from the file
    Scanner input = null;

    // Get file name from the text field
    String filename = tfFilename.getText().trim();

    try {
      // Create a scanner
      input = new Scanner(new File(filename));

```

```
164          // Create a statement
165          Statement statement = connection.createStatement();
166
167          System.out.println("Driver major version? " +
168            connection.getMetaData().getDriverMajorVersion());
169
170          // Determine if batchUpdatesSupported is supported
171          boolean batchUpdatesSupported = false;
172
173          try {
174            if (connection.getMetaData().supportsBatchUpdates()) {
175              batchUpdatesSupported = true;
176              System.out.println("batch updates supported");
177            }
178            else {
179              System.out.println("The driver " +
180                "does not support batch updates");
181            }
182          }
183          catch (UnsupportedOperationException ex) {
184            System.out.println("The operation is not supported");
185          }
186
187          // Determine if the driver is capable of batch updates
188          if (batchUpdatesSupported) {
189            // Read a line and add the insert table command to the batch
190            while (input.hasNext()) {
191              statement.addBatch(sqlInsert + input.nextLine() + ")");
192            }
193
194            statement.executeBatch();
195
196            lblStatus.setText("Batch updates completed");
197          }
198          else {
199            // Read a line and execute insert table command
200            while (input.hasNext()) {
201              statement.executeUpdate(sqlInsert + input.nextLine() + ")");
202            }
203
204            lblStatus.setText("Single row update completed");
205          }
206        }
207        catch (SQLException ex) {
208          System.out.println(ex);
209        }
210        catch (FileNotFoundException ex) {
211          System.out.println("File not found: " + filename);
212        }
213        finally {
214          if (input != null) input.close();
215        }
216      }
217    }
```

The insertRows method (lines 128-195) uses the batch updates to submit SQL INSERT commands to the database for execution, if the driver supports batch updates. Lines 152-164 check whether the driver supports batch updates. If the driver does not support the operation, an UnsupportedOperationException exception will be thrown (line 162) when the supportsBatchUpdates() method is invoked.

The tables must already be created in the database. The file format and contents must match the database table specification. Otherwise, the SQL INSERT command will fail.

In Exercise 35.1, you will write a program to insert a thousand records to a database and compare the performance with and without batch updates.

Check point

35.1 What is batch processing in JDBC? What are the benefits of using batch processing?

35.2 How do you add an SQL statement to a batch? How do you execute a batch?

35.3 Can you execute a SELECT statement in a batch?

35.4 How do you know whether a JDBC driver supports batch updates?

35.4 Scrollable and Updatable Result Set

Key Point: You can use scrollable and updatable result set to move the cursor anywhere in the result set to perform insertion, deletion, and update.

The result sets used in the preceding examples are read sequentially. A result set maintains a cursor pointing to its current row of data. Initially the cursor is positioned before the first row. The next() method moves the cursor forward to the next row. This is known as *sequential forward reading*.

A more powerful way of accessing database is to use a scrollable and updatable result, which enables you to scroll the rows both forward and backward and move the cursor to a desired location using the first, last, next, previous, absolute, or relative method. Additionally, you can insert, delete, or update a row in the result set and have the changes automatically reflected in the database.

To obtain a scrollable or updatable result set, you must first create a statement with an appropriate type and concurrency mode. For a static statement, use

```
Statement statement = connection.createStatement
  (int resultSetType, int resultSetConcurrency);
```

For a prepared statement, use

```
PreparedStatement statement = connection.prepareStatement
  (String sql, int resultSetType, int resultSetConcurrency);
```

The possible values of resultSetType are the constants defined in the ResultSet:

- TYPE_FORWARD_ONLY: The result set is accessed forward sequentially.
- TYPE_SCROLL_INSENSITIVE: The result set is scrollable, but not sensitive to changes in the database.

- TYPE_SCROLL_SENSITIVE: The result set is scrollable and sensitive to changes made by others. Use this type if you want the result set to be scrollable and updatable.

The possible values of resultSetConcurrency are the constants defined in the ResultSet:

- CONCUR_READ_ONLY: The result set cannot be used to update the database.

- CONCUR_UPDATABLE: The result set can be used to update the database.

For example, if you want the result set to be scrollable and updatable, you can create a statement, as follows:

```
Statement statement = connection.createStatement
  (ResultSet.TYPE_SCROLL_SENSITIVE, ResultSet.CONCUR_UPDATABLE)
```

You use the executeQuery method in a Statement object to execute an SQL query that returns a result set as follows:

```
ResultSet resultSet = statement.executeQuery(query);
```

You can now use the methods first(), next(), previous(), and last() to move the cursor to the first row, next row, previous row, and last row. The absolute(int row) method moves the cursor to the specified row; and the get*Xxx*(int columnIndex) or get*Xxx*(String columnName) method is used to retrieve the value of a specified field at the current row. The methods insertRow(), deleteRow(), and updateRow() can also be used to insert, delete, and update the current row. Before applying insertRow or updateRow, you need to use the method updateXxx(int columnIndex, *Xxx* value) or update(String columnName, *Xxx* value) to write a new value to the field at the current row. The cancelRowUpdates() method cancels the updates made to a row. The close() method closes the result set and releases its resource. The wasNull() method returns true if the last column read had a value of SQL NULL.

Listing 35.3 gives an example that demonstrates how to create a scrollable and updatable result set. The program creates a result set for the StateCapital table. The StateCapital table is defined as follows:

```
create table StateCapital (
  state varchar(40),
  capital varchar(40)
);
```

Listing 35.3 ScrollUpdateResultSet.java

```
import java.sql.*;

public class ScrollUpdateResultSet {
  public static void main(String[] args)
      throws SQLException, ClassNotFoundException {
    // Load the JDBC driver
    Class.forName("oracle.jdbc.driver.OracleDriver");
    System.out.println("Driver loaded");

    // Connect to a database
    Connection connection = DriverManager.getConnection
      ("jdbc:oracle:thin:@liang.armstrong.edu:1521:orcl",
       "scott", "tiger");
    connection.setAutoCommit(true);
    System.out.println("Database connected");

    // Get a new statement for the current connection
    Statement statement = connection.createStatement(
      ResultSet.TYPE_SCROLL_SENSITIVE, ResultSet.CONCUR_UPDATABLE);

    // Get ResultSet
    ResultSet resultSet = statement.executeQuery
      ("select state, capital from StateCapital");

    System.out.println("Before update ");
    displayResultSet(resultSet);

    // Update the second row
    resultSet.absolute(2); // Move cursor to the second row
    resultSet.updateString("state", "New S"); // Update the column
    resultSet.updateString("capital", "New C"); // Update the column
    resultSet.updateRow(); // Update the row in the data source

    // Insert after the last row
    resultSet.last();
    resultSet.moveToInsertRow(); // Move cursor to the insert row
    resultSet.updateString("state", "Florida");
    resultSet.updateString("capital", "Tallahassee");
    resultSet.insertRow(); // Insert the row
    resultSet.moveToCurrentRow(); // Move the cursor to the current row

    // Delete fourth row
    resultSet.absolute(4); // Move cursor to the 5th row
    resultSet.deleteRow(); // Delete the second row

    System.out.println("After update ");
    resultSet = statement.executeQuery
      ("select state, capital from StateCapital");
    displayResultSet(resultSet);

    // Close the connection
    resultSet.close();
  }

  private static void displayResultSet(ResultSet resultSet)
      throws SQLException {
    ResultSetMetaData rsMetaData = resultSet.getMetaData();
    resultSet.beforeFirst();
    while (resultSet.next()) {
      for (int i = 1; i <= rsMetaData.getColumnCount(); i++)
        System.out.printf("%-12s\t", resultSet.getObject(i));
      System.out.println();
    }
  }
}
```

<Output>

```
Driver loaded
Database connected
```

```
Before update
Indiana          Indianapolis
Illinois    Springfield
California       Sacramento
Georgia          Atlanta
Texas            Austin

After update
Indiana          Indianapolis
New S            New C
California       Sacramento
Texas            Austin
Florida          Tallahassee
```

The code in lines 18-19 creates a Statement for producing scrollable and updatable result sets.

The program moves the cursor to the second row in the result set (line 29), updates two columns in this row (lines 30-31), and invokes the updateRow() method to update the row in the underlying database (line 32).

An updatable ResultSet object has a special row associated with it that serves as a staging area for building a row to be inserted. This special row is called the *insert row*. To insert a row, first invoke the moveToInsertRow() method to move the cursor to the insert row (line 36), then update the columns using the updateXxx method (lines 37–38), and finally insert the row using the insertRow() method (line 39). Invoking moveToCurrentRow() moves the cursor to the current inserted row (lines 40).

The program moves to the fourth row and invokes the deleteRow() method to delete the row from the database (lines 43–44).

> NOTE: Not all current drivers support scrollable and updatable result sets. The example is tested using Oracle ojdbc6 driver. You can use supportsResultSetType(int type) and supportsResultSetConcurrency(int type, int concurrency) in the DatabaseMetaData interface to find out which result type and currency modes are supported by the JDBC driver. But even if a driver supports the scrollable and updatable result set, a result set for a complex query might not be able to perform an update. For example, the result set for a query that involves several tables is likely not to support update operations.

> NOTE: The program may not work, if lines 22–23 are replaced by

```
 ResultSet resultSet = statement.executeQuery
   ("select * from StateCapital");
```

Check point

35.5 What is a scrollable result set? What is an updatable result set?

35.6 How do you create a scrollable and updatable ResultSet?

35.7 How do you know whether a JDBC driver supports a scrollable and updatable ResultSet?

35.5 RowSet, JdbcRowSet, and CachedRowSet

Key Point: The RowSet interface can be used to simplify database programming.

The RowSet interface extends java.sql.ResultSet with additional capabilities that allow a RowSet instance to be configured to connect to a JDBC url, username, and password, set an SQL command, execute the command, and retrieve the execution result. In essence, it combines Connection, Statement, and ResultSet into one interface.

> NOTE:
> Not all JDBC drivers support RowSet. Currently, the JDBC-ODBC driver does not support all features of RowSet.

35.5.1 RowSet Basics

There are two types of RowSet objects: connected and disconnected. A *connected* RowSet object makes a connection with a data source and maintains that connection throughout its life cycle. A disconnected RowSet object makes a connection with a data source, executes a query to get data from the data source, and then closes the connection. A *disconnected* rowset may make changes to its data while it is disconnected and then send the changes back to the original source of the data, but it must reestablish a connection to do so.

There are several versions of RowSet. Two frequently used are JdbcRowSet and CachedRowSet. Both are subinterfaces of RowSet. JdbcRowSet is connected, while CachedRowSet is disconnected. Also, JdbcRowSet is neither serializable nor cloneable, while CachedRowSet is both. The database vendors are free to provide concrete implementations for these interfaces. Sun has provided the reference implementation JdbcRowSetImpl for JdbcRowSet and CachedRowSetImpl for CachedRowSet. Figure 35.3 shows the relationship of these components.

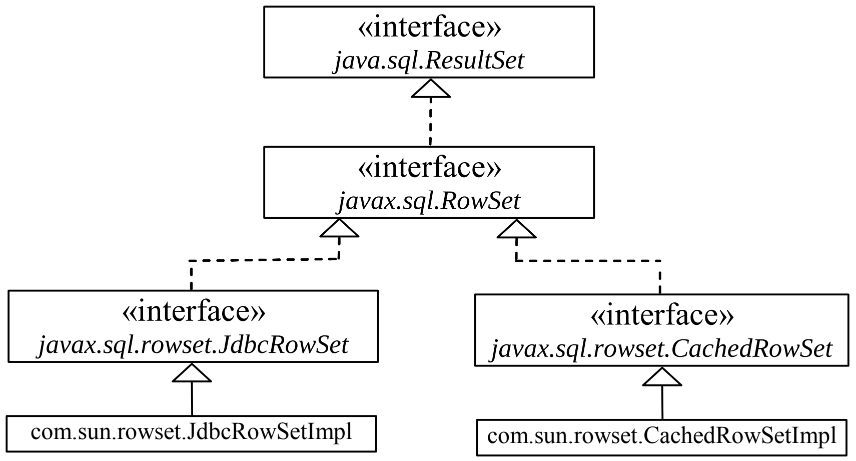

«interface»
java.sql.ResultSet
«interface»
javax.sql.RowSet
«interface»
javax.sql.rowset.JdbcRowSet
«interface»
javax.sql.rowset.CachedRowSet
com.sun.rowset.JdbcRowSetImpl
com.sun.rowset.CachedRowSetImpl

Figure 35.3

The JdbcRowSetImpl and CachedRowSetImpl are concrete implementations of RowSet.

The RowSet interface contains the JavaBeans properties with get and set methods. You can use the set methods to set a new url, username, password, and command for an SQL statement. Using a RowSet, Listing 37.1 can be simplified, as shown in Listing 35.4.

Listing 35.4 SimpleRowSet.java

```
 1  import java.sql.SQLException;
 2  import javax.sql.RowSet;
 3  import com.sun.rowset.*;
 4
 5  public class SimpleRowSet {
 6    public static void main(String[] args)
 7        throws SQLException, ClassNotFoundException {
 8      // Load the JDBC driver
 9      Class.forName("com.mysql.jdbc.Driver");
10      System.out.println("Driver loaded");
11
12      // Create a row set
13      RowSet rowSet = new JdbcRowSetImpl();
14
15      // Set RowSet properties
16      rowSet.setUrl("jdbc:mysql://localhost/javabook");
17      rowSet.setUsername("scott");
18      rowSet.setPassword("tiger");
19      rowSet.setCommand("select firstName, mi, lastName " +
20        "from Student where lastName = 'Smith'");
21      rowSet.execute();
22
23      // Iterate through the result and print the student names
24      while (rowSet.next())
25        System.out.println(rowSet.getString(1) + "\t" +
26          rowSet.getString(2) + "\t" + rowSet.getString(3));
27
28      // Close the connection
29      rowSet.close();
30    }
31  }
```

Line 13 creates a RowSet object using JdbcRowSetImpl. The program uses the RowSet's set method to set a URL, username, and password (lines 16-18) and a command for a query statement (line 19). Line 24 executes the command in the RowSet. The methods next() and getString(int) for processing the query result (lines 25-26) are inherited from ResultSet.

If you replace JdbcRowSet with CachedRowSet in line 13, the program will work just fine. Note that the JDBC-ODBC driver supports JdbcRowSetImpl, but not CachedRowSetImpl.

TIP
Since RowSet is a subinterface of ResultSet, all the methods in ResultSet can be used in RowSet. For example,

you can obtain ResultSetMetaData from a RowSet using the getMetaData() method.

35.5.2 RowSet for PreparedStatement

The discussion in §32.5, “PreparedStatement,” introduced processing parameterized SQL statements using the PreparedStatement interface. RowSet has the capability to support parameterized SQL statements. The set methods for setting parameter values in PreparedStatement are implemented in RowSet. You can use these methods to set parameter values for a parameterized SQL command. Listing 35.5 demonstrates how to use a parameterized statement in RowSet. Line 19 sets an SQL query statement with two parameters for lastName and mi in a RowSet. Since these two parameters are strings, the setString method is used to set actual values in lines 21-22.

Listing 35.5 RowSetPreparedStatement.java

```java
 1  import java.sql.*;
 2  import javax.sql.RowSet;
 3  import com.sun.rowset.*;
 4
 5  public class RowSetPreparedStatement {
 6    public static void main(String[] args)
 7        throws SQLException, ClassNotFoundException {
 8      // Load the JDBC driver
 9      Class.forName("com.mysql.jdbc.Driver");
10      System.out.println("Driver loaded");
11
12      // Create a row set
13      RowSet rowSet = new JdbcRowSetImpl();
14
15      // Set RowSet properties
16      rowSet.setUrl("jdbc:mysql://localhost/javabook");
17      rowSet.setUsername("scott");
18      rowSet.setPassword("tiger");
19      rowSet.setCommand("select * from Student where lastName = ? " +
20        "and mi = ?");
21      rowSet.setString(1, "Smith");
22      rowSet.setString(2, "R");
23      rowSet.execute();
24
25      ResultSetMetaData rsMetaData = rowSet.getMetaData();
26      for (int i = 1; i <= rsMetaData.getColumnCount(); i++)
27        System.out.printf("%-12s\t", rsMetaData.getColumnName(i));
28      System.out.println();
29
30      // Iterate through the result and print the student names
31      while (rowSet.next()) {
32        for (int i = 1; i <= rsMetaData.getColumnCount(); i++)
33          System.out.printf("%-12s\t", rowSet.getObject(i));
34        System.out.println();
35      }
36
37      // Close the connection
38      rowSet.close();
39    }
40  }
```

35.5.3 Scrolling and Updating RowSet

By default, a ResultSet object is neither scrollable nor updatable. However, a RowSet object is both. It is easier to scroll and update a database through a RowSet than through a ResultSet. Listing 35.6 rewrites Listing 35.3 using a RowSet. You can use methods such as absolute(int) to move the cursor and methods such as delete(), updateRow(), and insertRow() to update the database.

Listing 35.6 ScrollUpdateRowSet.java

```java
import java.sql.*;
import javax.sql.RowSet;
import com.sun.rowset.JdbcRowSetImpl;

public class ScrollUpdateRowSet {
  public static void main(String[] args)
      throws SQLException, ClassNotFoundException {
    // Load the JDBC driver
    Class.forName("com.mysql.jdbc.Driver");
    System.out.println("Driver loaded");

    // Create a row set
    RowSet rowSet = new JdbcRowSetImpl();

    // Set RowSet properties
    rowSet.setUrl("jdbc:mysql://localhost/javabook");
    rowSet.setUsername("scott");
    rowSet.setPassword("tiger");
    rowSet.setCommand("select state, capital from StateCapital");
    rowSet.execute();

    System.out.println("Before update ");
    displayRowSet(rowSet);

    // Update the second row
    rowSet.absolute(2); // Move cursor to the 2nd row
    rowSet.updateString("state", "New S"); // Update the column
    rowSet.updateString("capital", "New C"); // Update the column
    rowSet.updateRow(); // Update the row in the data source

    // Insert after the second row
    rowSet.last();
    rowSet.moveToInsertRow(); // Move cursor to the insert row
    rowSet.updateString("state", "Florida");
    rowSet.updateString("capital", "Tallahassee");
    rowSet.insertRow(); // Insert the row
    rowSet.moveToCurrentRow(); // Move the cursor to the current row

    // Delete fourth row
    rowSet.absolute(4); // Move cursor to the fifth row
    rowSet.deleteRow(); // Delete the second row

    System.out.println("After update ");
    displayRowSet(rowSet);

46      // Close the connection
47      rowSet.close();
48    }
49
50    private static void displayRowSet(RowSet rowSet)
51        throws SQLException {
52      ResultSetMetaData rsMetaData = rowSet.getMetaData();
53      rowSet.beforeFirst();
54      while (rowSet.next()) {
55        for (int i = 1; i <= rsMetaData.getColumnCount(); i++)
56          System.out.printf("%-12s\t", rowSet.getObject(i));
57        System.out.println();
58      }
59    }
60  }
```

If you replace JdbcRowSet with CachedRowSet in line 13, the database is not changed. To make the changes on the CachedRowSet effective in the database, you must invoke the acceptChanges() method after you make all the changes, as follows:

```
        // Write changes back to the database
        ((com.sun.rowset.CachedRowSetImpl)rowSet).acceptChanges();
```

This method automatically reconnects to the database and writes all the changes back to the database.

35.5.4 RowSetEvent

A RowSet object fires a RowSetEvent whenever the object's cursor has moved, a row has changed, or the entire row set has changed. This event can be used to synchronize a RowSet with the components that rely on the RowSet. For example, a visual component that displays the contents of a RowSet should be synchronized with the RowSet. The RowSetEvent can be used to achieve synchronization. The handlers in RowSetListener are cursorMoved(RowSetEvent), rowChanged(RowSetEvent), and cursorSetChanged(RowSetEvent).

Listing 35.7 gives an example that demonstrates RowSetEvent. A listener for RowSetEvent is registered in lines 14-26. When rowSet.execute() (line 33) is executed, the entire row set is changed, so the listener's rowSetChanged handler is invoked. When rowSet.last() (line 35) is executed, the cursor is moved, so the listener's cursorMoved handler is invoked. When rowSet.updateRow() (line 37) is executed, the row is updated, so the listener's rowChanged handler is invoked.

Listing 35.7 TestRowSetEvent.java

```
 1  import java.sql.*;
 2  import javax.sql.*;
 3  import com.sun.rowset.*;
 4
 5  public class TestRowSetEvent {
 6    public static void main(String[] args)
 7        throws SQLException, ClassNotFoundException {
 8      // Load the JDBC driver
 9      Class.forName("com.mysql.jdbc.Driver");
10      System.out.println("Driver loaded");
11
```

```
      // Create a row set
      RowSet rowSet = new JdbcRowSetImpl();
      rowSet.addRowSetListener(new RowSetListener() {
        public void cursorMoved(RowSetEvent e) {
          System.out.println("Cursor moved");
        }

        public void rowChanged(RowSetEvent e) {
          System.out.println("Row changed");
        }

        public void rowSetChanged(RowSetEvent e) {
          System.out.println("row set changed");
        }
      });

      // Set RowSet properties
      rowSet.setUrl("jdbc:mysql://localhost/javabook");
      rowSet.setUsername("scott");
      rowSet.setPassword("tiger");
      rowSet.setCommand("select * from Student");
      rowSet.execute();

      rowSet.last(); // Cursor moved
      rowSet.updateString("lastName", "Yao"); // Update column
      rowSet.updateRow(); // Row updated

      // Close the connection
      rowSet.close();
    }
  }
```

Check point

35.8 What are the advantages of RowSet?

35.9 What are JdbcRowSet and CachedRowSet? What are the differences between them?

35.10 How do you create a JdbcRowSet and a CachedRowSet?

35.11 Can you scroll and update a RowSet? What method must be invoked to write the changes in a CachedRowSet to the database?

35.12 Describe the handlers in RowSetListener.

35.6 Storing and Retrieving Images in JDBC

Key Point: You can store and retrieve images using JDBC.

A database can store not only numbers and strings, but also images. SQL3 introduced a new data type called BLOB (*B*inary *L*arge *OB*ject) for storing binary data, which can be used to store images. Another new SQL3 type is CLOB (*C*haracter *L*arge *OB*ject) for storing a large text in the character format. JDBC introduced the interfaces java.sql.Blob and java.sql.Clob to support mapping for these new SQL types. You can use getBlob, setBinaryStream, getClob, setBlob, and setClob, to access SQL BLOB and CLOB values in the interfaces ResultSet and PreparedStatement.

To store an image into a cell in a table, the corresponding column for the cell must be of the BLOB type. For example, the following SQL statement creates a table whose type for the flag column is BLOB.

```
create table Country(name varchar(30), flag blob,
  description varchar(255));
```

In the preceding statement, the description column is limited to 255 characters, which is the upper limit for MySQL. For Oracle, the upper limit is 32,672 bytes. For a large character field, you can use the CLOB type for Oracle, which can store up to two GB characters. MySQL does not support CLOB. However, you can use BLOB to store a long string and convert binary data into characters.

NOTE

Access does not support the BLOB and CLOB types.

To insert a record with images to a table, define a prepared statement like this one:

```
PreparedStatement pstmt = connection.prepareStatement(
  "insert into Country values(?, ?, ?)");
```

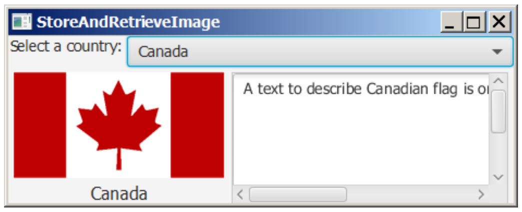
Images are usually stored in files. You may first get an instance of InputStream for an image file and then use the setBinaryStream method to associate the input stream with a cell in the table, as follows:

```
// Store image to the table cell
File file = new File(imageFilename);
InputStream inputImage = new FileInputStream(file);
pstmt.setBinaryStream(2, inputImage, (int)(file.length()));
```

To retrieve an image from a table, use the getBlob method, as shown below:

```
// Store image to the table cell
Blob blob = rs.getBlob(1);
ImageIcon imageIcon = new ImageIcon(
  blob.getBytes(1, (int)blob.length()));
```

Listing 35.8 gives a program that demonstrates how to store and retrieve images in JDBC. The program first creates the Country table and stores data to it. Then the program retrieves the country names from the table and adds them to a combo box. When the user selects a name from the combo box, the country's flag and description are displayed, as shown in Figure 35.4.



A text to describe Canadian flag is o

Figure 35.4

The program enables you to retrieve data, including images, from a table and displays them.

Listing 35.8 StoreAndRetrieveImage.java

```java
import java.sql.*;
import java.io.*;
import javafx.application.Application;
import javafx.scene.Scene;
import javafx.scene.control.ComboBox;
import javafx.scene.control.Label;
import javafx.scene.image.Image;
import javafx.scene.image.ImageView;
import javafx.scene.layout.BorderPane;
import javafx.stage.Stage;

public class StoreAndRetrieveImage extends Application {
  // Connection to the database
  private Connection connection;

  // Statement for static SQL statements
  private Statement stmt;

  // Prepared statement
  private PreparedStatement pstmt = null;
  private DescriptionPane descriptionPane
    = new DescriptionPane();

  private ComboBox<String> cboCountry = new ComboBox<>();

  @Override // Override the start method in the Application class
  public void start(Stage primaryStage) {
    try {
      connectDB(); // Connect to DB
      storeDataToTable(); //Store data to the table (including image)
      fillDataInComboBox(); // Fill in combo box

retrieveFlagInfo(cboCountry.getSelectionModel().getSelectedItem());
    }
    catch (Exception ex) {
      ex.printStackTrace();
    }

    BorderPane paneForComboBox = new BorderPane();
    paneForComboBox.setLeft(new Label("Select a country: "));
    paneForComboBox.setCenter(cboCountry);
    cboCountry.setPrefWidth(400);
    BorderPane pane = new BorderPane();
    pane.setTop(paneForComboBox);
    pane.setCenter(descriptionPane);

    Scene scene = new Scene(pane, 350, 150);
    primaryStage.setTitle("StoreAndRetrieveImage");
    primaryStage.setScene(scene); // Place the scene in the stage
    primaryStage.show(); // Display the stage

    cboCountry.setOnAction(e ->
      retrieveFlagInfo(cboCountry.getValue()));
  }

  private void connectDB() throws Exception {
    // Load the driver
    Class.forName("com.mysql.jdbc.Driver");
    System.out.println("Driver loaded");

    // Establish connection
    connection = DriverManager.getConnection
      ("jdbc:mysql://localhost/javabook", "scott", "tiger");
    System.out.println("Database connected");

    // Create a statement for static SQL
    stmt = connection.createStatement();

    // Create a prepared statement to retrieve flag and description
    pstmt = connection.prepareStatement("select flag, description " +
      "from Country where name = ?");
  }

  private void storeDataToTable() {
    String[] countries = {"Canada", "UK", "USA", "Germany",
      "Indian", "China"};

    String[] imageFilenames = {"image/ca.gif", "image/uk.gif",
      "image/us.gif", "image/germany.gif", "image/india.gif",
      "image/china.gif"};

    String[] descriptions = {"A text to describe Canadian " +
      "flag is omitted", "British flag ...", "American flag ...",
      "German flag ...", "Indian flag ...", "Chinese flag ..."};

    try {
      // Create a prepared statement to insert records
      PreparedStatement pstmt = connection.prepareStatement(
        "insert into Country values(?, ?, ?)");

      // Store all predefined records
      for (int i = 0; i < countries.length; i++) {
        pstmt.setString(1, countries[i]);

        // Store image to the table cell
        java.net.URL url =
          this.getClass().getResource(imageFilenames[i]);
        InputStream inputImage = url.openStream();
        pstmt.setBinaryStream(2, inputImage,
          (int)(inputImage.available()));

        pstmt.setString(3, descriptions[i]);
        pstmt.executeUpdate();
      }

      System.out.println("Table Country populated");
    }
    catch (Exception ex) {
      ex.printStackTrace();
    }
  }

  private void fillDataInComboBox() throws Exception {
    ResultSet rs = stmt.executeQuery("select name from Country");
    while (rs.next()) {
      cboCountry.getItems().add(rs.getString(1));
```

```
116      }
117      cboCountry.getSelectionModel().selectFirst();
118    }
119
120    private void retrieveFlagInfo(String name) {
121      try {
122        pstmt.setString(1, name);
123        ResultSet rs = pstmt.executeQuery();
124        if (rs.next()) {
125          Blob blob = rs.getBlob(1);
126          ByteArrayInputStream in = new ByteArrayInputStream
127            (blob.getBytes(1, (int)blob.length()));
128          Image image = new Image(in);
129          ImageView imageView = new ImageView(image);
130          descriptionPane.setImageView(imageView);
131          descriptionPane.setTitle(name);
132          String description = rs.getString(2);
133          descriptionPane.setDescription(description);
134        }
135      }
136      catch (Exception ex) {
137        System.err.println(ex);
138      }
139    }
140  }
```

DescriptionPane (line 21) is a component for displaying a country (name, flag, and description). This component was presented in Listing 16.6, DescriptionPane.java.

The storeDataToTable method (lines 73-110) populates the table with data. The fillDataInComboBox method (lines 112-118) retrieves the country names and adds them to the combo box. The retrieveFlagInfo(name) method (lines 120-139) retrieves the flag and description for the specified country name.

Check point

35.13 How do you store images into a database?

35.14 How do you retrieve images from a database?

35.15 Does Oracle support the SQL3 BLOB type and CLOB type? What about MySQL and Access?

Key Terms

- **BLOB type**
- **CLOB type**
- **batch mode**
- **cached row set**
- **row set**
- **scrollable result set**
- **updatable result set**

Chapter Summary

1. This chapter developed a universal SQL client that can be used to access any local or remote relational database.
2. You can use the addBatch(SQLString) method to add SQL statements to a statement for batch processing.
3. You can create a statement to specify that the result set be scrollable and updatable. By default, the result set is neither of these.
4. The RowSet can be used to simplify Java database programming. A RowSet object is scrollable and updatable. A RowSet can fire a RowSetEvent.
5. You can store and retrieve image data in JDBC using the SQL BLOB type.

Quiz

Answer the quiz for this chapter online at www.cs.armstrong.edu/liang/intro10e/quiz.html.

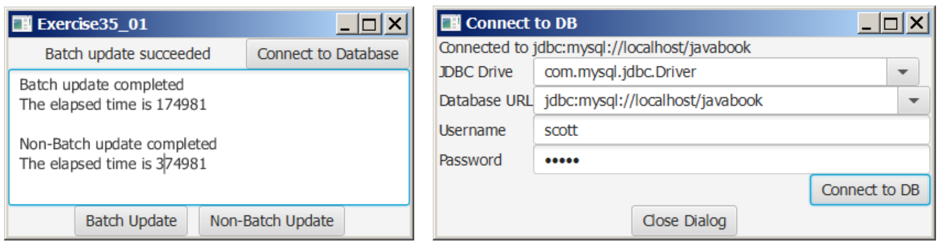
Programming Exercises

35.1*

(*Batch update*) Write a program that inserts a thousand records to a database, and compare the performance with and without batch updates, as shown in Figure 35.6a. Suppose the table is defined as follows:

```
create table Temp(num1 double, num2 double, num3 double)
```

Use the Math.random() method to generate random numbers for each record. Create a dialog box that contains DBConnectionPanel, discussed in Exercise 32.3. Use this dialog box to connect to the database. When you click the *Connect to Database* button in Figure 35.5a, the dialog box in Figure 35.5b is displayed.



```
Batch update completed
The elapsed time is 174981

Non-Batch update completed
The elapsed time is 374981
```

Connected to jdbc:mysql://localhost/javabook

JDBC Drive	com.mysql.jdbc.Driver
Database URL	jdbc:mysql://localhost/javabook
Username	scott
Password	•••••

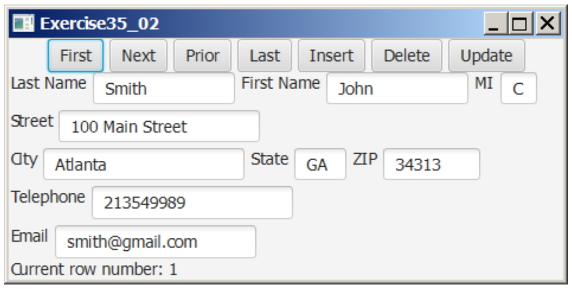
(a) (b)

Figure 35.5

The program demonstrates the performance improvements that result from using batch updates.

35.2**

(*Scrollable result set*) Write a program that uses the buttons *First*, *Next*, *Prior*, *Last*, *Insert*, *Delete*, and *Update*, and modify a single record in the Address table, as shown in Figure 35.6.



Last Name	Smith	First Name	John	MI	C
Street	100 Main Street				
City	Atlanta	State	GA	ZIP	34313
Telephone	213549989				
Email	smith@gmail.com				

Current row number: 1

Figure 35.6

You can use the buttons to display and modify a single record in the Address table.

The Address table is defined as follows:

```
create table Address (
  firstname varchar(25),
  mi char(1),
  lastname varchar(25),
  street varchar(40),
  city varchar(20),
  state varchar(2),
  zip varchar(5),
  telephone varchar(10),
  email varchar(30),
  primary key (firstname, mi, lastname)
);
```

*35.3 (*Display table contents*) Write a program that displays the content for a given table. As shown in Figure 35.8a, you enter a table and click the *Show Contents* button to display the table contents in a table view.

Figure 35.8

(a) Enter a table name to display the table contents. (b) Select a table name from the combo box to display

its contents.

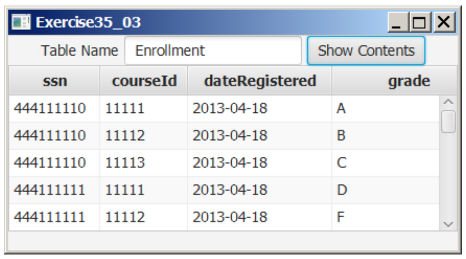


Table Name: Enrollment

ssn	courseId	dateRegistered	grade
444111110	11111	2013-04-18	A
444111110	11112	2013-04-18	B
444111110	11113	2013-04-18	C
444111111	11111	2013-04-18	D
444111111	11112	2013-04-18	F

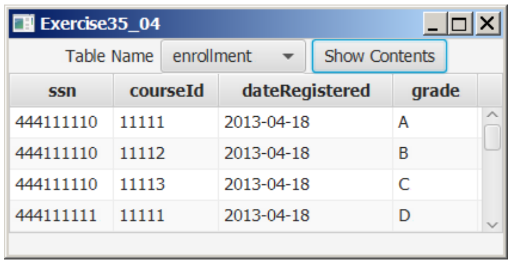


Table Name: enrollment

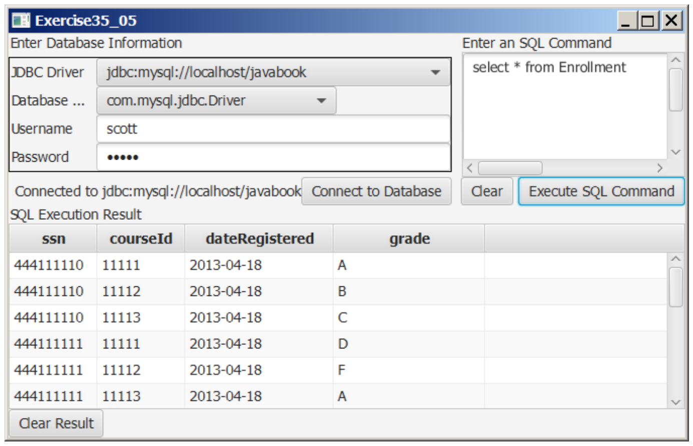
ssn	courseId	dateRegistered	grade
444111110	11111	2013-04-18	A
444111110	11112	2013-04-18	B
444111110	11113	2013-04-18	C
444111111	11111	2013-04-18	D

(a) (b)

***35.4** (*Find tables and showing their contents*) Write a program that fills in table names in a combo box, as shown in Figure 35.8b. You can select a table from the combo box to display its contents in a table view.

35.5**

(*Revise SQLClient.java*) Rewrite Listing 35.1, SQLClient.java, to display the query result in a TableView, as shown in Figure 35.9.



Enter Database Information

JDBC Driver: jdbc:mysql://localhost/javabook
Database ...: com.mysql.jdbc.Driver
Username: scott
Password: •••••

Enter an SQL Command

```
select * from Enrollment
```

Connected to jdbc:mysql://localhost/javabook

SQL Execution Result

ssn	courseId	dateRegistered	grade
444111110	11111	2013-04-18	A
444111110	11112	2013-04-18	B
444111110	11113	2013-04-18	C
444111111	11111	2013-04-18	D
444111111	11112	2013-04-18	F
444111111	11113	2013-04-18	A

Figure 35.9

The query result is displayed in a TableView.

35.5***

(*Edit table using RowSet*) Rewrite Listing 35.10 to add an *Insert* button to insert a new row and an *Update* button to update the row.

35.6*

(*Populate Salary table*) Rewrite Exercise 33.8 using a batch mode to improve performance.