24.9 PreparedStatements

A `PreparedStatement` enables you to create compiled SQL statements that execute more efficiently than `Statement`s. `PreparedStatement`s also can specify parameters, making them more flexible than `Statement`s—you can execute the same query repeatedly with different parameter values. For example, in the `books` database, you might want to locate all book titles for an author with a specific last and first name, and you might want to execute that query for several authors. With a `PreparedStatement`, that query is defined as:

```
PreparedStatement authorBooks = connection.prepareSta
      "SELECT LastName, FirstName, Title " +
      "FROM Authors INNER JOIN AuthorISBN " +
         "ON Authors.AuthorID=AuthorISBN.AuthorID " +
      "INNER JOIN Titles " +
         "ON AuthorISBN.ISBN=Titles.ISBN " +
      "WHERE LastName = ? AND FirstName = ?");
```

The two question marks (?) in the preceding SQL statement's last line are placeholders for values that will be passed to the database as part of the query. Before executing a `PreparedStatement`, the program must specify the values by using the `PreparedStatement` interface's *set* methods.

For the preceding query, both parameters are strings that can be set with `Prepared-Statement` method `setString` as follows:

```
authorBooks.setString(1, "Deitel");
authorBooks.setString(2, "Paul");
```

Method `setString`'s first argument represents the parameter number being set, and the second argument is that parameter's value. Parameter numbers are *counted from 1*, starting with the first question mark (?). When the program executes the preceding `Prepared-Statement` with the parameter values set above, the SQL passed to the database is

```
SELECT LastName, FirstName, Title
FROM Authors INNER JOIN AuthorISBN
   ON Authors.AuthorID=AuthorISBN.AuthorID
INNER JOIN Titles
   ON AuthorISBN.ISBN=Titles.ISBN
WHERE LastName = 'Deitel' AND FirstName = 'Paul'
```

Method `setString` automatically escapes `String` parameter values as necessary. For example, if the last name is O'Brien, the statement

```
authorBooks.setString(1, "O'Brien");
```

escapes the `'` character in O'Brien by replacing it with two single-quote characters, so that the `'` appears correctly in the

database.

Performance Tip 24.2

`PreparedStatement`*s are more efficient than* `Statement`*s when executing SQL statements multiple times and with different parameter values.*

Error-Prevention Tip 24.2

Use `PreparedStatement`*s with parameters for queries that receive* `String` *values as arguments to ensure that the* `String`*s are quoted properly in the SQL statement.*

Error-Prevention Tip 24.3

`PreparedStatement`*s help prevent SQL injection attacks, which typically occur in SQL statements that include user input improperly. To avoid this security issue, use* `Prepared-Statement`*s in which user input can be supplied only via parameters—indicated with ? when creating*

a `PreparedStatement`. *Once you've created such a* `PreparedStatement`, *you can use its* set *methods to specify the user input as arguments for those parameters.*

Interface `PreparedStatement` provides *set* methods for each supported SQL type. It's important to use the *set* method that's appropriate for the parameter's SQL type in the database—`SQLException`s occur when a program attempts to convert a parameter value to an incorrect type.

24.9.1 `AddressBook` App That Uses `PreparedStatements`

We now present an `AddressBook` JavaFX app that enables you to browse existing entries, add new entries and search for entries with a last name that begins with the specified characters. Our `addressbook` Java DB database (created in Section 24.5) contains an `Addresses` table with the columns `AddressID`, `FirstName`, `LastName`, `Email` and `PhoneNumber`. The column `AddressID` is an auto-incremented identity column in the `Addresses` table.

24.9.2 Class `Person`

Our `AddressBook` loads data into `Person` objects (Fig. 24.31). Each represents one entry in the `addressbook` database. The class contains instance variables for the address ID, first name, last name, email address and phone number, as well as *set* and *get* methods for manipulating these fields and a `toString` method that returns the `Person`'s name in the format

```
last name, first name
```

Though we do not use the address ID in this example, we included it in class `Person` for use in Exercises 24.7–24.8.

```
1   // Fig. 24.31: Person.java
2   // Person class that represents an entry in an a
3   public class Person {
4      private int addressID;
5      private String firstName;
6      private String lastName;
7      private String email;
8      private String phoneNumber;
9
10      // constructor
11      public Person() {}
12
13      // constructor
14      public Person(int addressID, String firstName
15         String email, String phoneNumber) {
16         setAddressID(addressID);
17         setFirstName(firstName);
18         setLastName(lastName);
19         setEmail(email);
20         setPhoneNumber(phoneNumber);
21      }
22
23      // sets the addressID
24      public void setAddressID(int addressID) {this
25
26      // returns the addressID
27      public int getAddressID() {return addressID;}
28
29      // sets the firstName
30      public void setFirstName(String firstName) {
31         this.firstName = firstName;
32      }
33
34      // returns the first name
```

```
35      public String getFirstName() {return firstNam
                    36
           37      // sets the lastName
38      public void setLastName(String lastName) {thi
                    39
         40      // returns the last name
41      public String getLastName() {return lastName;
                    42
         43      // sets the email address
44      public void setEmail(String email) {this.emai
                    45
       46      // returns the email address
 47      public String getEmail() {return email;}
                    48
         49      // sets the phone number
50      public void setPhoneNumber(String phoneNumber
    51          this.phoneNumber = phoneNumber;
                     52      }
                    53
        54      // returns the phone number
55      public String getPhoneNumber() {return phoneN
                    56
57      // returns the string representation of the P
                58      @Override
         59      public String toString()
60         {return getLastName() + ", " + getFirstNam
                    61   }
```

Fig. 24.31

`Person` class that represents an entry in an address book.

24.9.3 Class

PersonQueries

Class `PersonQueries` (Fig. 24.32) manages the **Address Book** application's database connection and creates the `PreparedStatement`s for interacting with the database. Lines 17– 19 declare three `PreparedStatement` variables. The constructor (lines 22–47) connects to the database at lines 24–25.

```
 1   // Fig. 24.32: PersonQueries.java
 2   // PreparedStatements used by the Address Book a
 3   import java.sql.Connection;
 4   import java.sql.DriverManager;
 5   import java.sql.PreparedStatement;
 6   import java.sql.ResultSet;
 7   import java.sql.SQLException;
 8   import java.util.List;
 9   import java.util.ArrayList;
10
11   public class PersonQueries {
12      private static final String URL = "jdbc:derby
13      private static final String USERNAME = "deite
14      private static final String PASSWORD = "deite
15
16      private Connection connection; // manages con
17      private PreparedStatement selectAllPeople;
18      private PreparedStatement selectPeopleByLastN
19      private PreparedStatement insertNewPerson;
20
21      // constructor
22      public PersonQueries() {
23         try {
24            connection =
25               DriverManager.getConnection(URL, USE
26
27            // create query that selects all entrie
```

```
            selectAllPeople = connection.prepareSta
               "SELECT * FROM Addresses ORDER BY La

            // create query that selects entries wi
            // that begin with the specified charac
            selectPeopleByLastName = connection.pre
               "SELECT * FROM Addresses WHERE LastN
               "ORDER BY LastName, FirstName");

            // create insert that adds a new entry
            insertNewPerson = connection.prepareSta
                "INSERT INTO Addresses " +
               "(FirstName, LastName, Email, PhoneN
                  "VALUES (?, ?, ?, ?)");
                }
         catch (SQLException sqlException) {
            sqlException.printStackTrace();
            System.exit(1);
         }
      }

   // select all of the addresses in the databas
      public List<Person> getAllPeople() {
      // executeQuery returns ResultSet containi
      try (ResultSet resultSet = selectAllPeople
         List<Person> results = new ArrayList<Pe

            while (resultSet.next()) {
               results.add(new Person(
               resultSet.getInt("AddressID"),
               resultSet.getString("FirstName"),
               resultSet.getString("LastName"),
               resultSet.getString("Email"),
               resultSet.getString("PhoneNumber"
            }

            return results;
         }
      catch (SQLException sqlException) {
         sqlException.printStackTrace();
```

```
                }

            return null;
        }

    // select person by last name
    public List<Person> getPeopleByLastName(Strin
        try {
            selectPeopleByLastName.setString(1, las
        }
        catch (SQLException sqlException) {
            sqlException.printStackTrace();
            return null;
        }

        // executeQuery returns ResultSet containi
        try (ResultSet resultSet = selectPeopleByL
            List<Person> results = new ArrayList<Pe

            while (resultSet.next()) {
                results.add(new Person(
                    resultSet.getInt("addressID"),
                    resultSet.getString("FirstName"),
                    resultSet.getString("LastName"),
                    resultSet.getString("Email"),
                    resultSet.getString("PhoneNumber"
                }

            return results;
        }
        catch (SQLException sqlException) {
            sqlException.printStackTrace();
            return null;
        }
    }

    // add an entry
    public int addPerson(String firstName, Strin
        String email, String phoneNumber) {

```

```
108         // insert the new entry; returns # of row
109         try {
110            // set parameters
111            insertNewPerson.setString(1, firstName
112            insertNewPerson.setString(2, lastName)
113            insertNewPerson.setString(4, email);
114            insertNewPerson.setString(4, phoneNumb
115
116            return insertNewPerson.executeUpdate()
117         }
118         catch (SQLException sqlException) {
119            sqlException.printStackTrace();
120            return 0;
121         }
122      }
123
124      // close the database connection
125      public void close() {
126         try {
127            connection.close();
128         }
129         catch (SQLException sqlException) {
130            sqlException.printStackTrace();
131         }
132      }
133   }
```

Fig. 24.32

`PreparedStatements` used by the **Address Book** application.

Creating `PreparedStatements`

Lines 28–29 invoke `Connection` method `prepareStatement` to create the `PreparedStatement` `selectAllPeople` that selects all the rows in the `Addresses` table and sorts them by last name, then by first name. Lines 33–35 create the `PreparedStatement` `selectPeopleByLastName` with a parameter. This statement uses the SQL `LIKE` operator to search the `Addresses` table by last name. The `?` character specifies the last-name parameter—as you'll see, the text we set as this parameter's value will end with `%`, so that the database will return entries for last names that start with the characters entered by the user. Lines 38–41 create the `PreparedStatement` `insertNewPerson` with four parameters that represent the first name, last name, email address and phone number for a new entry. Again, notice the `?` characters used to represent these parameters.

`PersonQueries` Method `getAllPeople`

Method `getAllPeople` (lines 50–71) executes `PreparedStatement` `selectAllPeople` (line 52) by calling method `executeQuery`, which returns a `ResultSet` containing the rows that match the query (in this

case, all the rows in the `Addresses` table). Lines 55–62 place the query results in an `ArrayList<Person>`, which is returned to the caller at line 64.

`PersonQueries` Method `getPeopleByLastName`

Method `getPeopleByLastName` (lines 74–102) uses `PreparedStatement` method `set-String` to set the parameter of `selectPeopleByLastName` (line 76). Then, line 84 executes the query and lines 87–94 place the query results in an `ArrayList<Person>`. Line 96 returns the `ArrayList` to the caller.

`PersonQueries` Methods `addPerson` and `Close`

Method `addPerson` (lines 105–122) uses `PreparedStatement` method `setString` (lines 111–114) to set the parameters for the `insertNewPerson` `PreparedStatement`. Line 116 uses `PreparedStatement` method `executeUpdate` to update the database by inserting the new record. This method returns an integer indicating the number of rows that were updated (or inserted) in the database. Method `close` (lines 125–132) simply closes the database connection.

24.9.4 AddressBook GUI

Figure 24.33 shows the app's GUI (defined in `AddressBook.fxml`) labeled with its **fx:id**s. Here we point out only the key elements and their event-handler methods, which you'll see in class `AddressBookController` (Fig. 24.34). For the complete layout details, open `AddressBook.fxml` in Scene Builder. The GUI's primary layout is a `BorderPane`. The controller class defines three event-handling methods:

- `addEntryButtonPressed` is called when the **Add Entry** `Button` is pressed.
- `findButtonPressed` is called when the **Find** `Button` is pressed.
- `browseAllButtonPressed` is called when the **Browse All** `Button` is pressed.

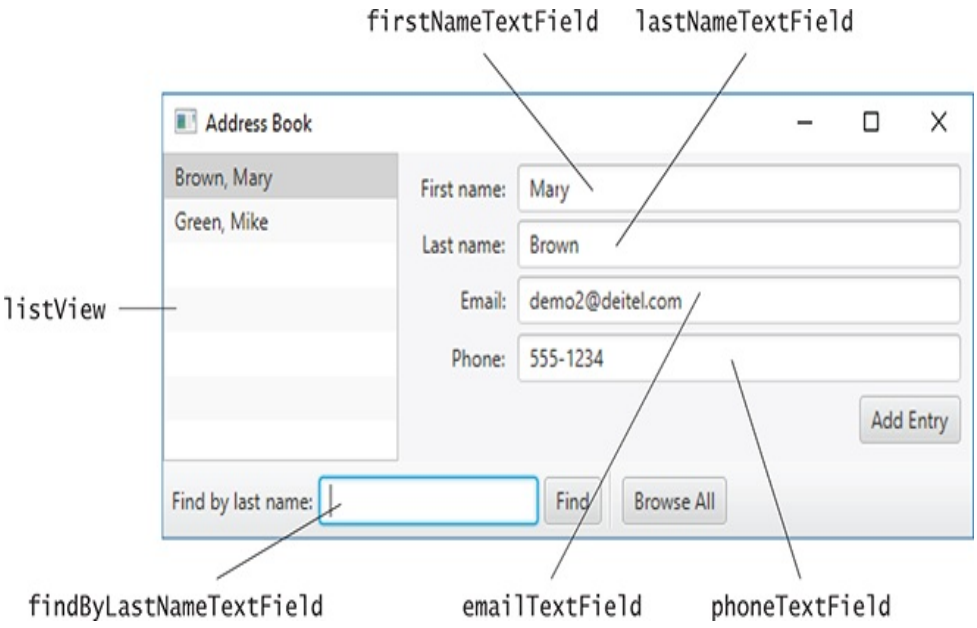


Fig. 24.33

`AddressBook` GUI with its **fx:id**s.

24.9.5 Class `AddressBookController`

The `AddressBookController` (Fig. 24.34) class uses a `PersonQueries` object to interact with the database. We do not show the JavaFX `Application` subclass here (located in `AddressBook.java`), because it performs the same tasks you've seen previously to load the app's FXML GUI and initialize the controller.

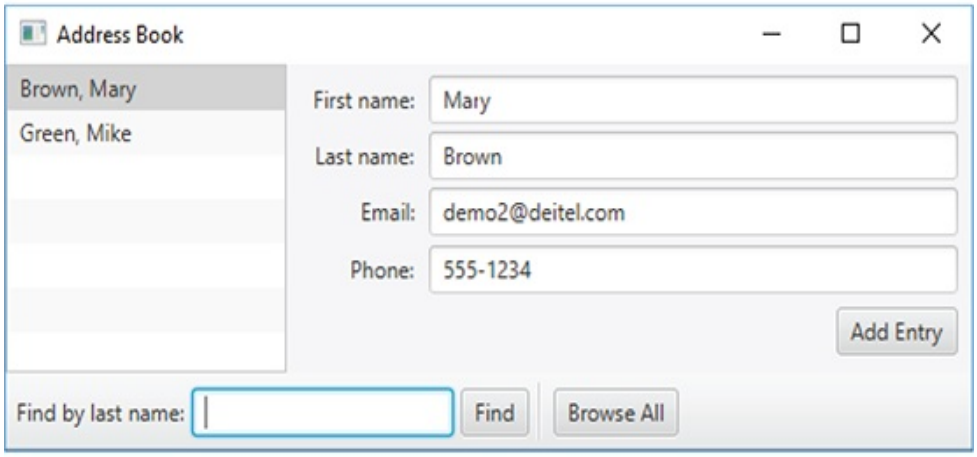
```
   1   // Fig. 24.34: AddressBookController.java
   2   // Controller for the AddressBook app
   3   import java.util.List;
   4   import javafx.application.Platform;
   5   import javafx.collections.FXCollections;
   6   import javafx.collections.ObservableList;
   7   import javafx.event.ActionEvent;
   8   import javafx.fxml.FXML;
   9   import javafx.scene.control.Alert;
  10   import javafx.scene.control.Alert.AlertType;
  11   import javafx.scene.control.ListView;
  12   import javafx.scene.control.TextField;
  13
  14   public class AddressBookController {
  15      @FXML private ListView<Person> listView; // d
  16      @FXML private TextField firstNameTextField;
  17      @FXML private TextField lastNameTextField;
  18      @FXML private TextField emailTextField;
```

```
    @FXML private TextField phoneTextField;
    @FXML private TextField findByLastNameTextFie

    // interacts with the database
    private final PersonQueries personQueries = n

    // stores list of Person objects that results
    private final ObservableList<Person> contactL
        FXCollections.observableArrayList();

    // populate listView and set up listener for
    public void initialize() {
        listView.setItems(contactList); // bind to
        getAllEntries(); // populates contactList,

        // when ListView selection changes, displa
        listView.getSelectionModel().selectedItemP
            (observableValue, oldValue, newValue) -
                displayContact(newValue);
            }
        );
    }

    // get all the entries from the database to p
    private void getAllEntries() {
        contactList.setAll(personQueries.getAllPeo
        selectFirstEntry();
    }

    // select first item in listView
    private void selectFirstEntry() {
        listView.getSelectionModel().selectFirst()
    }

    // display contact information
    private void displayContact(Person person) {
        if (person != null) {
            firstNameTextField.setText(person.getFi
            lastNameTextField.setText(person.getLas
            emailTextField.setText(person.getEmail(
```

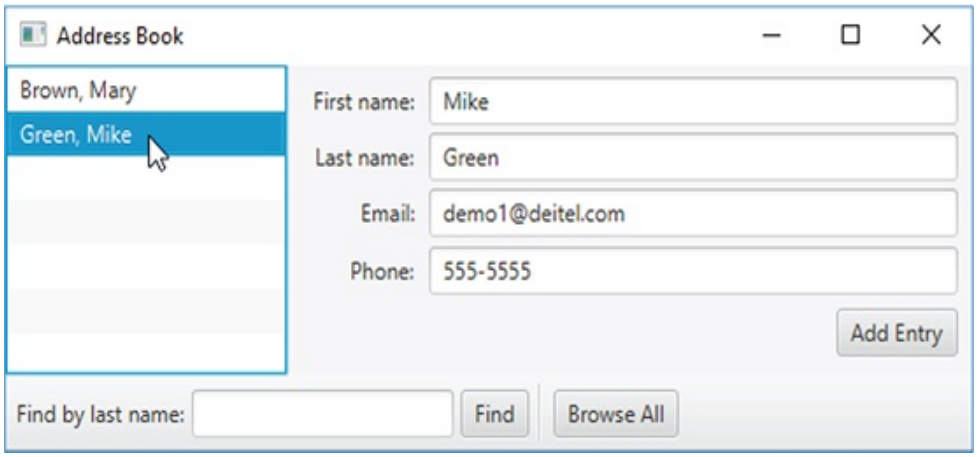
```
59            phoneTextField.setText(person.getPhoneN
                  60         }
                61         else {
    62            firstNameTextField.clear();
     63           lastNameTextField.clear();
      64           emailTextField.clear();
      65           phoneTextField.clear();
                  66         }
                   67      }
                       68
           69       // add a new entry
                  70      @FXML
71      void addEntryButtonPressed(ActionEvent event)
72         int result = personQueries.addPerson(
73            firstNameTextField.getText(), lastNameT
74            emailTextField.getText(), phoneTextFiel
                       75
          76         if (result == 1) {
77            displayAlert(AlertType.INFORMATION, "En
78               "New entry successfully added.");
                   79         }
                 80         else {
81            displayAlert(AlertType.ERROR, "Entry No
    82              "Unable to add entry.");
                   83         }
                       84
           85         getAllEntries();
                    86      }
                       87
88      // find entries with the specified last name
                  89      @FXML
90      void findButtonPressed(ActionEvent event) {
91         List<Person> people = personQueries.getPeo
92            findByLastNameTextField.getText() + "%"
                       93
94         if (people.size() > 0) { // display all en
    95            contactList.setAll(people);
        96            selectFirstEntry();
                   97         }
                 98         else {
```

```
99              displayAlert(AlertType.INFORMATION, "La
100                "There are no entries with the speci
                    101          }
                      102       }
                         103
          104       // browse all the entries
                      105       @FXML
106         void browseAllButtonPressed(ActionEvent even
              107           getAllEntries();
                        108       }
                           109
          110       // display an Alert dialog
          111       private void displayAlert(
112           AlertType type, String title, String mess
    113           Alert alert = new Alert(type);
        114           alert.setTitle(title);
    115           alert.setContentText(message);
         116           alert.showAndWait();
                        117       }
                         118    }
```

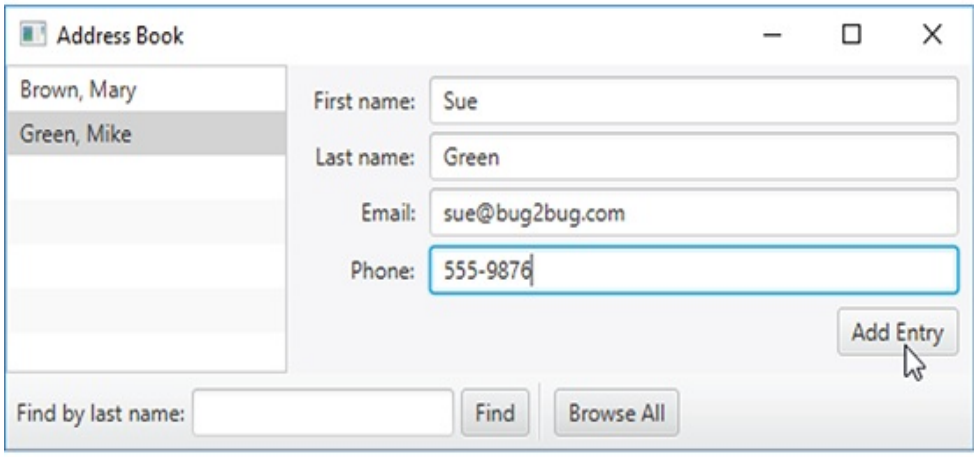
a) Initial **Address Book** screen showing entries.



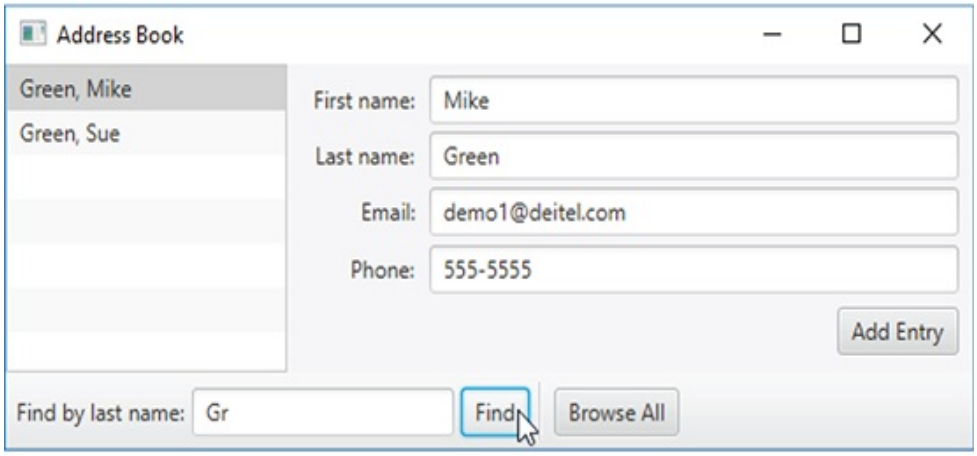
b) Viewing the entry for **Green, Mike**.



c) Adding a new entry for **Sue Green**.



d) Searching for last names that start with **Gr**.



e) Returning to the complete list by clicking **Browse All**.

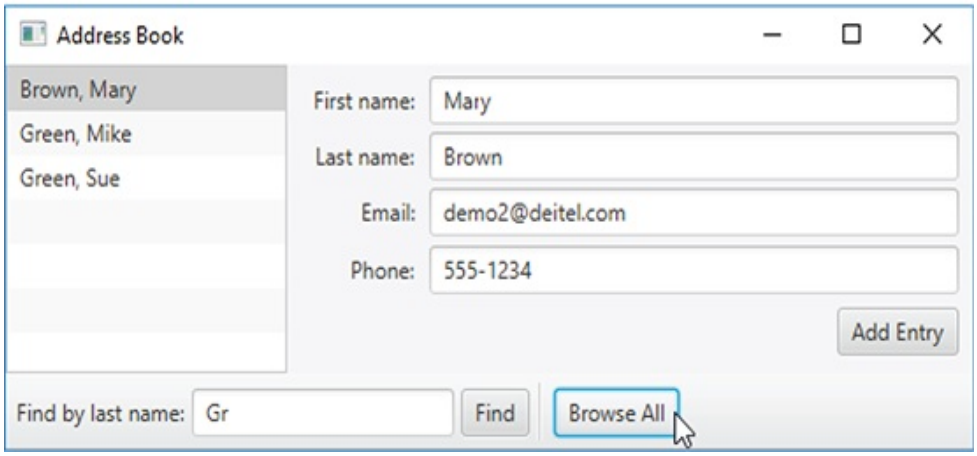


Fig. 24.34

Controller for the `AddressBook` app.

Instance Variables

Line 23 creates the `PersonQueries` object. We use the same techniques to populate the `ListView` that we used in Section 13.5, so lines 26–27 create an `ObservableList<Person>` named `contactList` to store the `Person` objects returned by the `PersonQueries` object.

Method `initialize`

When the FXMLLoader initializes the controller, method `initialize` (lines 30–40) performs the following tasks:

- Line 31 binds the `contactList` to the `ListView`, so that each time this `ObservableList<Person>` changes, the `ListView` will update its list of items.
- Line 32 calls method `getAllEntries` (declared in lines 43–46) to get all the entries from the database and place them in the `contactList`.
- Lines 35–39 register a `ChangeListener` that displays the selected contact when the user selects a new item in the `ListView`. In this case, we used a lambda expression to create the event handler (Fig. 13.15 showed a similar `ChangeListener` defined as an anonymous inner class).

Methods `getAllEntries` and `selectFirstEntry`

When the app first executes, when the user clicks the **Browse All** `Button` and when the user adds a new entry to the database, method `getEntries` (lines 43–46) calls `PersonQueries` method `getAllPeople` (line 44) to obtain all the entries. The resulting `List<Person>` is passed to `ObservableList` method `setAll` to replace the `contactList`'s contents. At this point, the `ListView` updates its list of items based on the new contents of `contactList`.

Next line 45 selects the first item in the `ListView` by calling method `select-FirstEntry` (lines 49–51). Line 50 selects the `ListView`'s first item to display that contact's data.

Method `displayContact`

When an item is selected in the `ListView`, the `ChangeListener` registered in method `initialize` calls `displayContact` (lines 54–67) to display the selected `Person`'s data. If the argument is `null`, the method clears the `TextField`'s contents.

Method `addEntryButtonPressed`

To add a new entry into the database, you can enter the first name, last name, email and phone number (the `AddressID` will *autoincrement*) in the `TextField`s that display contact information, then press the **Add Entry** `Button`. Method `addEntryButtonPressed` (lines 70–86) calls `PersonQueries` method `addPerson` (lines 72–74) to add the new entry to the database. Line 85 calls `getAllEntries` to obtain the updated database contents and display them in the `ListView`.

Method `findButtonPressed`

When the user presses the **Find** `Button`, method `findButtonPressed` (lines 89–102) is called. Lines 91–92 call `PersonQueries` method `getPeopleByLastName` to search the database. Note that line 92 appends a `%` to the text input by the user. This enables the corresponding SQL query, which contains a `LIKE` operator, to locate last names that begin with the characters the user typed in the `findByLastNameTextField`. If there are several such entries, they’re all displayed in the `ListView` when the `contactList` is updated (line 95) and the first one is selected (line 96).

Method `browseAllButtonPressed`

When the user presses the **Browse All** `Button`, method `browseAllButtonPressed` (lines 105–108) simply calls method `getAllEntries` to get all the database entries and display them in the `ListView`.