SQL and Java

Database Systems Lecture 20
Natasha Alechina
In this Lecture

• SQL in Java
  • SQL from within other Languages
  • SQL, Java, and JDBC
• For More Information
  • Sun Java tutorial:
    http://java.sun.com/docs/books/tutorial/jdbc
  • Connolly and Begg 29.7
  • Ullman and Widom 8.5
SQL and Other Languages

- Combining SQL and another language
  - Use SQL to run queries on the database
  - Use another language (Java, C, etc) to do the rest of the work: e.g. user interface, or complicated processing
  - Need an interface between the two

- ODBC (Open DB Connectivity) is a common standard
  - Provides an API which is widely supported
  - Allows you to pass queries to a database, and return the results to a program
JDBC

- JDBC is a Java API for database connectivity
  - It is not the same as ODBC but implements a similar specification
  - JDBC enables programmers to write Java applications that
    - Connect to a database
    - Send queries and update statements to the database
    - Retrieve and process the results received from the database in answer to the query
JDBC
JDBC

• JDBC consists of:
  • The JDBC™ API proper: interfaces, classes and methods for executing SQL statements, retrieving results, and propagating changes back to the database
  • JDBC Driver Manager: a class that defines objects which can connect Java applications to a JDBC driver.
• JDBC Test Suite
• JDBC–ODBC Bridge
Using JDBC

• Basic steps when using JDBC
  • Register a database driver
  • Open a connection
  • Pass some queries to the database
  • Process the results as needed
  • Close the connection
  • Deal with any errors

• Preamble: import java.sql.*;
Register a Driver

• We need to register an appropriate driver with the DriverManager
  • There is a different driver for each DBMS
  • Here is how to register a driver for Oracle:

```java
DriverManager.registerDriver(new oracle.jdbc.driver.OracleDriver());
```
Open a Connection

• Next we open a connection to the database from the DriverManager
  • We give the address of the database, a username and a password

```java
Connection conn = DriverManager.getConnection(
    "jdbc:oracle:thin:@oracle.cs.nott.ac.uk:1521:maindb", "xxx07u", "somepassword");
```

SQL and Java
Now we can send queries to the DB

- We do this through a Statement object
- Each Statement can deal with one query at a time
- A single Connection can have several statements open at any time

Statement objects

- Are created from a Connection
- The executeUpdate() method runs a query that doesn’t return any results (UPDATE, CREATE TABLE, etc)
- executeQuery() is used when a result is expected
Passing Queries to the DB

```java
Statement sttable = conn.createStatement();
sttable.executeUpdate("CREATE TABLE Fruit(Name VARCHAR(10),Amount INT)");
sttable.close();

Statement stinsert1 = conn.createStatement();
stinsert1.executeUpdate("INSERT INTO Fruit VALUES('Apple', 5)" );
stinsert1.close();
```

SQL and Java
Passing Queries to the DB

Statement stinsert2 = conn.createStatement();
stinsert2.executeUpdate("INSERT INTO Fruit VALUES('Pumpkin', 1)" );
stinsert2.close();
Processing Query Results

- When a query returns a result
  - We use the Statement object’s `executeQuery` method
  - The results are put in a ResultSet object
  - Each Statement can deal with a single ResultSet at any one time

- The ResultSet object
  - Is essentially a table
  - Has a cursor that points to the current row of data
  - Initially the cursor is positioned before the first row
  - The `next()` method moves to the next row, and returns false if there isn’t one

SQL and Java
Processing Query Results

```java
Statement stresult = conn.createStatement();
ResultSet fruit = stresult.executeQuery("SELECT * FROM Fruit");
while(fruit.next()) {
    System.out.println(fruit.getString("Name") + ", " + fruit.getInt("Amount"));
}
fruit.close();
```
Working with ResultSets

• We get values from the ResultSet with
  • getInt()
  • getString()
  • getDouble()
  • etc.

• Each takes either
  • The name of the column as a String, or
  • The index of the column as an integer
Advanced ResultSets

• By default a ResultSet
  • Allows you to go over the results once, from start to finish
  • Allows you to read, but not change, the information in the result

• We can change this behaviour so that
  • We can move forward and backwards
  • We can update existing rows
  • We can add rows
  • This is decided when we create the Statement object from the Connection

SQL and Java
Creating Statements Again

```
conn.createStatement(<scroll>, <update>);
```

- `<scroll>` is one of
  - `ResultSet.TYPE_FORWARD_ONLY`
  - `ResultSet.TYPE_SCROLL_SENSITIVE`
  - `ResultSet.TYPE_SCROLL_INSENSITIVE`

- `<update>` is one of
  - `ResultSet.CONCUR_READ_ONLY`
  - `ResultSet.CONCUR_UPDATABLE`
# Scrollable ResultSets

- If we use the option `TYPE_SCROLL_SENSITIVE` or `TYPE_SCROLL_INSENSITIVE`:
  - We can move around the ResultSets made from that statement.
  - There are a lot of options available for this.
  - For a result set called `rs`...

<table>
<thead>
<tr>
<th>Current row</th>
<th>rs.first(); rs.absolute(1)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>rs.absolute(2)</td>
</tr>
<tr>
<td></td>
<td>rs.absolute(3)</td>
</tr>
<tr>
<td></td>
<td>rs.relative(-2)</td>
</tr>
<tr>
<td>rs.previous(); rs.relative(-1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>rs.absolute(-3)</td>
</tr>
<tr>
<td></td>
<td>rs.absolute(-2)</td>
</tr>
<tr>
<td></td>
<td>rs.absolute(-1)</td>
</tr>
<tr>
<td>rs.next(); rs.relative(1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>rs.relative(2)</td>
</tr>
<tr>
<td>rs.next(); rs.relative(1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>rs.relative(2)</td>
</tr>
<tr>
<td>rs.last(); rs.absolute(-1)</td>
<td></td>
</tr>
</tbody>
</table>
Updating ResultSets

• If we use the option
  CONCUR_UPDATABLE
    • We can update the values in the result set or add a new row
    • In Oracle you can’t have an updatable forward-only result set
    • Also in Oracle you have to explicitly specify the columns in your SELECT statement if you want to update it (no SELECT *...)

SQL and Java
Updating a Row

// Make an updatable Statement
Statement result2 = conn.createStatement(
    ResultSet.TYPE_SCROLL_SENSITIVE,
    ResultSet.CONCUR_UPDATABLE);
ResultSet rset2 = result2.executeQuery("SELECT Name, Amount FROM Fruit");
rset2.absolute(2);// set current row to second
rset2.updateInt("Amount", 3); //
rset2.updateRow(); // updates the second row
Inserting a Row

// rset2 is set up as in the previous example
// Get ready to insert a row
rset2.moveToInsertRow();
// Put the values of the new row in each column
rset2.updateString("Name", "Orange");
rset2.updateInt("Amount", 7);
// Add this row
rset2.insertRow();
// Go back to the row we were at before inserting
rset2.moveToCurrentRow();
Dealing with Errors

• Things can go wrong with all of this
  • Incorrect SQL statements
  • DBMS might not be available
  • DBMS might not support some features

• If something goes wrong then an SQLException occurs

• If an exception is thrown:
  • We need to deal with it as best we can
  • Make sure any database objects are closed
  • If a connection is left open it can consume resources and might interfere with later use of the database
// Declaration of any database objects
try {
    // Some database code
} catch (Exception e) {
    // Error reporting etc.
} finally {
    // Make sure all database objects are closed and cleaned up
}
Closing Objects

- To make sure the object is closed
  - See if the object exists
  - If it does, call its close method
  - This might throw an exception itself, which needs to be caught
  - At some stage we have to stop handling the exceptions

```java
Connection conn;
try {
    ...
} finally {
    if (conn != null) {
        try {
            conn.close();
        } catch (...) {
            // ...
        }
    }
}
```