

Database Application Development JDBC and SQLJ

CS430/630
Lecture 14

Slides based on "Database Management Systems" 3rd ed, Ramakrishnan and Gehrke

Outline

- ▶ Embedded SQL
 - ▶ Dynamic SQL
 - ▶ JDBC (API)
 - ▶ SQLJ (Embedded)
 - ▶ Stored procedures
- } Many host languages:
C, Cobol, Pascal, etc.
- } Java

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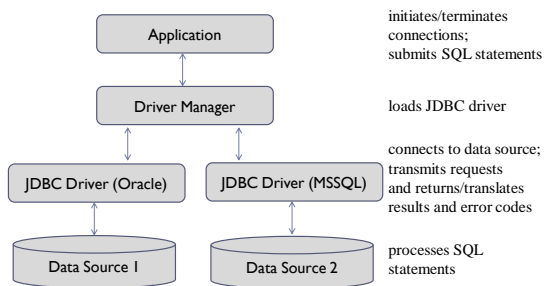
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APIs: Alternative to Embedding

- ▶ Use library that implements API of DBMS calls
 - ▶ No need to modify compilation process
 - ▶ API: standardized interface with objects and procedures
- ▶ Pass SQL strings from the programming language
 - ▶ API returns results in language-friendly form
- ▶ DBMS API for Java is Sun's **JDBC**
 - ▶ It is mainly a specification
 - ▶ DBMS-neutral
 - ▶ Each DBMS vendor can implement its own version
 - ▶ JDBC driver maps calls, translates them into DBMS-specific code packages `java.sql.*` or `javax.sql.*`
 - ▶ Collection of classes and interfaces

JDBC: Architecture



Driver Types

- ▶ **Bridge**
 - ▶ Translates SQL commands into non-native API
 - ▶ Example: JDBC-ODBC bridge
- ▶ **Direct translation to native API via non-Java driver**
 - ▶ Translates SQL commands to native API of data source
 - ▶ Need OS-specific binary on each client
- ▶ **Direct translation to native API via Java driver**
 - ▶ Converts JDBC calls directly to network protocol used by DBMS
 - ▶ Needs DBMS-specific Java driver at each client
- ▶ **Network bridge**
 - ▶ Send commands over the network to middleware server
 - ▶ Needs only small JDBC driver at each client

Using JDBC

- ▶ 3 steps to submit a database query:

1. Load the JDBC driver
2. Connect to the data source
3. Execute SQL statements

JDBC Driver Management

- ▶ All drivers are managed by the **DriverManager** class
- ▶ Loading a JDBC driver:
 - ▶ From inside the Java code:

```
Class.forName("oracle.jdbc.driver.OracleDriver");
```

- ▶ When starting the Java VM

```
-Djdbc.drivers=oracle.jdbc.driver
```

Connections to JDBC

- ▶ Interaction with data source through sessions
 - ▶ A connection identifies a logical session
 - ▶ JDBC URL: `jdbc:<protocol>:<otherParameters>`

- ▶ Example:

```
String url="jdbc:oracle:www.books.oracle.com:3083";
Connection conn;
try{
    conn = DriverManager.getConnection(url,
        "user", "password");
} catch SQLException e {...}
```

- ▶ Many other forms: check Java API
 - ▶ Properties of connection: autocommit, connection pooling, etc.

Executing SQL Statements

- ▶ **Statement** class
 - ▶ 2 subclasses:
 - PreparedStatement** (semi-static SQL statements)
 - CallableStatement** (stored procedures)
- ▶ **PreparedStatement** class:
 - ▶ Precompiled, parametrized SQL statements
 - ▶ Structure is fixed
 - ▶ Values of parameters are determined at run-time

Example

```
/* local variables */
int sid=10;
String sname = "Yuppy";
int rating = 5;
float age = 40.0;

/* creating the statement object */
String sql="INSERT INTO Sailors VALUES(?,?,?,?)";
PreparedStatement pstmt=conn.prepareStatement(sql);
```

Example (contd.)

```
/* initialize parameters */
pstmt.clearParameters();
pstmt.setInt(1,sid);
pstmt.setString(2,sname);
pstmt.setInt(3,rating);
pstmt.setFloat(4,age);

/* no results will be returned, use executeUpdate() method */
int numRows = pstmt.executeUpdate();
```

- ▶ **executeUpdate()** returns the number of affected records

Retrieving Data: ResultSet class

- ▶ **Statement.executeQuery** returns data
 - ▶ encapsulated in a **ResultSet** object (a cursor)
 - ▶ **PreparedStatement** can also be used for this purpose
 - ▶ Retrieval by attribute name or position
- ```
Statement stmt = conn.createStatement();
ResultSet rs=stmt.executeQuery(
 "SELECT sname FROM Sailors WHERE rating = " + rating);

// rs is now a cursor
while (rs.next()) { // process the data
 String name = rs.getString("sname");// rs.getString(1);
}
```

## ResultSet

- ▶ **ResultSet** is a very powerful cursor:
  - ▶ **next()**, **previous()**, **first()**, **last()**
  - ▶ **absolute(int num)**: moves to the row with the specified number
  - ▶ **relative (int num)**: moves forward or backward

## Matching Java and SQL Data Types

| SQL Type  | Java class         | ResultSet get method |
|-----------|--------------------|----------------------|
| BIT       | Boolean            | getBoolean()         |
| CHAR      | String             | getString()          |
| VARCHAR   | String             | getString()          |
| DOUBLE    | Double             | getDouble()          |
| FLOAT     | Double             | getDouble()          |
| INTEGER   | Integer            | getInt()             |
| REAL      | Double             | getFloat()           |
| DATE      | java.sql.Date      | getDate()            |
| TIME      | java.sql.Time      | getTime()            |
| TIMESTAMP | java.sql.Timestamp | getTimestamp()       |

## JDBC Exceptions and Warnings

- ▶ Most of java.sql methods throw **SQLException**
- ▶ **SQLWarning** is a subclass of **SQLException**
  - ▶ not as severe (their existence has to be explicitly tested)

```
try {
 stmt=conn.createStatement();
 ...
 SQLWarning warning=conn.getWarnings();
 while(warning != null) {
 // handle SQLWarnings;
 warning = warning.getNextWarning();
 }
 conn.clearWarnings();
} catch (SQLException ex) {
 // handle the exception
}
```

## Examining Database Metadata

- ▶ **DatabaseMetaData** object gives catalog information

```
DatabaseMetaData md=conn.getMetaData();
ResultSet trs=md.getTables(null,null,null,null);
while(trs.next()) {
 String tableName = trs.getString("TABLE_NAME");
 System.out.println("Table:" + tableName);
 ResultSet crs = md.getColumns(null,null,tableName, null);
 while (crs.next()) {
 System.out.println(crs.getString("COLUMN_NAME"));
 }
}
```

SQLJ

## SQLJ

- ▶ SQLJ complements JDBC with a (semi-)static query model

- ▶ Compiler can perform syntax checks, type checking, schema/query consistency

```
#sql cursor_name = {
 SELECT name, rating INTO :name, :rating
 FROM Books WHERE sid = :sid;}
```

Compare to JDBC:

```
sid=rs.getInt(1);
if (sid==1) {sname=rs.getString(2);}
else { sname2=rs.getString(2);}
```

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