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

Many host languages:
C, Cobol, Pascal, etc.

- JDBC (API)
- SQLJ (Embedded)

Java

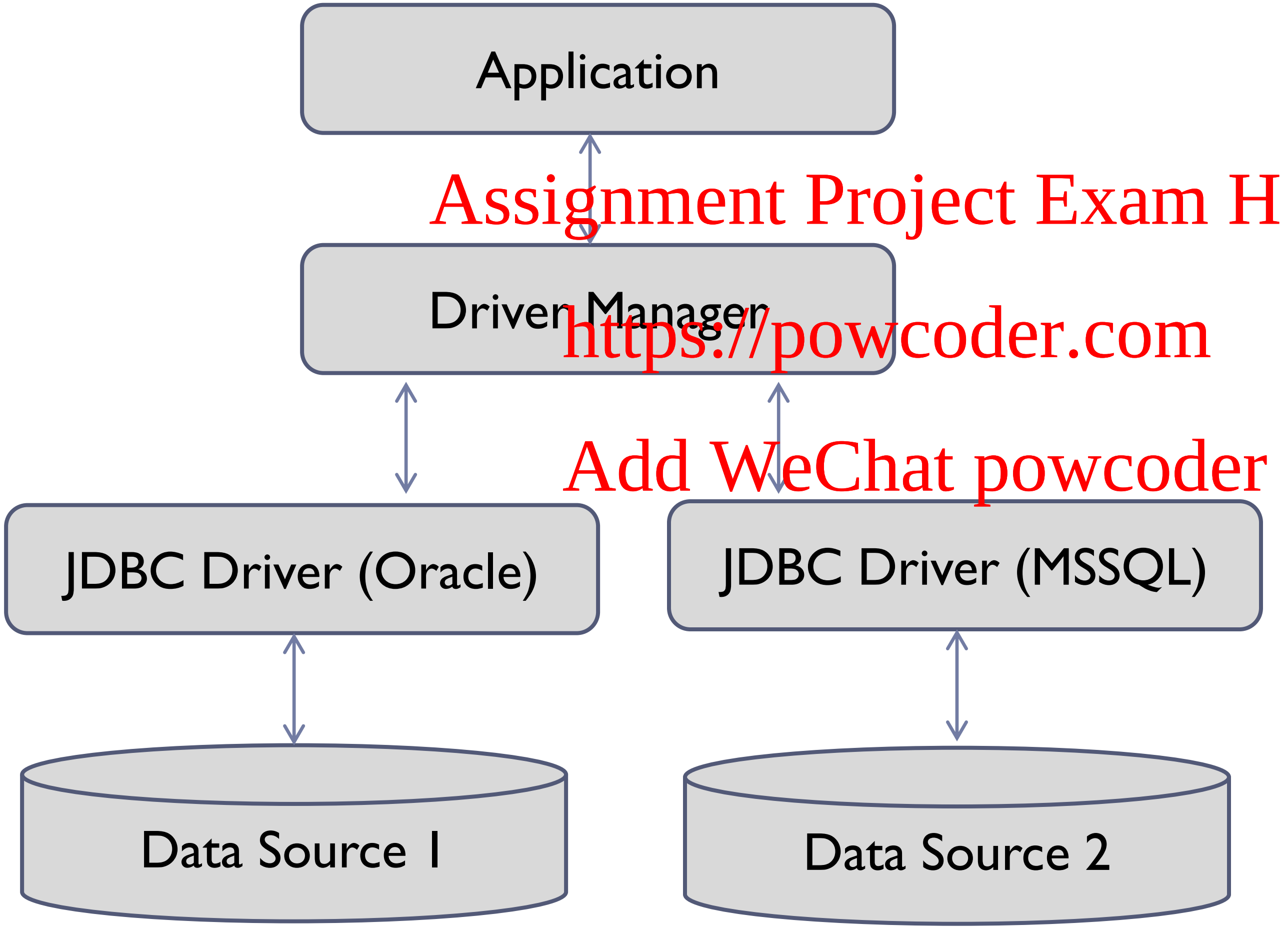
- Stored procedures

JDBC

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 result sets 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 traps calls, translates them into DBMS-specific code
  - Packages `java.sql.*, javax.sql.*`
  - Collection of classes and interfaces

JDBC: Architecture



initiates/terminates connections;
submits SQL statements

loads JDBC driver

connects to data source; transmits requests and returns/translates results and error codes

processes SQL statements

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 in JDBC

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

```
String url=“jdbc:oracle:www.bookstore.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 subclases:

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(?,?,?,?)”;
PreparedStatment 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

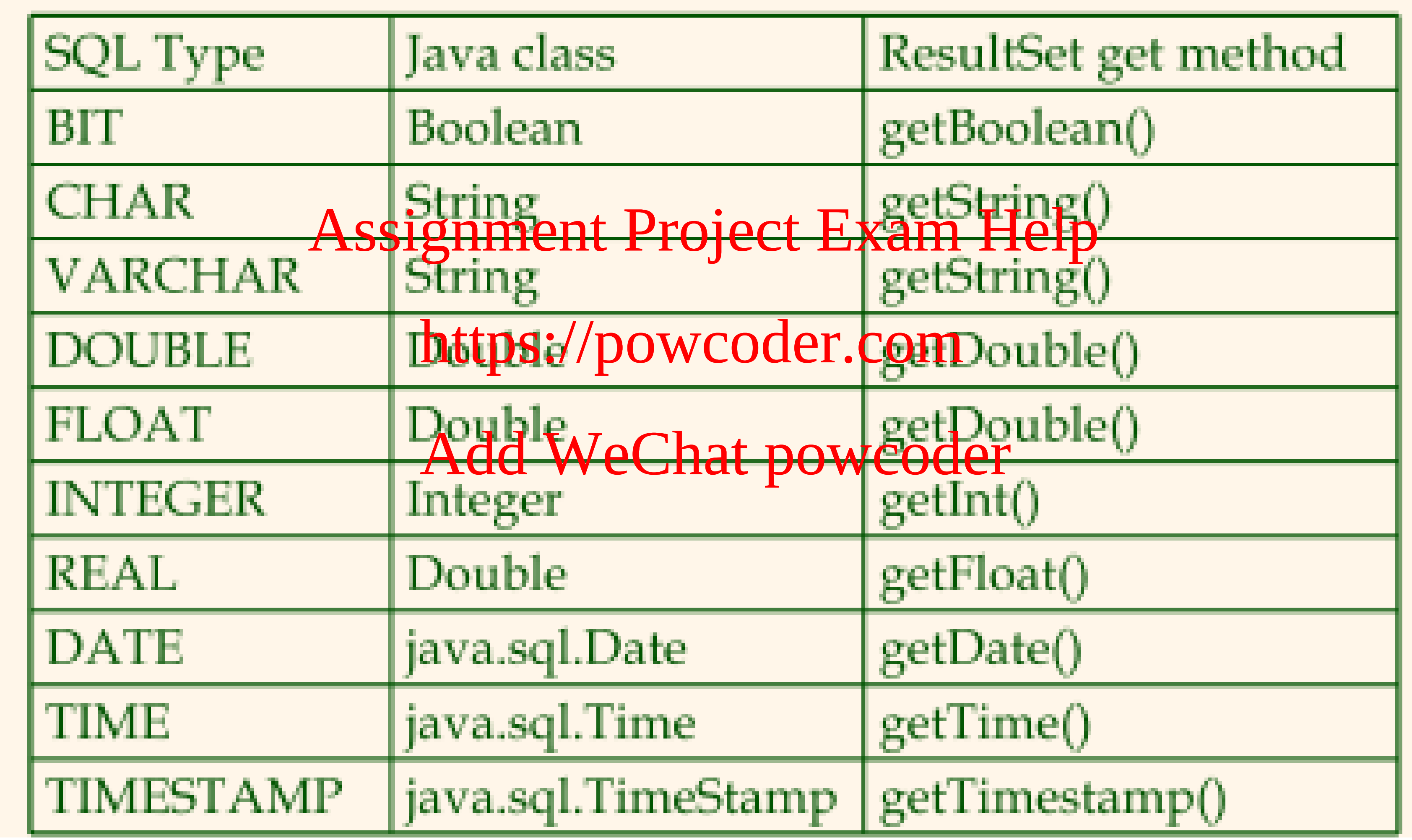
```
Statement stmt = conn.createStatement();
ResultSet rs=stmt.executeQuery(
  “SELECT sname FROM Sailors WHERE rating = “ + rating );

// 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 SQLe) {
    // 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);}
```