CS422 Principles of Database Systems

JDBC and Embedded SQL

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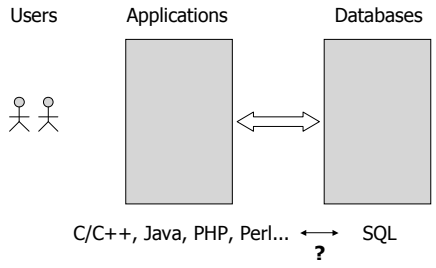
Applications and Databases



Call-level Interface (CLI)

- A library of functions that allow applications to
  - connect to the database
  - send SQL statements to the database
  - get the results back from the database

```
Connection c = DriverManager.getConnection( url );
Statement stmt = c.createStatement();
ResultSet rs = stmt.executeQuery( "select * from items");
while( rs.next() ) {
  // some processing here
}
```

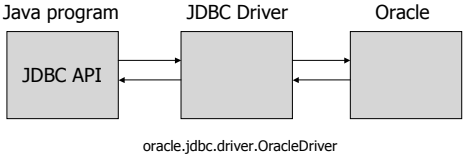
Embedded SQL

- Embed SQL statements directly in host language
  - Variables shared by SQL and the host language
  - Check SQL syntax at compilation time
  - Part of the SQL standard

```
double price;
#sql {select price into :price from items where name = 'milk'};
System.out.println( "The price of milk is " + price + "." );
```

JDBC

- An interface between Java programs and SQL databases



Setup Oracle JDBC Driver

- Download *instantclient-basic* (see http://sun.calstatela.edu/~cysun/www/teaching/cs422/extras/server.html)
- Add one of following JAR files to your class path:
  - `classes12.jar` – for JDK 1.2
  - `ojdbc14.jar` – for JDK 1.4 or above

JDBC Basics …

- import java.sql.*;
- Load driver
  - Class.forName("oracle.jdbc.driver.OracleDriver")
- Create connection
  - Connection c = DriverManager.getConnection(url, username, password);
  - URL
    - jdbc:oracle:thin:@*host*:*port*:*service*
    - E.g. jdbc:oracle:thin:@cs.calstatela.edu:1521:orc

… JDBC Basics

- Create statement
  - Statement stmt = c.createStatement();
    - stmt.executeQuery()
    - stmt.executeUpdate()
- Get result back
  - ResultSet rs

http://java.sun.com/j2se/1.5.0/docs/api/java/sql/package-summary.html

DB Query Results

- In a program, we want to
  - Access each row
  - Access column in a row
  - Access column names

select * from items;

name	price	quantity
milk	3.99	2
beer	6.99	3

ResultSet: Row Access

- `next()` – move cursor down one row
  - `true` if the current row is valid
  - `false` if no more rows
  - Cursor starts from *before the 1st row*

ResultSet: Column Access

- Access the columns of *current row*
- getXxx(String columnName)
  - E.g. getString("user");
- getXxx(int columnIndex)
  - columnIndex starts from 1
  - E.g. getString(1);

ResultSet: Column Names

ResultSetMetaData meta = rs.getMetaData();

- ResultSetMetaData
  - getColumnName(columnIndex)
    - Column name
  - getColumnLabel(columnIndex)
    - Column title for display or printout

ResultSet: Size

- No size() method?
- Something about *FetchSize*
  - getFetchSize()
  - setFetchSize(int nrows)

Prepared Statements

- Statements with parameters

```
String sql = "insert into items values (? ? ?)";

PreparedStatement pstmt =c.prepareStatement(sql);

pstmt.setString(1, "orange");
pstmt.setDouble(2, 1.59);
pstmt.setInt(3, 4);

pstmt.executeUpdate();
```

Benefits of Using Prepared Statements

- Easier to create the query string
- Much more secure if part of the query string is provided by user
- Better performance (maybe)

```
// without PreparedStatement, you need to worry
// about quotations
String sql = "select salary from employees where " +
             "username ='" + username + "'";

// and somebody may try to pass a username like
// "cysun' or username <> 'cysun"
```

Call Stored Procedures

- Different DBMS have different implementations of stored procedures.

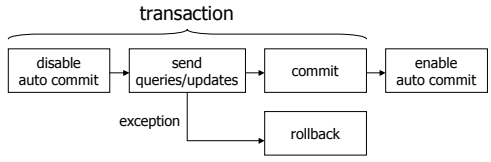
```
CallableStatement cstmt = c.prepareCall("{call sum2p(?,?,?)}");

cstmt.setInt(1, 12);
cstmt.setInt(2, 22);
cstmt.registerOutParameter(3, Types.INTEGER);

cstmt.executeUpdate();

System.out.println( cstmt.getInt(3) );
```

Transactions in JDBC



A Transaction Example

- TxnExample.java

```
Connection c = DriverManager.getConnection( url, user, pass );
Statement stmt = c.createStatement();

c.setAutoCommit( false );
stmt.executeUpdate( "insert into turnins values (1,1,'Foo.java')" );
stmt.executeUpdate( "insert into turnins values (1,2,'Bar.java')" );
c.commit();
```

Rollback upon Exception

- rollback() should be called *explicitly* if a SQLException is raised during a transaction.

```
catch( SQLException e ) {
    System.err.println( e.getMessage() );
    if( c != null ) {
        try {
            c.rollback();
         } catch( SQLException ex ) {
            System.err.println( ex.getMessage() );
        }
    }
}
```

SQLJ – Embed SQL in Java

- Part of SQJ-99 standard
- Oracle's SQLJ implementation is built on top of JDBC
  - requires JDBC driver (*classes12.jar*, not *ojdbc14.jar*)

Setting Up SQLJ

- Download from http://sun.calstatela.edu/~cysun/documentation/oracle/sqlj/
  - runtime12.jar
  - translator.jar
- Add the two jar files to your CLASSPATH
- java sqlj.tools.Sqlj *<filename.sqlj>*

An SQLJ Example

```
Oracle.connect (
    "jdbc:oracle:thin:@cs.calstatela.edu:1521:orc",
    "cs422stu31",
    "abcd"
);
double price;
#sql {
    select price into :price from items
    where name = 'milk'
};
System.out.println( "The price of milk is " + price + "." );
```

SQLJ Basics

- Making connection
- Variables shared by Java and SQL
- SELECT...INTO
- Handling NULL value

Iterators

- An *iterator* must be declared to handle queries that return multiple rows.

```
#sql <modifier> iterator IteratorName( column_list );
```

An Iterator Example

```
#sql iterator Results ( String name, double price );

Results r;
#sql r = { select name, price from items };

while( r.next() )
   System.out.println( r.name() + ", " + r.price() );
```

- Note that based on the iterator declaration, two methods are automatically created:
  - `String name()`
  - `double price()`

Dynamic SQL

- When SQL statements are generated by the host language at runtime.
- It's easy to have dynamic SQL in JDBC, but not so easy in embedded SQL
  - SQL statements have to be enclosed in the #sql block
  - SQL statements are checked at compile time.
- Solution
  - IN variables or `EXECUTE IMMEDIATE`

About SQLJ

- The good
  - simple syntax
  - SQL statements are checked at compile time
- The bad
  - Creating dynamic SQL statements is not as easy as in JDBC
  - More library dependency
- The Ugly
  - Oracle seems to be phasing out support for SQLJ, so you shouldn't use it for any new applications