

# JDBC™ RowSet Implementations Tutorial

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RowSet Overview	3
<b>What Can RowSet Objects Do?</b>	<b>3</b>
Function as a JavaBeans™ Component	4
Properties	4
Event Notification	5
Add Scrollability or Updatability	5
<b>Kinds of RowSet Objects</b>	<b>6</b>
Connected RowSet Objects	6
Disconnected RowSet Objects	6
JdbcRowSet	9
<b>Creating a JdbcRowSet Object</b>	<b>9</b>
Passing a ResultSet Object	10
Using the Default Constructor	11
Setting Properties	12
Setting Parameters for the Command	13
<b>Using a JdbcRowSet Object</b>	<b>14</b>
Navigating a JdbcRowSet Object	14
Updating a Column Value	16
Inserting a Row	16
Deleting a Row	17
<b>Code Sample</b>	<b>18</b>
CachedRowSet	21
<b>Setting Up a CachedRowSet Object</b>	<b>21</b>
Creating a CachedRowSet Object	22
Using the Default Constructor	22
Passing a SyncProvider Implementation	22
Setting Properties	23
Setting Key Columns	24
<b>Populating a CachedRowSet Object</b>	<b>24</b>
What a Reader Does	25
<b>Updating a CachedRowSet Object</b>	<b>26</b>
Updating a Column Value	26
Inserting and Deleting Rows	27
<b>Updating the Data Source</b>	<b>27</b>
What a Writer Does	28
Using the Default Implementation	28
Using a SyncResolver Object	29
<b>Notifying Listeners</b>	<b>30</b>
Setting Up Listeners	30
How Notification Works	31
<b>Sending Large Amounts of Data</b>	<b>31</b>

	<b>Code Sample</b>	<b>34</b>
JoinRowSet	45	
	<b>Creating a JoinRowSet Object</b>	<b>45</b>
	<b>Adding RowSet Objects</b>	<b>46</b>
FilteredRowSet	51	
	<b>Creating a Predicate Object</b>	<b>52</b>
	Creating a FilteredRowSet Object	56
	Creating and Setting a Predicate Object	57
	<b>Working with Filters</b>	<b>58</b>
	<b>Updating a FilteredRowSet Object</b>	<b>60</b>
	Inserting or Updating a Row	60
	Deleting a Row	61
	Combining Two Filters into One	61
WebRowSet	63	
	<b>Creating and Populating a WebRowSet Object</b>	<b>64</b>
	Writing and Reading a WebRowSet Object to XML	65
	Using the writeXml Method	65
	Using the readXml Method	66
	<b>What Is in the XML Document</b>	<b>66</b>
	Properties	68
	Metadata	69
	Data	70
	<b>Making Changes to a WebRowSet Object</b>	<b>71</b>
	Inserting a Row	72
	Deleting a Row	72
	Modifying a Row	73
	<b>WebRowSet Code Example</b>	<b>74</b>
	<b>WebRowSet XML Schema</b>	<b>76</b>

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# RowSet Overview

**A** JDBC RowSet object holds tabular data in a way that makes it more flexible and easier to use than a result set. Sun Microsystems has defined five RowSet interfaces for some of the more popular uses of a RowSet object, and the Java Community Process has produced standard reference implementations for these five RowSet interfaces. In this tutorial you will learn how easy it is to use these reference implementations, which together with the interfaces are part of the Java™ 2 Platform, Standard Edition 5.0 (J2SE™ 5.0).

Sun provides the five versions of the RowSet interface and their implementations as a convenience for developers. Developers are free write their own versions of the `javax.sql.RowSet` interface, to extend the implementations of the five RowSet interfaces, or to write their own implementations. However, many programmers will probably find that the standard reference implementations already fit their needs and will use them as is.

This chapter gives you an overview of the five RowSet interfaces, and the succeeding chapters walk you through how to use each of the reference implementations.

## What Can RowSet Objects Do?

All RowSet objects are derived from the `ResultSet` interface and therefore share its capabilities. What makes JDBC RowSet objects special is that they add new capabilities, which you will learn to use in the following chapters.

## Function as a JavaBeans™ Component

All RowSet objects are JavaBeans components. This means that they have the following:

- Properties
- The JavaBeans notification mechanism

### Properties

All RowSet objects have properties. A property is a field that has the appropriate getter and setter methods in the interface implementation. For example, the BaseRowSet abstract class, a convenience class in the JDBC RowSet Implementations, provides the methods for setting and getting properties, among other things. All of the RowSet reference implementations extend this class and thereby have access to these methods. If you wanted to add a new property, you could add the getter and setter methods for it to your implementation. However, the BaseRowSet class provides more than enough properties for most needs.

Just because there are getter and setter methods for a property does not mean that you must set a value for every property. Many properties have default values, and setting values for others is optional if that property is not used. For example, all RowSet objects must be able to obtain a connection to a data source, which is generally a database. Therefore, they must have set the properties needed to do that. You can get a connection in two different ways, using the DriverManager mechanism or using a DataSource object. Both require the username and password properties to be set, but using the DriverManager requires that the url property be set, whereas using a DataSource object requires that the dataSourceName property be set.

The default value for the type property is ResultSet.TYPE\_SCROLL\_INSENSITIVE and for the concurrency property is ResultSet.CONCUR\_UPDATABLE. If you are working with a driver or database that does not offer scrollable and updatable ResultSet objects, you can use a RowSet object populated with the same data as a ResultSet object and thereby effectively make that ResultSet object scrollable and updatable. You will see how this works in the chapter “JdbcRowSet.”

The following BaseRowSet methods set other properties:

- ¥ setCommand
- setEscapeProcessing—default is on
- ¥ setFetchDirection
- ¥ setFetchSize

- ¥ setMaxFieldSize
- ¥ setMaxRows
- setQueryTimeout—default is no time limit
- setShowDeleted—default is not to show deleted rows
- setTransactionIsolation—default is not to see dirty reads
- setTypeMap—default is null

You will see a lot more of the `command` property in future chapters.

## Event Notification

`RowSet` objects use the JavaBeans event model, in which registered components are notified when certain events occur. For all `RowSet` objects, three events trigger notifications:

1. A cursor movement
2. The update, insertion, or deletion of a row
3. A change to the entire `RowSet` contents

The notification of an event goes to all *listeners*, components that have implemented the `RowSetListener` interface and have had themselves added to the `RowSet` object's list of components to be notified when any of the three events occurs.

A listener could be a GUI component such as bar graph. If the bar graph is tracking data in a `RowSet` object, it would want to know the new data values whenever the data changed. It would therefore implement the `RowSetListener` methods to define what it will do when a particular event occurs. Then it also needs to be added to the `RowSet` object's list of listeners. The following line of code registers the bar graph component *bg* with the `RowSet` object *rs*.

```
rs.addListener(bg);
```

Now *bg* will be notified each time the cursor moves, a row is changed, or all of *rs* gets new data.

## Add Scrollability or Updatability

Some DBMSs do not support result sets that are scrollable, and some do not support result sets that are updatable. If a driver for that DBMS does not add scrollability or updatability, you can use a `RowSet` object to do it. A `RowSet` object is scrollable and updatable by default, so by populating a `RowSet` object with the

contents of a result set, you can effectively make the result set scrollable and updatable.

## Kinds of RowSet Objects

A RowSet object is considered either connected or disconnected. A *connected* RowSet object uses a driver based on JDBC technology (“JDBC driver”) to make a connection to a relational database and maintains that connection throughout its life span. A *disconnected* RowSet object makes a connection to a data source only to read in data from a ResultSet object or to write data back to the data source. After reading data from or writing data to its data source, the RowSet object disconnects from it, thus becoming “disconnected.” During much of its life span, a disconnected RowSet object has no connection to its data source and operates independently. The next two sections tell you what being connected or disconnected means in terms of what a RowSet object can do.

### Connected RowSet Objects

Only one of the standard RowSet implementations is a connected RowSet: JdbcRowSet. Being always connected to a database, it is most similar to a ResultSet object and is often used as a wrapper to make an otherwise nonscrollable and readonly ResultSet object scrollable and updatable.

As a JavaBeans component, a JdbcRowSet object can be used, for example, in a GUI tool to select a JDBC driver. A JdbcRowSet object can be used this way because it is effectively a wrapper for the driver that obtained its connection to the database.

### Disconnected RowSet Objects

The other four implementations are disconnected RowSet implementations. Disconnected RowSet objects have all the capabilities of connected RowSet objects plus they have the additional capabilities available only to disconnected RowSet objects. For example, not having to maintain a connection to a data source makes disconnected RowSet objects far more lightweight than a JdbcRowSet object or a ResultSet object. Disconnected RowSet objects are also serializable, and the combination of being both serializable and lightweight makes them ideal for sending

data over a network. They can even be used for sending data to thin clients such as PDAs and mobile phones.

The `CachedRowSet` interface defines the basic capabilities available to all disconnected `RowSet` objects. The other three are extensions of it providing more specialized capabilities. The following outline shows how they are related.

```
    CachedRowSet
      WebRowSet
        JoinRowSet
          FilteredRowSet
```

A `CachedRowSet` object has all the capabilities of a `JdbcRowSet` object plus it can also do the following:

- Obtain a connection to a data source and execute a query
- Read the data from the resulting `ResultSet` object and populate itself with that data
- Manipulate data and make changes to data while it is disconnected
- Reconnect to the data source to write changes back to it
- Check for conflicts with the data source and resolve those conflicts

A `WebRowSet` object has all the capabilities of a `CachedRowSet` object plus it can also do the following:

- Write itself as an XML document
- Read an XML document that describes a `WebRowSet` object

A `JoinRowSet` object has all the capabilities of a `WebRowSet` object (and therefore also a `CachedRowSet` object) plus it can also do the following:

- Form the equivalent of an SQL `JOIN` without having to connect to a data source

A `FilteredRowSet` object likewise has all the capabilities of a `WebRowSet` object (and therefore also a `CachedRowSet` object) plus it can also do the following:

- Apply filtering criteria so that only selected data is visible. This is equivalent to executing a query on a `RowSet` object without having to use a query language or connect to a data source.

The following chapters walk you through how to use the reference implementations for each of the interfaces introduced in this chapter.

---

# JdbcRowSet

**A** `JdbcRowSet` object is basically an enhanced `ResultSet` object. It maintains a connection to its data source, just as a `ResultSet` object does. The big difference is that it has a set of properties and a listener notification mechanism that make it a JavaBeans™ component. This chapter covers properties, and the chapter “`CachedRowSet`” covers the listener notification mechanism in the section “Notifying Listeners,” on page 30.

One of the main uses of a `JdbcRowSet` object is to make a `ResultSet` object scrollable and updatable when it does not otherwise have those capabilities.

In this chapter, you will learn how to:

- Create a `JdbcRowSet` object
- Set properties
- Move the cursor to different rows
- Update data
- Insert a new row
- Delete a row

## Creating a `JdbcRowSet` Object

You can create a `JdbcRowSet` object in two ways:

- By using the reference implementation constructor that takes a `ResultSet` object

- By using the reference implementation default constructor

## Passing a ResultSet Object

The simplest way to create a `JdbcRowSet` object is to produce a `ResultSet` object and pass it to the `JdbcRowSetImpl` constructor. Doing this not only creates a `JdbcRowSet` object but also populates it with the data in the `ResultSet` object.

As an example, the following code fragment uses the `Connection` object `con` to create a `Statement` object, which then executes a query. The query produces the `ResultSet` object `rs`, which is passed to the constructor to create a new `JdbcRowSet` object initialized with the data in `rs`.

```
Statement stmt = con.createStatement();
ResultSet rs = stmt.executeQuery(select * from COFFEES);
JdbcRowSet jdbcRs = new JdbcRowSetImpl(rs);
```

Note that because no arguments are passed to the method `createStatement`, any `ResultSet` objects it produces will be neither scrollable nor updatable. As a result, you can move the cursor for `rs` only forward, and you cannot make changes to the data in `rs`. However, we now have the data from `rs` in `jdbcRs`, and you can move the cursor for `jdbcRs` to any position and can also modify the data in `jdbcRs`.

Because the newly created `JdbcRowSet` object `jdbcRs` contains exactly the same data as `rs`, it can be considered a wrapper for `rs`. Assume that Table 2–1 COFFEES represents the data in both `rs` and `jdbcRs`.

**Table 2–1 COFFEES**

COF_NAME	SUP_ID	PRICE	SALES	TOTAL
Colombian	101	7.99	0	0
French_Roast	49	8.99	0	0
Espresso	150	9.99	0	0
Colombian_Decaf	101	8.99	0	0
French_Roast_Decaf	49	9.99	0	0

The column names mean the following:

**COF\_NAME** = Coffee Name

**SUP\_ID** = Supplier Identification Number

**PRICE** = Price per pound of coffee

**SALES** = Number of pounds of coffee sold in the current week

**TOTAL** = Total number of pounds of coffee sold

Being scrollable and updatable are only two of the default properties of a `JdbcRowSet` object. In addition to populating `JdbcRs` with the data from `rs`, the constructor also sets the following properties with the following values:

- `type`—`ResultSet.TYPE_SCROLL_INSENSITIVE` (has a scrollable cursor)
- `concurrency`—`ResultSet.CONCUR_UPDATABLE` (can be updated)
- `escapeProcessing`—`true` (the driver will do escape processing)
- `maxRows`—`0` (no limit on the number of rows)
- `maxFieldSize`—`0` (no limit on the number of bytes for a column value; applies only to columns that store `BINARY`, `VARBINARY`, `LONGVARBINARY`, `CHAR`, `VARCHAR`, and `LONGVARCHAR` values)
- `queryTimeout`—`0` (has no time limit for how long it takes to execute a query)
- `showDeleted`—`false` (deleted rows are not visible)
- `transactionIsolation`—`Connection.TRANSACTION_READ_COMMITTED` (reads only data that has been committed)
- `typeMap`—`null` (the type map associated with a `Connection` object used by this `RowSet` object is null)

The main thing you need to remember from this list is that a `JdbcRowSet` and all other `RowSet` objects are scrollable and updatable unless you set different values for those properties.

## Using the Default Constructor

The following line of code creates an empty `JdbcRowSet` object.

```
JdbcRowSet jdbcRs2 = new JdbcRowSetImpl();
```

All of the reference implementation constructors assign the default values for the properties listed in the section “Passing a `ResultSet` Object,” so although `JdbcRs2` has no data yet, it has the same properties set with default values as `JdbcRs`. To populate `JdbcRs2` with data, you need a `ResultSet` object with the desired data. This

means you need to get a connection and execute a query, which requires your setting the properties needed for getting a connection and setting the query to be executed. You will see how to set these properties in the next section.

## Setting Properties

The section “Passing a ResultSet Object” lists the properties that are set by default when a new RowSet object is created. If you use the default constructor, you need to set some additional properties before you can populate your new JdbcRowSet object with data.

In order to get its data, a JdbcRowSet object first needs to connect to a database. The following four properties hold information used in obtaining a connection to a database.

- `username`—the name a user supplies to a database as part of gaining access
- `password`—the user’s database password
- `url`—the JDBC URL for the database to which the user wants to connect
- `datasourceName`—the name used to retrieve a DataSource object that has been registered with a JNDI naming service

As was mentioned in the chapter “Overview,” which of these properties you need to set depends on how you are going to make a connection. The preferred way is to use a DataSource object, but it may not be practical for some readers to register a DataSource object with a JNDI naming service, which is generally done by a person acting in the capacity of a system administrator. Therefore, the code examples all use the DriverManager mechanism to obtain a connection, for which you use the `url` property and not the `datasourceName` property.

The following lines of code set the `username`, `password`, and `url` properties so that a connection can be obtained using the DriverManager mechanism. (You will find the JDBC URL to set as the value for the `url` property in the documentation for your JDBC driver.)

```
jdbcRs.setUsername("hardy");  
jdbcRs.setPassword("oursecret");  
jdbcRs.setUrl("jdbc:mySubprotocol:mySubname");
```

Another property that you must set is the `command` property. This property is the query that determines what data the JdbcRowSet object will hold. For example, the

following line of code sets the `command` property with a query that produces a `ResultSet` object containing all the data in the table `COFFEES`.

```
jdbcTemplate.setCommand("select * from COFFEES");
```

Once you have set the `command` property and the properties necessary for making a connection, you are ready to populate `jdbcTemplate` with data. You can do this by simply calling the `execute` method.

```
jdbcTemplate.execute();
```

The `execute` method does many things for you behind the scenes.

1. It makes a connection to the database using the values you assigned to the `url`, `username`, and `password` properties.
2. It executes the query you set for the `command` property.
3. It reads the data from the resulting `ResultSet` object into `jdbcTemplate`.

At this point, `jdbcTemplate` and `jdbcTemplate2` should be identical.

## Setting Parameters for the Command

In the preceding code fragments, we used a command that selected all of the data in the table `COFFEES`. If you wanted a `JdbcRowSet` object populated with only some of the data, you would need to use a `where` clause. For example, the query in the following line of code selects the coffee name and price for coffees whose price is greater than 7.99.

```
select COF_NAME, PRICE from COFFEES where PRICE > 7.99;
```

For more flexibility, you could use a placeholder parameter instead of 7.99. A placeholder parameter is a question mark (“?”) used in place of a literal value.

```
select COF_NAME, PRICE from COFFEES where PRICE > ?;
```

In this case, you have to supply the value for the placeholder parameter before you can execute the query. A query with placeholder parameters is a `PreparedStatement` object, and you use the equivalent of `PreparedStatement` setter methods to supply a placeholder parameter value, as is done in the following line of code. The first argument is the ordinal position of the placeholder parameter, and the sec-

ond argument is the value to assign to it. When there is only one placeholder parameter, its ordinal position is, of course, one.

```
jdbcRs.setFloat(1, 8.99);
```

If your query has two placeholder parameters, you must set values for both of them.

```
select COF_NAME, PRICE from COFFEES where PRICE > ? and SUP_ID = ?;
```

```
jdbcRs.setFloat(1, 8.99f);  
jdbcRs.setInt(2, 101);
```

Note that ordinal position is the placeholder parameter's position in the command and has nothing to do with its column index in the `ResultSet` object or in `jdbcRs`.

## Using a JdbcRowSet Object

You update, insert, and delete a row in a `JdbcRowSet` object the same way you update, insert, and delete a row in an updatable `ResultSet` object. Similarly, you navigate a `JdbcRowSet` object the same way you navigate a scrollable `ResultSet` object.

The Coffee Break chain of coffee houses acquired another chain of coffee houses and now has a legacy database that does not support scrolling or updating of a result set. In other words, any `ResultSet` object produced by this legacy database does not have a scrollable cursor, and the data in it cannot be modified. However, by creating a `JdbcRowSet` object populated with the data from a `ResultSet` object, you can, in effect, make the `ResultSet` object scrollable and updatable.

As mentioned previously, a `JdbcRowSet` object is by default scrollable and updatable. Because its contents are identical to those in a `ResultSet` object, operating on the `JdbcRowSet` object is equivalent to operating on the `ResultSet` object itself. And because a `JdbcRowSet` object has an ongoing connection to the database, changes it makes to its own data are also made to the data in the database.

## Navigating a JdbcRowSet Object

A `ResultSet` object that is not scrollable can use only the `next` method to move its cursor forward, and it can only move the cursor forward from the first row to the

last row. A `JdbcRowSet` object, however, can use all of the cursor movement methods defined in the `ResultSet` interface.

First, let's look at how the method `next` works. The Coffee Break owner wants a list of the coffees sold in his coffee houses and the current price for each. The following code fragment goes to each row in `COFFEES` and prints out the values in the columns `COF_NAME` and `PRICE`. The method `next` initially puts the cursor above the first row so that when it is first called, the cursor moves to the first row. On subsequent calls, this method moves the cursor to the next row. Because `next` returns `true` when there is another row and `false` when there are no more rows, it can be put into a `while` loop. This moves the cursor through all of the rows, repeatedly calling the method `next` until there are no more rows. As noted earlier, this is the only cursor movement method that a nonscrollable `ResultSet` object can call.

```
while (jdbcRs.next()) {
    String name = jdbcRs.getString("COF_NAME");
    Float price = jdbcRs.getFloat("PRICE");
    System.out.println(name + "    " + price);
}
```

A `JdbcRowSet` object can call the method `next`, as seen in the preceding code fragment, and it can also call any of the other `ResultSet` cursor movement methods. For example, the following lines of code move the cursor to the fourth row in `jdbcRs` and then to the third row.

```
jdbcRs.absolute(4);
jdbcRs.previous();
```

The method `previous` is analogous to the method `next` in that it can be used in a `while` loop to traverse all of the rows in order. The difference is that you must move the cursor to after the last row, and `previous` moves the cursor toward the beginning.

```
jdbcRs.afterLast();
while (jdbcRs.previous()) {
    String name = jdbcRs.getString("COF_NAME");
    Float price = jdbcRs.getFloat("PRICE");
    System.out.println(name + "    " + price);
}
```

The output for this piece of code will have the same data as the code fragment using the method `next`, except the rows will be printed in the opposite order, going from the last row to the first.

You will see the use of more cursor movement methods in the section on updating data.

## Updating a Column Value

You update data in a `JdbcRowSet` object the same you update data in a `ResultSet` object.

Let's assume that the Coffee Break owner wants to raise the price for a pound of Espresso coffee. If he knows that Espresso is in the third row of `jdbRs`, the code for doing this might look like the following:

```
jdbRs.absolute(3);
jdbRs.updateFloat("PRICE", 10.99f);
jdbRs.updateRow();
```

The code moves the cursor to the third row, changes the value for the column "PRICE" to 10.99, and then updates the database with the new price. There are two things to note. First, for the first argument to the method `setFloat`, we could have given the column number (which in this case is 4) instead of the column name.

Second, the data type for this column is an SQL `FLOAT` in order to make creating the table easier. The SQL data type used for money values is more commonly either `DECIMAL` or `NUMERIC`, but DBMSs are not consistent in the names they use for these types. This inconsistency makes writing a code example for creating the table `COFFEES` more complicated. Therefore, for the sake of simplicity, we use the type `FLOAT`, which DBMSs are more consistent in naming. Also note that the new value for the price is `10.99f`. The `f` is necessary to tell the compiler that the value is a float.

Third, calling the method `updateRow` updates the database because `jdbRs` has maintained its connection to the database. For disconnected `RowSet` objects, the situation is different, as you will see in the chapter "CachedRowSet."

## Inserting a Row

If the owner of the Coffee Break chain wants to add one or more coffees to what he offers, he will need to add one row to the `COFFEES` table for each new coffee, as is done in the following code fragment. You will notice that because `jdbRs` is always connected to the database, inserting a row into a `JdbcRowSet` object is the same as inserting a row into a `ResultSet` object: You move to the insert row, use the

appropriate updater method to set a value for each column, and call the method `insertRow`.

```
jdbcRs.moveToInsertRow();
jdbcRs.updateString("COF_NAME", "House_Blend");
jdbcRs.updateInt("SUP_ID", 49);
jdbcRs.updateFloat("PRICE", 7.99f);
jdbcRs.updateInt("SALES", 0);
jdbcRs.updateInt("TOTAL", 0);
jdbcRs.insertRow();
jdbcRs.moveToCurrentRow();

jdbcRs.moveToInsertRow();
jdbcRs.updateString("COF_NAME", "House_Blend_Decaf");
jdbcRs.updateInt("SUP_ID", 49);
jdbcRs.updateFloat("PRICE", 8.99f);
jdbcRs.updateInt("SALES", 0);
jdbcRs.updateInt("TOTAL", 0);
jdbcRs.insertRow();
jdbcRs.moveToCurrentRow();
```

When you call the method `insertRow`, the new row is inserted into *jdbcRs* and is also inserted into the database. The preceding code fragment goes through this process twice, so two new rows are inserted into *jdbcRs* and the database.

## Deleting a Row

As is true with updating data and inserting a new row, deleting a row is just the same for a `JdbcRowSet` object as for a `ResultSet` object. The owner wants to discontinue selling French Roast decaf coffee, which is the last row in *jdbcRs*. In the following lines of code, the first line moves the cursor to the last row, and the second line deletes the last row from *jdbcRs* and from the database.

```
jdbcRs.last();
jdbcRs.deleteRow();
```

## Code Sample

The following code sample, which you will find in the `samples` directory, is a complete, runnable program incorporating the code fragments shown in this chapter. The code does the following:

1. Declares four variables
2. Loads the driver and gets a connection
3. Creates a `Statement` object and executes a query
4. Creates a new `JdbcRowSet` object initialized with the `ResultSet` object that was produced by the execution of the query
5. Moves to the third row and updates the `PRICE` column in that row
6. Inserts two new rows, one for `HOUSE_BLEND` and one for `HOUSE_BLEND_DECAF`
7. Moves to the last row and deletes it

```
import java.sql.*;
import javax.sql.rowset.*;
import com.sun.rowset.*;

public class JdbcRowSetSample {
    public static void main(String args[]) {
        JdbcRowSet jdbcRs;
        ResultSet rs;
        Statement stmt;
        Connection con;
        try {
            Class.forName("com.inet.ora.OraDriver");
            con = DriverManager.getConnection(
                "jdbc:inetora:129.158.229.89:1521:orc19", "scott", "tiger");
            stmt = con.createStatement();
            rs = stmt.executeQuery("select * from COFFEES");
            jdbcRs = new JdbcRowSetImpl(rs);

            jdbcRs.absolute(3);
            jdbcRs.updateFloat("PRICE", 10.99f);
            jdbcRs.updateRow();

            jdbcRs.first();
            jdbcRs.moveToInsertRow();
            jdbcRs.updateString( COF_NAME , HouseBlend );
            jdbcRs.updateInt( SUP_ID ,49);
            jdbcRs.updateFloat( PRICE ,7.99f);
            jdbcRs.updateInt( SALES ,0);
```

```
        jdbcRs.updateInt( TOTAL ,0);
        jdbcRs.insertRow();
        jdbcRs.moveToCurrentRow();

        jdbcRs.moveToInsertRow();
        jdbcRs.updateString( COF_NAME , HouseDecaf );
        jdbcRs.updateInt( SUP_ID ,49);
        jdbcRs.updateFloat( PRICE ,8.99f);
        jdbcRs.updateInt( SALES ,0);
        jdbcRs.updateInt( TOTAL ,0);
        jdbcRs.insertRow();
        jdbcRs.moveToCurrentRow();

        jdbcRs.last();
        jdbcRs.deleteRow();
    } catch(SQLException sqle) {
        System.out.println("SQL Exception encountered: " + sqle.getMessage());
    } catch(Exception e) {
        System.out.println("Unexpected Exception: " + e.getMessage());
        e.printStackTrace();
    }
}
}
```



---

# CachedRowSet

A `CachedRowSet` object is special in that it can operate without being connected to its data source, that is, it is a *disconnected* `RowSet` object. It gets the name “`CachedRowSet`” from the fact that it stores (caches) its data in memory so that it can operate on its own data rather than on the data stored in a database.

The `CachedRowSet` interface is the superinterface for all disconnected `RowSet` objects, so everything demonstrated in this chapter also applies to `WebRowSet`, `JoinRowSet`, and `FilteredRowSet` objects.

Note that although the data source for a `CachedRowSet` object (and the `RowSet` objects derived from it) is almost always a relational database, a `CachedRowSet` object is capable of getting data from any data source that stores its data in a tabular format. For example, a flat file or spread sheet could be the source of data. This is true when the `RowSetReader` object for a disconnected `RowSet` object is implemented to read data from such a data source. The reference implementation of the `CachedRowSet` interface has a `RowSetReader` object that reads data from a relational database, so in this tutorial, the data source is always a database.

## Setting Up a `CachedRowSet` Object

Setting up a `CachedRowSet` object involves creating it, setting its properties, and setting its key columns.

## Creating a CachedRowSet Object

You can create a new `CachedRowSet` object in two different ways:

- By using the default constructor
- By passing a `SyncProvider` implementation to the constructor

### Using the Default Constructor

One of the ways you can create a `CachedRowSet` object is by calling the default constructor defined in the reference implementation, as is done in the following line of code.

```
CachedRowSet crs = new CachedRowSetImpl();
```

`crs` has the same default values for its properties that a `JdbcRowSet` object has when it is first created. In addition, it has been assigned an instance of the default `SyncProvider` implementation, `ROptimisticProvider`.

A `SyncProvider` object supplies a `RowSetReader` object (a *reader*) and a `RowSetWriter` object (a *writer*), which a disconnected `RowSet` object needs in order to read data from its data source or to write data back to its data source. What a reader and writer do is explained later in the sections “What a Reader Does” (page 25) and “What a Writer Does” (page 28). One thing to keep in mind is that readers and writers work entirely behind the scenes, so the explanation of how they work is for your information only. Having some background on readers and writers should help you understand what some of the methods defined in the `CachedRowSet` interface do behind the scenes.

### Passing a SyncProvider Implementation

A second way to create a `CachedRowSet` object is to pass the fully qualified name of a `SyncProvider` implementation to the `CachedRowSetImpl` constructor.

```
CachedRowSet crs2 = CachedRowSetImpl("com.fred.providers.HighAvailabilityProvider");
```

The preceding example assumes that `com.fred.providers.HighAvailabilityProvider` is a third party implementation of the `SyncProvider` interface. Presumably, this implementation has reader and writer implementations that differ from those in the `ROptimisticProvider` implementation. You will see more about alternate possibilities, especially for writer implementations, later.

## Setting Properties

Generally, the default values for properties are fine as they are, but you may change the value of a property by calling the appropriate setter method. And there are some properties without default values that you need to set yourself.

In order to get data, a disconnected `RowSet` object needs to be able to connect to a data source and have some means of selecting the data it is to hold. Four properties hold information necessary to obtain a connection to a database.

- `username`—the name a user supplies to a database as part of gaining access
- `password`—the user’s database password
- `url`—the JDBC URL for the database to which the user wants to connect
- `datasourceName`—the name used to retrieve a `DataSource` object that has been registered with a JNDI naming service

As was mentioned in the chapter “Overview,” which of these properties you need to set depends on how you are going to make a connection. The preferred way is to use a `DataSource` object, but it may not be practical for some readers to register a `DataSource` object with a JNDI naming service, which is generally done by a person acting in the capacity of a system administrator. Therefore, the code examples all use the `DriverManager` mechanism to obtain a connection, for which you use the `url` property and not the `datasourceName` property.

The following lines of code set the `username`, `password`, and `url` properties so that a connection can be obtained using the `DriverManager` mechanism. (You will find the JDBC URL to set as the value for the `url` property in the documentation for your JDBC driver.)

```
crs.setUsername("hardy");
crs.setPassword("oursecret");
crs.setUrl("jdbc:mySubprotocol:mySubname");
```

Another property that you must set is the `command` property. In the reference implementation, data is read into a `RowSet` object from a `ResultSet` object. The query that produces that `ResultSet` object is the value for the `command` property. For example, the following line of code sets the `command` property with a query that produces a `ResultSet` object containing all the data in the table `COF_INVENTORY`.

```
crs.setCommand("select * from COF_INVENTORY");
```

You will see how the `command` property is used and `crs` is filled with data later in this chapter.

## Setting Key Columns

If you are going to make any updates to *crs* and want those updates saved in the database, you must set one more piece of information: the key columns. Key columns are essentially the same as a primary key because they indicate one or more columns that uniquely identify a row. The difference is that a primary key is set on a table in the database, whereas key columns are set on a particular *RowSet* object. The following lines of code set the key columns for *crs* to the first column.

```
int [] keys = {1};  
crs.setKeyColumns(keys);
```

The first column in the table *COFFEES* is *COF\_NAME*. It can serve as the key column because every coffee name is different and therefore uniquely identifies one row and only one row in the table *COFFEES*. The method *setKeyColumns* takes an array to allow for the fact that it may take two or more columns to identify a row uniquely.

As a point of interest, the method *setKeyColumns* does not set a value for a property. In this case, it sets the value for the field *keyCols*. Key columns are used internally, so after setting them, you do nothing more with them. You will see how and when key columns are used in the section “SyncResolver.”

## Populating a CachedRowSet Object

Populating a disconnected *RowSet* object involves more work than populating a connected *RowSet* object. The good news is that all the extra work is done behind the scenes; as a programmer, it is still very simple for you. After you have done the preliminary work to set up the *CachedRowSet* object *crs*, shown in the previous sections of this chapter, the following line of code populates *crs*.

```
crs.execute();
```

The data in *crs* is the data in the *ResultSet* object produced by executing the query in the *command* property.

What is different is that the *CachedRowSet* implementation for the method *execute* does a lot more than the *JdbcRowSet* implementation. Or more correctly, the *CachedRowSet* object’s reader, to which the method *execute* delegates its tasks, does a lot more.

Every disconnected RowSet object has a SyncProvider object assigned to it, and this SyncProvider object is what provides the RowSet object's *reader* (a RowSetReader object). When we created *crs*, we used the default CachedRowSetImpl constructor, which, in addition to setting default values for properties, assigns an instance of the RIOptimisticProvider implementation as the default SyncProvider object.

## What a Reader Does

When an application calls the method `execute`, a disconnected RowSet object's reader works behind the scenes to populate the RowSet object with data. A newly created CachedRowSet object is not connected to a data source and therefore must obtain a connection to that data source in order to get data from it. The reference implementation of the default SyncProvider object (RIOptimisticProvider) provides a reader that obtains a connection by using the values set for the user name, password, and either the the JDBC URL or the data source name, whichever was set more recently. Then the reader executes the query set for the command. It reads the data in the ResultSet object produced by the query, populating the CachedRowSet object with that data. Finally, the reader closes the connection, making the CachedRowSet object lightweight again.

After the method `execute` has been called and the reader has populated the CachedRowSet object *crs* with the data from the table COF\_INVENTORY, *crs* contains the data in Table 3–1.

**Table 3–1** COF\_INVENTORY

WAREHOUSE_ID	COF_NAME	SUP_ID	QUAN	DATE
1234	House_Blend	49	0	2006_04_01
1234	House_Blend_Decaf	49	0	2006_04_01
1234	Colombian	101	0	2006_04_01
1234	French_Roast	49	0	2006_04_01
1234	Espresso	150	0	2006_04_01
1234	Colombian_Decaf	101	0	2006_04_01

## Updating a CachedRowSet Object

In our ongoing Coffee Break scenario, the owner wants to streamline operations. He decides to have employees at the warehouse enter inventory directly into a PDA (personal digital assistant), thereby avoiding the error-prone process of having a second person do the data entry. A `CachedRowSet` object is ideal in this situation because it is lightweight, serializable, and can be updated without a connection to the data source.

The owner will have his programmer create a GUI tool for the PDA that his warehouse employees will use for entering inventory data. Headquarters will create a `CachedRowSet` object populated with the table showing the current inventory and send it via the Internet to the PDAs. When a warehouse employee enters data using the GUI tool, the tool adds each entry to an array, which the `CachedRowSet` object will use to perform the updates behind the scenes. Upon completion of the inventory, the PDAs send their new data back to headquarters, where the data is uploaded to the main server.

[???Is this how things would work? Please fix this as necessary.????? I know nothing about PDAs.]

## Updating a Column Value

Updating data in a `CachedRowSet` object is just the same as updating data in a `JdbcRowSet` object. For example, the following code fragment could represent what a `CachedRowSet` object would do when a warehouse employee entered values to be set in the `QUAN` column of the table `COF_INVENTORY`. The date of the inventory was entered at headquarters, so that does not need to be changed. The cursor is moved to before the first row so that the first call to the method `next` will put the cursor on the first row. For each row, after the value for the column `QUAN` has been set with a new value, the method `updateRow` is called to save the new value to memory.

```
int [] quantity = {873, 927, 985, 482, 358, 531};
int len = quantity.length;
crs.beforeFirst();
while (crs.next()) {
    for(int i = 0; i < len; i++) {
        crs.updateInt("QUAN", quantity[i]);
        crs.updateRow();
    }
}
```

## Inserting and Deleting Rows

Just as with updating a column value, the code for inserting and deleting rows in a `CachedRowSet` object is the same as for a `JdbcRowSet` object.

If the warehouse has received a shipment of a type of coffee that has not yet been entered in the `COF_INVENTORY` table, the GUI tool could have the warehouse employee enter the necessary information for adding a new row. The implementation of the tool could insert the new row into the `CachedRowSet` object `crs` with the following code fragment.

```
crs.moveToInsertRow();
crs.updateInt("WAREHOUSE_ID", 1234);
crs.updateString("COF_NAME", "Supremo");
crs.updateInt("SUP_ID", 150);
crs.updateInt("QUAN", 580);
java.util.Date 2006_04_01 = java.util.Date.valueOf("2006-04-01");
crs.updateDate("DATE", 2006_04_01);
crs.insertRow();
crs.moveToCurrentRow();
```

If headquarters has discontinued Espresso coffee, it would probably remove the row for that coffee itself. However, in our scenario, a warehouse employee using a PDA also has the capability of removing it. The following code fragment finds the row where the value in the `COF_NAME` column is Espresso and deletes it from `crs`.

```
while (crs.next()) {
    if (crs.getString("COF_NAME").equals("Espresso")) {
        crs.deleteRow();
        break;
    }
}
```

## Updating the Data Source

There is a major difference between making changes to a `JdbcRowSet` object and making changes to a `CachedRowSet` object. Because a `JdbcRowSet` object is connected to its data source, the methods `updateRow`, `insertRow`, and `deleteRow` can update both the `JdbcRowSet` object and the data source. In the case of a disconnected `RowSet` object, however, these methods update the data stored in the `CachedRowSet` object's memory but cannot affect the data source. A disconnected

RowSet object must call the method `acceptChanges` in order to save its changes to the data source. In our inventory scenario, back at headquarters, an application will call the method `acceptChanges` to update the database with the new values for the column `QUAN`.

```
crs.acceptChanges();
```

## What a Writer Does

Like the method `execute`, the method `acceptChanges` does its work invisibly. Whereas the method `execute` delegates its work to the RowSet object's reader, the method `acceptChanges` delegates its tasks to the RowSet object's writer. Behind the scenes, the writer opens a connection to the database, updates the database with the changes made to the RowSet object, and then closes the connection.

## Using the Default Implementation

The difficulty is that a *conflict* can arise. A conflict is a situation in which another party has updated a value in the database that corresponds to a value that was updated in a RowSet object. Which value should be persisted in the database? What the writer does when there is a conflict depends on how it is implemented, and there are many possibilities. At one end of the spectrum, the writer does not even check for conflicts and just writes all changes to the database. This is the case with the `RIXMLProvider` implementation, which is used by a `WebRowSet` object. At the other end, the writer makes sure there are no conflicts by setting database locks that prevent others from making changes.

The writer for `crs` is the one provided by the default `SyncProvider` implementation, `RIOptimisticProvider`. The `RIOptimisticProvider` implementation gets its name from the fact that it uses an optimistic concurrency model. This model assumes that there will be few, if any, conflicts and therefore sets no database locks. The writer checks to see if there are any conflicts, and if there are none, it writes the changes made to `crs` to the database to be persisted. If there are any conflicts, the default is not to write the new RowSet values to the database.

In our scenario, the default behavior works very well. Because no one at headquarters is likely to change the value in the `QUAN` column of `COF_INVENTORY`, there will be no conflicts. As a result, the values entered into `crs` at the warehouse will be written to the database and thus persisted, which is the desired outcome.

## Using a SyncResolver Object

In other situations, however, it is possible for conflicts to exist. To accommodate these situations, the `RIOPtimisticProvider` implementation provides an option that lets you look at the values in conflict and decide which ones to persist. This option is the use of a `SyncResolver` object.

When the writer has finished looking for conflicts and has found one or more, it creates a `SyncResolver` object containing the database values that caused the conflicts. Next, the method `acceptChanges` throws a `SyncProviderException` object, which an application may catch and use to retrieve the `SyncResolver` object. The following lines of code retrieve the `SyncResolver` object *resolver*.

```
try {
    crs.acceptChanges();
} catch (SyncProviderException spe) {
    SyncResolver resolver = spe.getSyncResolver();
```

*resolver* is a `RowSet` object that replicates *crs* except that it contains only the values in the database that caused a conflict. All other column values are `null`.

With *resolver* in hand, you can iterate through its rows to locate the values that are not `null` and are therefore values that caused a conflict. Then you can locate the value at the same position in *crs* and compare them. The following code fragment retrieves *resolver* and uses the `SyncResolver` method `nextConflict` to iterate through the rows that have conflict values. *resolver* gets the status of each conflict value, and if it is `UPDATE_ROW_CONFLICT`, meaning that the *crs* was attempting an update when the conflict occurred, *resolver* gets the row number of that value. Then the code moves the cursor for *crs* to the same row. Next, the code finds the column in that row of *resolver* that contains a conflict value, which will be a value that is not `null`. After retrieving the value in that column from both *resolver* and *crs*, you can compare the two and decide which one you want to be persisted. Finally, the code sets that value in both *crs* and the database using the method `setResolvedValue`.

```
try {
    crs.acceptChanges();
} catch (SyncProviderException spe) {
    SyncResolver resolver = spe.getSyncResolver();

    Object crsValue; // value in crs
    Object resolverValue; // value in the SyncResolver object
    Object resolvedValue; // value to be persisted

    while (resolver.nextConflict()) {
```

```

if (resolver.getStatus() == SyncResolver.UPDATE_ROW_CONFLICT) {
    int row = resolver.getRow();
    crs.absolute(row);

    int colCount = crs.getMetaData().getColumnCount();
    for (int j = 1; j <= colCount; j++) {
        if (resolver.getConflictValue(j) != null) {
            crsValue = crs.getObject(j);
            resolverValue = resolver.getConflictValue(j);
            . . . // compare crsValue and resolverValue to determine the
                // value to be persisted

            resolvedValue = crsValue;
            resolver.setResolvedValue(j, resolvedValue);
        }
    }
}
}
}
}

```

## Notifying Listeners

Being a JavaBeans component means that a RowSet object can notify other components when certain things happen to it. For example, if data in a RowSet object changes, the RowSet object can notify interested parties of that change. The nice thing about this notification mechanism is that, as an application programmer, all you have to do is add or remove the components that will be notified.

## Setting Up Listeners

A *listener* for a RowSet object is a component that implements the following methods from the RowSetListener interface:

- `cursorMoved`—defines what the listener will do, if anything, when the cursor in the RowSet object moves
- `rowChanged`—defines what the listener will do, if anything, when one or more column values in a row have changed, a row has been inserted, or a row has been deleted
- `rowSetChanged`—defines what the listener will do, if anything, when the RowSet object has been populated with new data

An example of a component that might want to be a listener is a `BarGraph` object that graphs the data in a `RowSet` object. As the data changes, the `BarGraph` object can update itself to reflect the new data.

As an application programmer, the only thing you need to do to take advantage of the notification mechanism is to add or remove listeners. The following line of code means that every time the cursor for `crs` moves, values in `crs` are changed, or `crs` as a whole gets new data, the `BarGraph` object `bar` will be notified.

```
crs.addRowSetListener(bar);
```

You can also stop notifications by removing a listener, as is done in the following line of code.

```
crs.removeRowSetListener(bar);
```

In our Coffee Break scenario, let's assume that headquarters checks with the database periodically to get the latest price list for the coffees it sells online. In this case, the listener is the `PriceList` object `priceList` at the Coffee Break web site, which must implement the `RowSetListener` methods `cursorMoved`, `rowChanged`, and `rowSetChanged`. The implementation of `cursorMoved` could be to do nothing because the position of the cursor does not affect `priceList`. The implementations for `rowChanged` and `rowSetChanged`, on the other hand, need to ascertain what changes have been made and to update `priceList` accordingly. The chapter "WebRowSet," on page xref, shows an easy way to send data in XML format, which is the standard for Web services communications.

## How Notification Works

In the reference implementation, methods that cause any of the `RowSet` events automatically notify all registered listeners. For example, any method that moves the cursor also calls the method `cursorMoved` on each of the listeners. Similarly, the method `execute` calls the method `rowSetChanged` on all listeners, and `acceptChanges` calls `rowChanged` on all listeners.

## Sending Large Amounts of Data

Code #2

This sample code demonstrates paging. Headquarters is sending an updated list of all the merchandise that individual Coffee Break coffee houses can order. Because it is presumably very large, we will not make this runnable code but instead use it just to show what the code would look like.

1. Create a `CachedRowSet` object and populate it with the table `GLOBAL_CATALOG`. This table is larger than the amount of memory available to the `CachedRowSet` object, so it has to be sent in chunks, with each chunk in a separate `CachedRowSet` object.

Assume that the table has 9,873 rows, and the memory for a `CachedRowSet` object is 200 rows. This means that the table needs to be sent in 5 separate `CachedRowSet` objects. The table can have the same columns as the table below (`MERCH_INVENTORY`) except that the `QUAN` and `DATE` columns are replaced by the `PRICE` column.

The data types for the columns in the table `GLOBAL_CATALOG` are

```
ITEM_ID --- INTEGER
ITEM_NAME --- VARCHAR(40)
SUP_ID --- INTEGER
PRICE --- REAL
```

### Code #3

This sample code demonstrates paging and using the method `acceptChanges`. The table `MERCH_INVENTORY` needs to be created. For the tutorial, the table will be pretty small but can still show how data can be sent in smaller pieces. There are currently only 12 rows, which could be sent in 3 different `CachedRowSet` objects with 4 rows each.

Note on the table below (`MERCH_INVENTORY`): This table will need to be created. The data types for the columns are

```
ITEM_ID --- int
ITEM_NAME --- String
SUP_ID --- int
QUAN --- long
```

`DATE` --- Date (Should we use a Date object, a String, or what?) I guess we could make the variable name for the Date object indicate what the date is.

```
Date 2006_04_01 = newDate(xxxxxxxxxxL); // number of milliseconds to
// represent April 1, 2006
```

**Table 3-2** MERCH\_INVENTORY

ITEM_ID	ITEM_NAME	SUP_ID	QUAN	DATE
00001234	Cup_Large	00456	28	2006_04_01
00001235	Cup_Small	00456	36	2006_04_01
00001236	Saucer	00456	64	2006_04_01
00001287	Carafe	00456	12	2006_04_01
00006931	Carafe	00927	3	2006_04_01
00006935	PotHolder	00927	88	2006_04_01
00006977	Napkin	00927	108	2006_04_01
00006979	Towel	00927	24	2006_04_01
00004488	CofMaker	08732	5	2006_04_01
00004490	CofGrinder	08732	9	2006_04_01
00004495	EspMaker	08732	4	2006_04_01
00006914	Cookbook	00927	12	2006_04_01

1. Create a `CachedRowSet` object and set its properties so that it can make a connection to the DB.

2. Populate it with the table `MERCH_INVENTORY` using the method `execute` (unless there is a compelling reason to use the method `populate`). Use paging to send 4 rows at a time, which will require 3 `CachedRowSet` objects.

For each `CachedRowSet` object:

3. Set `QUAN` column for every row to 0.

4. Update `QUAN` column for every row to the number of items counted (the number currently in the table above).

5. Synchronize with the DB by calling the method `acceptChanges`. (I am assuming that you would have to do this with each `CachedRowSet`.)

Question:

How would adding a new row work? Would that need to be a totally separate operation? In this case, where all `CachedRowSet` objects already have their limit of rows, would you have to just create a new one and populate it by hand with the new row? And then would you write the `CachedRowSet` object with its one row back to the DB?

If you had a `CachedRowSet` object with fewer rows than its limit, could you just add the new row to that? How would you know that it had less than its limit? Call the method `last`, then call the method `getRow`, and then compare that to the limit?

6. Add a new row for a new item offered at this Coffee Break coffee house. Values (0006914, "Tablecloth", 00927, 14, 2006\_04\_01).

## Code Sample

```
import java.sql.*;
import javax.sql.rowset.*;
import com.sun.rowset.*;

public class CachedRowSetSample {

    public static void main( String [] args) {
        String strUrl = "";
        String userId = "";
        String strPassword = "";
        CachedRowSet crs;
        int i = 1;
        try { Class.forName("com.inet.ora.OraDriver");
            Connection con = DriverManager.getConnection(
                strUrl, userId, strPassword);
            Statement stmt = con.createStatement();
            try {
                stmt.executeUpdate("drop table merch_inventory");
            } catch (Exception e) {
                // Do nothing
            }
            Statement stmt1 = con.createStatement();
```

```

stmt1.executeUpdate( create table merch_inventory(item_id int, item_name
varchar(20),sup_id int, quan int, date_val timestamp) );
PreparedStatement pstmt = con.prepareStatement( insert into merch_inventory
values(?,?,?,?) );
for (int j = 0 ; j < 13; j++) {
pstmt.setInt(1,1235+j);
pstmt.setString(2, item +j);
pstmt.setInt(3,j);
pstmt.setInt(4,0);
pstmt.setObject(5,new Date(104,04,06));
pstmt.executeUpdate();
}
con.commit();
// Create new cachedRowSet object.
crs = new CachedRowSetImpl();
// Set all the properties.
crs.setUrl(strUrl);
crs.setUsername(userId);
crs.setPassword(strPassword);
crs.setCommand( select * from MERCH_INVENTORY );
// Setting the page size to 4, such that we
// get the data in chunks of 4 rows @ a time.
crs.setPageSize(4);
// Now get the first set of data. crs.execute();
// Keep on getting data in chunks until done.
while(crs.nextPage()) {
System.out.println( Page number: +i);
while(crs.next()) {
if(crs.getInt( ITEM_ID ) == 1235) {
System.out.println( QUAN value: +crs.getInt( QUAN ));
crs.updateInt( QUAN ,99);
crs.updateRow();
// Syncing the row back to the DB
crs.acceptChanges();
} // End of inner while
i++;
} // End of outer while
// Inserting a new row

// Doing a previous page to come back to the last page
// as we ll be after the last page.
crs.previousPage();
crs.moveToInsertRow();
crs.updateInt( ITEM_ID ,6914);
crs.updateString( ITEM_NAME , TableCloth );
crs.updateInt( SUP_ID ,927);

```

```

crs.updateInt( QUAN ,14);
crs.updateDate( DATE_VAL ,new Date(104,04,06));
    crs.insertRow();
    crs.moveToCurrentRow();

    // Syncing the new ro back to the database.

    crs.acceptChanges();
} catch( SQLException sqle) {
System.out.println( SQLException caught: +sqle.getMessage());
} catch(Exception e) {
System.out.println( Unexpected exception: +e.getMessage());
e.printStackTrace();
}
} // End of main.
} // End of class.

import java.sql.*;
import javax.sql.rowset.*;
import com.sun.rowset.*;

public class CachedRowSetSample {

// Assign the following properties accordingly before
// running this example.

    public static void main( String [] args) {

        String strUrl = "jdbc:inetora:129.158.229.21:1521:orcl9";
        String userId = "scott";
        String strPassword = "tiger";
        CachedRowSet crs;
        int i = 1;

        try {
            Class.forName("com.inet.ora.OraDriver");
            Connection con = DriverManager.getConnection(
                strUrl, userId, strPassword);
            Statement stmt = con.createStatement();

            try
            {
                stmt.executeUpdate("drop table merch_inventory");
            }
        }
    }
}

```

```
}catch(Exception e) {  
    // Do nothing  
}  
  
Statement stmt1 = con.createStatement();  
stmt1.executeUpdate("create table merch_inventory(item_id int, item_name  
varchar(20),sup_id int, quan int, date_val timestamp)");  
  
    PreparedStatement pStmt = con.prepareStatement("insert into  
merch_inventory values(?,?,?,?)");  
  
    // this has to be done 13 times for each row  
pStmt.setInt(1,1234);  
pStmt.setString(2,"Cup_Large");  
pStmt.setInt(3,456);  
pStmt.setInt(4,28);  
pStmt.setObject(5,new Date(106,04,01));  
pStmt.executeUpdate();  
  
pStmt.setInt(1,1235);  
pStmt.setString(2,"Cup_Small");  
pStmt.setInt(3,456);  
pStmt.setInt(4,36);  
pStmt.setObject(5,new Date(106,04,01));  
pStmt.executeUpdate();  
  
pStmt.setInt(1,1236);  
pStmt.setString(2,"Saucer");
```

```
pStmt.setInt(3,456);  
pStmt.setInt(4,64);  
pStmt.setObject(5,new Date(106,04,01));  
pStmt.executeUpdate();
```

```
pStmt.setInt(1,1287);  
pStmt.setString(2,"Carafe");  
pStmt.setInt(3,456);  
pStmt.setInt(4,12);  
pStmt.setObject(5,new Date(106,04,01));  
pStmt.executeUpdate();
```

```
pStmt.setInt(1,6931);  
pStmt.setString(2,"Carafe");  
pStmt.setInt(3,927);  
pStmt.setInt(4,3);  
pStmt.setObject(5,new Date(106,04,01));  
pStmt.executeUpdate();
```

```
pStmt.setInt(1,6935);  
pStmt.setString(2,"PotHolder");  
pStmt.setInt(3,927);  
pStmt.setInt(4,88);  
pStmt.setObject(5,new Date(106,04,01));  
pStmt.executeUpdate();
```

```
pStmt.setInt(1,6977);
```

```
pStmt.setString(2,"Napkin");  
pStmt.setInt(3,927);  
pStmt.setInt(4,108);  
pStmt.setObject(5,new Date(106,04,01));  
pStmt.executeUpdate();
```

```
pStmt.setInt(1,6979);  
pStmt.setString(2,"Towel");  
pStmt.setInt(3,927);  
pStmt.setInt(4,24);  
pStmt.setObject(5,new Date(106,04,01));  
pStmt.executeUpdate();
```

```
pStmt.setInt(1,4488);  
pStmt.setString(2,"CofMaker");  
pStmt.setInt(3,8372);  
pStmt.setInt(4,5);  
pStmt.setObject(5,new Date(106,04,01));  
pStmt.executeUpdate();
```

```
pStmt.setInt(1,4490);  
pStmt.setString(2,"CofGrinder");  
pStmt.setInt(3,8732);  
pStmt.setInt(4,9);  
pStmt.setObject(5,new Date(106,04,01));  
pStmt.executeUpdate();
```

```
pStmt.setInt(1,4495);  
pStmt.setString(2,"EspMaker");  
pStmt.setInt(3,8732);  
pStmt.setInt(4,4);  
pStmt.setObject(5,new Date(106,04,01));  
pStmt.executeUpdate();
```

```
pStmt.setInt(1,6914);  
pStmt.setString(2,"Cookbook");  
pStmt.setInt(3,927);  
pStmt.setInt(4,12);  
pStmt.setObject(5,new Date(106,04,01));  
pStmt.executeUpdate();
```

```
pStmt.setInt(1,6917);  
pStmt.setString(2,"Boiler");  
pStmt.setInt(3,927);  
pStmt.setInt(4,10);  
pStmt.setObject(5,new Date(106,04,01));  
pStmt.executeUpdate();
```

```
con.commit();
```

```
// Create new cachedRowSet object.
```

```
crs = new CachedRowSetImpl();
```

```
// Set all the properties.
```

```
crs.setUrl(strUrl);
crs.setUsername(userId);
crs.setPassword(strPassword);
crs.setCommand("select * from MERCH_INVENTORY");

// Setting the page size to 4, such that we
// get the data in chunks of 4 rows @ a time.

crs.setPageSize(4);

// Now get the first set of data.
crs.execute();

// Keep on getting data in chunks until done.
while(crs.nextPage()) {
    System.out.println("Page number: "+i);
    while(crs.next()) {
        if(crs.getInt("ITEM_ID") == 1235) {
            System.out.println("QUAN value: "+crs.getInt("QUAN"));
            crs.updateInt("QUAN",99);
            crs.updateRow();

            // This acceptChanges eventhough inside a loop will happen
            // only once since the if condition is satisfied only for
            // one ITEM_ID.
            // Syncing the row back to the DB
            crs.acceptChanges();
        }
    }
}
```

```
    }  
    } // End of inner while  
  
    i++;  
} // End of outer while  
  
// Inserting a new row  
  
// Doing a previous page to come back to the last page  
// as we'll be after the last page.  
crs.previousPage();  
    crs.moveToInsertRow();  
    crs.updateInt("ITEM_ID",6922);  
    crs.updateString("ITEM_NAME","TableCloth");  
    crs.updateInt("SUP_ID",927);  
    crs.updateInt("QUAN",14);  
    crs.updateDate("DATE_VAL",new Date(106,04,01));  
    crs.insertRow();  
    crs.moveToCurrentRow();  
  
    // Syncing the new ro back to the database.  
  
    crs.acceptChanges();  
  
} catch( SQLException sqle) {  
    System.out.println("SQLException caught: "+sqle.getMessage());
```

```
} catch(Exception e) {  
    System.out.println("Unexpected exception: "+e.getMessage());  
    e.printStackTrace();  
}  
  
} // End of main.  
} // End of class.
```



---

# JoinRowSet

**A** `JoinRowSet` implementation lets you create an SQL JOIN between `RowSet` objects when they are not connected to a data source. This is important because it saves the overhead of having to create one or more connections. In this chapter, you will learn how to do the following:

- Create a `JoinRowSet` object
- Add `RowSet` objects to form an SQL JOIN
- Manage match columns

**NOTE:** You should have read the chapter “`CachedRowSet`” before reading this chapter. The `JoinRowSet` interface is a subinterface of the `CachedRowSet` interface and thereby inherits the capabilities of a `CachedRowSet` object. This means that a `JoinRowSet` object is a disconnected `RowSet` object and can operate without always being connected to a data source.

## Creating a `JoinRowSet` Object

A `JoinRowSet` object serves as the holder of an SQL JOIN. The following line of code shows how easy it is to create a `JoinRowSet` object.

```
JoinRowSet jrs = new JoinRowSetImpl();
```

The variable `jrs` holds nothing until `RowSet` objects are added to it.

## Adding RowSet Objects

Any RowSet object can be added to a JoinRowSet object as long as it can be part of an SQL JOIN. A JdbcRowSet object, which is always connected to its data source, can be added, but normally it forms part of a JOIN by operating with the data source directly instead of becoming part of a JOIN by being added to a JoinRowSet object. The point of providing a JoinRowSet implementation is to make it possible for disconnected RowSet objects to become part of a JOIN relationship.

The owner of The Coffee Break chain of coffee houses wants to get a list of the coffees he buys from a Acme, Inc. In order to do this, he will have to get information from two tables, COFFEES and SUPPLIERS. In the database world before RowSet technology, the owner or his programmers would send the following query to the database:

```
String query = "SELECT COFFEES.COF_NAME FROM COFFEES, SUPPLIERS " +  
              "WHERE SUPPLIERS.SUP_NAME = Acme.Inc. and " +  
              "SUPPLIERS.SUP_ID = COFFEES.SUP_ID";
```

In the world of RowSet technology, you can accomplish the same result without having to send a query to the data source. You can add RowSet objects containing the data in the two tables to a JoinRowSet object. Then, because all the pertinent data is in the JoinRowSet object, you can perform a query on it to get the desired data.

The following code fragments create two CachedRowSet objects, *coffees* populated with the data from the table COFFEES, and *suppliers* populated with the data from the table SUPPLIERS. The readers (RowSetReader objects) for *coffees* and *suppliers* have to make a connection to the database to execute their commands and get

populated with data, but once that is done, they do not have to reconnect again in order to form a JOIN.

```

CachedRowSet coffees = new CachedRowSetImpl();
coffees.setCommand("SELECT * FROM COFFEES");
coffees.setUsername(name);
coffees.setPassword(password);
coffees.setURL("jdbcDriverURL1");
coffees.execute();
    
```

```

CachedRowSet suppliers = new CachedRowSetImpl();
suppliers.setCommand("SELECT * FROM SUPPLIERS");
suppliers.setUsername(name);
suppliers.setPassword(password);
suppliers.setURL("jdbcDriverURL2");
suppliers.execute();
    
```

The contents of these two tables are shown in Table 4–1 COFFEES and Table 4–2 SUPPLIERS.

**Table 4–1 COFFEES**

COF_NAME	SUP_ID	PRICE	SALES	TOTAL
Colombian	101	7.99	0	0
French_Roast	49	8.99	0	0
Espresso	150	10.99	0	0
Colombian_Decaf	101	8.99	0	0
House_Blend	49	7.99	0	0
House_Blend_Decaf	49	8.99	0	0

**Table 4–2 SUPPLIERS**

SUP_ID	SUP_NAME	STREET	CITY	STATE	ZIP
101	Acme, Inc.	99 Market Street	Groundsville	CA	95199
49	Superior Coffee	1 Party Place	Mendocino	CA	95460

Table 4-2 SUPPLIERS

SUP_ID	SUP_NAME	STREET	CITY	STATE	ZIP
150	The High Ground	100 Coffee Lane	Meadows	CA	93966

Looking at the SUPPLIERS table, you can see that Acme, Inc. has an identification number of 101. The coffees in the table COFFEES with the supplier identification number of 101 are Colombian and Colombian\_Decaf. The joining of information from both tables is possible because the two tables have the column SUP\_ID in common. In JDBC RowSet technology, SUP\_ID, the column on which the JOIN is based, is called the *match column*.

Each RowSet object added to a JoinRowSet object must have a match column, the column on which the JOIN is based. There are two ways to set the match column for a RowSet object. The first way is to pass the match column to the JoinRowSet method addRowSet, as shown in the following line of code.

```
jrs.addRowSet(coffees, 2);
```

This line of code adds *coffees* to *jrs* and sets the second column of *coffees* (SUP\_ID) as the match column. The line of code could also have used the column name rather than the column number.

```
jrs.addRowSet(coffees, "SUP_ID");
```

At this point, *jrs* has only *coffees* in it. The next RowSet object added to *jrs* will have to be able to form a JOIN with *coffees*, which is true of *suppliers* because both tables have the column SUP\_ID. The following line of code adds *suppliers* to *jrs* and sets the column SUP\_ID as the match column.

```
jrs.addRowSet(suppliers, 1);
```

Now *jrs* contains a JOIN between *coffees* and *suppliers* from which the owner can get the names of the coffees that he gets from Acme, Inc. Because the code did not set the type of JOIN, *jrs* holds an inner JOIN, which is the default. In other words, a row in *jrs* combines a row in *coffees* and a row in *suppliers*. It holds the columns in *coffees* plus the columns in *suppliers* for rows in which the value in the COFFEES.SUP\_ID column matches the value in SUPPLIERS.SUP\_ID. The following code prints out the names of coffees supplied by Acme, Inc. Note that this is pos-

sible because the column SUP\_NAME, which is from *suppliers*, and COF\_NAME, which is from *coffees*, are now both included in the JoinRowSet object *jrs*.

```
System.out.println("Coffees bought from Acme, Inc. ");
while (jrs.next()) {
    if (jrs.getString("SUP_NAME") = "Acme, Inc.") {
        String name = jrs.getString("COF_NAME");
        System.out.println("    " + name);
    }
}
```

This will produce output similar to the following:

```
Coffees bought from Acme, Inc.:
    Colombian
    Colombian_Decaf
```

The JoinRowSet interface provides constants for setting the type of JOIN that will be formed, but currently the only type that is implemented is JoinRowSet.INNER\_JOIN.



---

# FilteredRowSet

**A** `FilteredRowSet` object lets you cut down the number of rows that are visible in a `RowSet` object so that you can work with only the data that is relevant to what you are doing. You decide what limits you want to set on your data (how you want to “filter” the data) and apply that filter to a `FilteredRowSet` object. In other words, the `FilteredRowSet` object makes visible only the rows of data that fit within the limits you set. A `JdbcRowSet` object, which always has a connection to its data source, can do this filtering with a query to the data source that selects only the columns and rows you want to see. The query’s `WHERE` clause defines the filtering criteria. A `FilteredRowSet` object provides a way for a disconnected `RowSet` object to do this filtering without having to execute a query on the data source, thus avoiding having to get a connection to the data source and sending queries to it.

For example, assume that the Coffee Break chain of coffee houses has grown to hundreds of stores throughout the country, and all of them are listed in a table called `COFFEE_HOUSES`. The owner wants to measure the success of only the stores in California using his laptop, which cannot make a connection to his database system. This comparison will look at the profitability of selling merchandise versus selling coffee drinks plus various other measures of success, and it will rank California stores by coffee drink sales, merchandise sales, and total sales. Because the table `COFFEE_HOUSES` has hundreds of rows, these comparisons will be faster and easier if the amount of data being searched is cut down to only those rows where the value in the column `STORE_ID` indicates California.

This is exactly the kind of problem that a `FilteredRowSet` object addresses by providing the following capabilities:

- Ability to limit the rows that are visible according to set criteria
- Ability to select which data is visible without being connected to a data source

In this chapter you will walk through how to do the following:

- Define filtering criteria in a `Predicate` object
- Create a `FilteredRowSet` object and set it with a `Predicate` object
- Set a `FilteredRowSet` object with a new `Predicate` object to filter data even further
- Update a `FilteredRowSet` object
- Remove all filters so that all rows are once again visible

## Creating a Predicate Object

To set the criteria for which rows in a `FilteredRowSet` object will be visible, you define a class that implements the `Predicate` interface. This `Predicate` object is initialized with the following:

- The high end of the range within which values must fall
- The low end of the range within which values must fall
- The column name or column number of the column with the value that must fall within the range of values set by the high and low boundaries

Note that the range of values is inclusive, meaning that a value at the boundary is included in the range. For example, if the range has a high of 100 and a low of 50, a value of 50 is considered to be within the range. A value of 49 is not. Likewise, 100 is within the range, but 101 is not.

In line with the scenario where the owner wants to compare California stores, we need to write an implementation of the `Predicate` interface that filters for Coffee Break coffee houses located in California. There is no one right way to do this, which means that we have a lot of latitude in how we write the implementation. For example, we are free to name the class and its members whatever we want and to implement a constructor and the three `evaluate` methods in any way that accomplishes what we want.

The table listing all of the coffee houses, named `COFFEE_HOUSES`, has hundreds of rows. To make things more manageable, only part of the table is shown in this example, but it is enough so that you can see how it is set up and how the filtering is done.

A value in the column `STORE_ID` is an int that indicates, among other things, the state in which the coffee house is located. A value beginning with 10, for example, means that the state is California. `STORE_ID` values beginning with 32 indicate Oregon, and those beginning with 33 indicate the state of Washington. Table 5–1 shows an abbreviated version of the table `COFFEE_HOUSES`.

**Table 5–1** `COFFEE_HOUSES`

<b>STORE_ID</b>	<b>CITY</b>	<b>COFFEE</b>	<b>MERCH</b>	<b>TOTAL</b>
10023	Mendocino	3450	2005	5455
33002	Seattle	4699	3109	7808
10040	SF	5386	2841	8227
32001	Portland	3147	3579	6726
10042	SF	2863	1874	4710
10024	Sacramento	1987	2341	4328
10039	Carmel	2691	1121	3812
10041	LA	1533	1007	2540
33002	Olympia	2733	1550	4283
33010	Seattle	3210	2177	5387
10035	SF	1922	1056	2978
10037	LA	2143	1876	4019
10034	San_Jose	1234	1032	2266
32004	Eugene	1356	1112	2468
10041	LA	2284	1732	4016

Our implementation could look like the following.

```
public class Filter1 implements Predicate {
    private int lo;
    private int hi;
    private String colName;
    private int colNumber;

    public Filter1(int lo, int hi, int colNumber) {
        this.lo = lo;
        this.hi = hi;
        this.colNumber = colNumber;
    }

    public Filter1(int lo, int hi, String colName) {
        this.lo = lo;
        this.hi = hi;
        this.colName = colName;
    }

    public boolean evaluate(RowSet rs {
        CachedRowSet crs = (CachedRowSet)rs;
        boolean bool1;
        boolean bool2;

        if (rs.getInt(colNumber) >= lo &&
            (rs.getInt(colNumber) <= hi) {
            return true;
        } else {
            return false;
        }
    }
}
```

This is a very simple implementation that checks the value in the column `STORE_ID` in the current row to see if it is in the range of 10000 to 10999, inclusive. All Coffee Break coffee houses in California have an identification number in which the first two digits of a five-digit number are 10, so a `Filter1` object allows only the rows where the `STORE_ID` column value indicates a California location to be visible.

Note that the `Filter1` object just defined applies to one column. It is possible to have it apply to two or more columns by making each of the parameters arrays

instead of single values. For example, the constructor for a Filter object could look like the following:

```
public Filter2(Object [] lo, Object [] hi, Object [] colNumber) {
    this.lo = lo;
    this.hi = hi;
    this.colNumber = colNumber;
}
```

The first element in *colNumber* gives the first column in which the value will be checked against the first element in *lo* and the first element in *hi*. The value in the second column indicated by *colNumber* will be checked against the second elements in *lo* and *hi*, and so on. Therefore, the number of elements in the three arrays should be the same. Here is what an implementation of the method `evaluate(RowSet rs)` might look like for a Filter2 object, in which the parameters are arrays.

```
public boolean evaluate(RowSet rs) {
    CachedRowSet crs = (CachedRowSet)rs;
    boolean bool1;
    boolean bool2;

    for (int i = 0; i < colNumber.length; i++) {
        if ((rs.getObject(colNumber[i]) >= lo [i]) &&
            (rs.getObject(colNumber[i]) <= hi[i]) {
            bool1 = true;
        } else {
            bool2 = true;
        }
    }
    if (bool2) {
        return false;
    } else {
        return true;
    }
}
```

The advantage of using a Filter2 implementation is that you can use parameters of any Object type and can check one column or multiple columns without having to write another implementation. However, you must pass an Object type, which means that you must convert a primitive type to its Object type. For example, if you use an int for *lo* and *hi*, you must convert the int to an Integer object before passing it to the constructor. String objects are already an Object type, so you do

not have to convert them. The following line of code creates an Integer object that you could pass to the constructor for a Filter2 object.

```
Integer loInt = new Integer(10000);
```

## Creating a FilteredRowSet Object

The reference implementation for the FilteredRowSet interface, FilteredRowSetImpl, includes a default constructor, which is used in the following line of code to create the empty FilteredRowSet object *frs*.

```
FilteredRowSet frs = new FilteredRowSetImpl();
```

The implementation extends the BaseRowSet abstract class, so *frs* has the default properties defined in BaseRowSet. This means that *frs* is scrollable, updatable, does not show deleted rows, has escape processing turned on, and so on. Also, because the FilteredRowSet interface is a subinterface of CachedRowSet, Joinable, and WebRowSet, *frs* has the capabilities of each. It can operate as a disconnected RowSet object, can be part of a JoinRowSet object, and can read and write itself in XML format.

Like other disconnected RowSet objects, *frs* must populate itself with data from a tabular data source, which is a relational database in the reference implementation. The following code fragment sets the properties necessary to connect to a database to execute its command. Note that this code uses the DriverManager class to make a connection, which is done for convenience. Normally, it is better to use a DataSource object that has been registered with a naming service that implements the Java™ Naming and Directory Interface (JNDI).

```
frs.setCommand("SELECT * FROM COFFEE_HOUSES");  
frs.setURL("jdbc:mySubprotocol:myDatabase");  
frs.setUsername("Vladimir");  
frs.setPassword("secret");
```

The following line of code populates *frs* with the data stored in the COFFEE\_HOUSE table.

```
frs.execute();
```

The method execute does all kinds of things behind the scenes by calling on the RowSetReader object for *frs*, which creates a connection, executes the command for *frs*, populates *frs* with the data from the ResultSet object that is produced, and closes the connection. Note that if the table COFFEE\_HOUSES had more rows than

*frs* could hold in memory at one time, the `CachedRowSet` paging methods would have been used. If you need a refresher on paging or the method `execute`, see the chapter on the `CachedRowSet` implementation [xref TBD].

In our scenario, the Coffee Break owner would have done the preceding tasks in the office and then downloaded *frs* to his laptop. From now on, *frs* will operate independently, without the benefit of a connection to the data source.

## Creating and Setting a Predicate Object

Now that the `FilteredRowSet` object *frs* contains the list of Coffee Break establishments, we can set selection criteria for narrowing down the number of rows in *frs* that are visible. The following line of code uses the `Filter1` class we defined earlier in the chapter to create the object *filter1*, which checks the column `STORE_ID` to determine which stores are in California (which `STORE_ID` numbers fall between 10000 and 10999, inclusive).

```
Filter1 filter1 = new Filter1(10000, 10999, "STORE_ID");
```

The next line of code sets *filter1* as the filter for *frs*.

```
frs.setFilter(filter1);
```

To do the actual filtering, you call the method `next`, which in the reference implementation calls the appropriate version of the `Predicate` method `implement` behind the scenes. [Add material on three evaluate methods.]

If the return value is `true`, the row will be visible; if the return value is `false`, it will not. Thus, the following code fragment iterates through *frs* and prints only the rows in which the store is in California.

```
while (frs.next()) {
    int storeId = frs.getInt("STORE_ID");
    String city = frs.getString("CITY");
    long cof = frs.getLong("COF_SALES");
    long merch = frs.getLong("MERCH_SALES");
    long total = frs.getLong("TOTAL_SALES");

    print(storeId + "      ")
    print(city + "        ")
    print(cof + "         ")
    print(merch + "       ")
    println(total );
}
```

If none of the rows satisfied the criteria in *filter1*, there would have been no visible rows and nothing would have been printed.

## Working with Filters

This section walks you through defining a different filter, setting it, and unsetting it. It also shows you how to update a `FilteredRowSet` object and the conditions under which you can modify values and insert or delete a row.

You set multiple filters serially. The first time you call the method `setFilter` and pass it a `Predicate` object, you have applied the filtering criteria in that filter. After calling the method `next` on each row, which makes visible only those rows that satisfy the filter, you can call `setFilter` again, passing it a different `Predicate` object. Even though only one filter is set at a time, the effect is that both filters apply cumulatively .

For example, the owner has gotten a list of the Coffee Break stores in California by setting *filter1* as the `Predicate` object for *frs*. Now he wants to compare the stores in two California cities, San Francisco (SF in the table `COFFEE_HOUSES`) and Los Angeles (LA in the table). The first thing to do is to write a `Predicate` implementation that filters for stores in either SF or LA.

```
public class CityFilter implements Predicate {

    private Object city1;
    private Object city2;
    private Object colName;
    private int colNumber;

    public CityFilter(Object [] city1, Object [] city2, Object [] colName) {
        this.city1 = city1;
        this.city2 = city2;
        this.colName = colName;
    }

    public CityFilter(Object [] city1, Object [] city2, int [] colNumber) {
        this.city1 = city1;
        this.city2 = city2;
        this.colNumber = colNumber;
    }

    public boolean evaluate(RowSet rs) {
        CachedRowSet crs = (CachedRowSet)rs;
        boolean bool1;
```

```

boolean bool2;

for (int i = 0; i < colName.length; i++) {
    if ((rs.getObject(colName[i] = city1[i]) ||
        (rs.getObject(colName[i] = city2[i]) {
        bool1 = true;
    } else {
        bool2 = true;
    }
    }
    if (bool2) {
        return false;
    } else {
        return true;
    }
}
}
... // implementations for the other two versions of evaluate
}

```

The following code fragment sets the new filter and iterates through the rows in *frs*, printing out the rows where the CITY column contains either SF or LA. Note that *frs* currently contains only rows where the store is in California, so the criteria of the Predicate object *state* are still in effect when the filter is changed to another Predicate object. The code that follows sets the filter to the CityFilter object *city*. The CityFilter implementation uses arrays as parameters to the constructors to illustrate how that can be done.

```

Object [] city1 = {"SF"};
Object [] city2 = {"LA"};
Object [] colName = {"CITY"};
CityFilter city = new CityFilter(city1, city2, colName);

frs.setFilter(city);

while (frs.next()) {
    int storeId = frs.getInt("STORE_ID");
    String city = frs.getString("CITY");
    long cof = frs.getLong("COF_SALES");
    long merch = frs.getLong("MERCH_SALES");
    long total = frs.getLong("TOTAL_SALES");

    print(storeId + "    ")
    print(city + "    ")
    print(cof + "    ")
    print(merch + "    ")
    println(total );
}

```

The printout should contain a row for each store that is in San Francisco, California or Los Angeles, California. If there were a row in which the CITY column contained LA and the STORE\_ID column contained 40003, it would not be included in the list because it had already been filtered out when the filter was set to *state*. (40003 is not in the range of 10000 to 10999.)

## Updating a FilteredRowSet Object

You can make a change to a FilteredRowSet object but only if that change does not violate any of the filtering criteria currently in effect. For example, you can insert a new row or change one or more values in an existing row if the new value or values are within the filtering criteria.

### Inserting or Updating a Row

Assume that two new Coffee Break coffee houses have just opened and the owner wants to add them to his list. If a row to be inserted does not meet the cumulative filtering criteria in effect, it will be blocked from being added.

The current state of *frs* is that the Filter1 object *state* was set and then the CityFilter object *city* was set. As a result, *frs* currently makes visible only those rows that satisfy the criteria for both filters. And, equally important, you cannot add a row to *frs* unless it satisfies the criteria for both filters. [??true??] The following code fragment attempts to insert two new rows into *frs*, one row in which the values in the STORE\_ID and CITY columns both meet the criteria, and one row in which the value in STORE\_ID does not pass the filter but the value in the CITY column does.

```
frs.moveToInsertRow();

frs.updateInt("STORE_ID", 10101);
frs.updateString("CITY", "SF");
frs.updateLong("COF_SALES", 0);
frs.updateLong("MERCH_SALES", 0);
frs.updateLong("TOTAL_SALES", 0);
frs.insertRow();

frs.updateInt("STORE_ID", 33101);
frs.updateString("CITY", "SF");
frs.updateLong("COF_SALES", 0);
frs.updateLong("MERCH_SALES", 0);
```

```
frs.updateLong("TOTAL_SALES", 0);
frs.insertRow();

frs.moveToCurrentRow();
```

If you were to iterate through *frs* using the method `next`, you would find a row for the new coffee house in San Francisco, California, but not for the store in San Francisco, Washington.

The owner can add the store in Washington by nullifying the filter. With no filter set, all rows in *frs* are once more visible, and a store in any location can be added to the list of stores. The following line of code unsets the current filter, effectively nullifying both of the Predicate implementations previously set on *frs*.

```
frs.setFilter(null);
```

## Deleting a Row

If the owner decides to close down or sell one of the Coffee Break coffee houses, he will want to delete it from the `COFFEE_HOUSES` table. He can delete the row for the underperforming coffee house as long as it is visible.

Given that the method `setFilter` has just been called with the argument `null`, there is no filter set on *frs*. This means that all rows are visible and can therefore be deleted. However, after the `Filter1` object *state*, which filtered out any state other than California, was set, only stores located in California could be deleted. When the `CityFilter` object *city* was set for *frs*, only coffee houses in San Francisco, California or Los Angeles, California could be deleted because they were in the only rows visible.

## Combining Two Filters into One

It is possible to apply different criteria to different columns in a `FilteredRowSet` object. For example, you can combine the criteria used in *state* and *city* into one Predicate object by initializing the constructor with arrays.

[code fragment illustrating]



---

# WebRowSet

**A** WebRowSet object is very special because in addition to offering all of the capabilities of a CachedRowSet object, it can write itself as an XML document and can also read that XML document to convert itself back to a WebRowSet object. Because XML is the language through which disparate enterprises can communicate with each other, it has become the standard for Web Services communication. As a consequence, a WebRowSet object fills a real need by making it easy for Web Services to send and receive data from a database in the form of an XML document.

In this chapter, you will learn how to do the following:

- Create and populate a WebRowSet object
- Write a WebRowSet object to an XML document
- Read data, properties, and metadata into a WebRowSet object from an XML document
- Make updates to a WebRowSet object
- Synchronize data back to the data source

Optional:

- Understand the structure and elements of the WebRowSet XML Schema

In the *Java Web Services Tutorial*, which uses the same Coffee Break scenario we have been using, the company has expanded to selling coffee online. Users order coffee by the pound from the Coffee Break web site. The price list is regularly updated by getting the latest information from the company's database. In the original tutorial, the price list was sent in a message that was an XML docu-

ment composed using the SAAJ API. In this chapter you will see how much easier it is to send the price data using a `WebRowSet` object, which can write itself as an XML document with a single method call.

## Creating and Populating a `WebRowSet` Object

You create a new `WebRowSet` object with the default constructor defined in the reference implementation, `WebRowSetImpl`, as shown in the following line of code.

```
WebRowSet priceList = new WebRowSetImpl();
```

Although `priceList` has no data yet, it has the default properties of a `BaseRowSet` object. Its `SyncProvider` object is at first set to the `RIOptimisticProvider` implementation, which is the default for all disconnected `RowSet` objects. However, the `WebRowSet` implementation resets the `SyncProvider` object to be the `RIXMLProvider` implementation. You will learn more about the `RIXMLProvider` implementation in the section “Synchronizing Back to the Data Source” [xref].

Getting back to our scenario, the Coffee Break headquarters regularly sends price list updates to its Web site. The Java Web Services Tutorial stated that this routine updating was done, but it did not show how it was done. This chapter on `WebRowSet` objects will show one way you can send the latest price list in an XML document.

The price list consists of the data in the columns `COF_NAME` and `PRICE` from the table `COFFEES`. The following code fragment sets the properties needed and populates `priceList` with the price list data.

```
priceList.setCommand("SELECT COF_NAME, PRICE FROM COFFEES");  
priceList.setURL("jdbc:mySubprotocol:myDatabase");  
priceList.setUsername("myUsername");  
priceList.setPassword("myPassword");  
priceList.execute();
```

At this point, in addition to the default properties, `priceList` contains the data in the columns `COF_NAME` and `PRICE` from the `COFFEES` table and also the metadata about these two columns.

## Writing and Reading a WebRowSet Object to XML

Writing a `WebRowSet` object as an XML document is very easy: All you do is call the method `writeXml`. Similarly, all you do to read that XML document's contents into a `WebRowSet` object is to call the method `readXml`. Both of these methods do their work behind the scenes, meaning that everything except the results is invisible to you.

### Using the `writeXml` Method

The method `writeXML` writes the `WebRowSet` object that invoked it as an XML document that represents its current state. It writes this XML document to the stream that you pass to it. The stream can be an `OutputStream` object, such as a `FileOutputStream` object, or a `Writer` object, such as a `FileWriter` object. If you pass the method `writeXml` an `OutputStream` object, you will write in bytes, which can handle all types of data; if you pass it a `Writer` object, you will write in characters. The following code demonstrates writing the `WebRowSet` object `priceList` as an XML document to the `FileOutputStream` object `oStream`.

```
java.io.FileOutputStream oStream = new java.io.FileOutputStream("priceList.xml");
priceList.writeXml(oStream);
```

The following code writes the XML document representing `priceList` to the `FileWriter` object `writer` instead of to an `OutputStream` object. The `FileWriter` class is a convenience class for writing characters to a file.

```
java.io.FileWriter writer = new java.io.FileWriter("priceList.xml");
priceList.writeXml(writer);
```

The other two versions of the method `writeXml` let you populate a `WebRowSet` object with the contents of a `ResultSet` object before writing it to a stream. In the following line of code, the method `writeXml` reads the contents of the `ResultSet` object `rs` into `priceList` and then writes `priceList` to the `FileOutputStream` object `oStream` as an XML document.

```
priceList.writeXml(rs, oStream);
```

In the next line of code, `writeXml` populates `priceList` with the contents of `rs`, but it writes the XML document to a `FileWriter` object instead of to an `OutputStream` object.

```
priceList.writeXml(rs, writer);
```

## Using the readXml Method

The method `readXml` parses an XML document in order to construct the `WebRowSet` object the XML document describes. Analogous to the method `writeXml`, you can pass `readXml` an `InputStream` object or a `Reader` object from which to read the XML document.

```
java.io.FileInputStream iStream = new java.io.FileInputStream("priceList.xml");  
priceList.readXml(iStream);
```

```
java.io.FileReader reader = new java.io.FileReader("priceList.xml");  
priceList.readXml(reader);
```

Note that you can read the XML description into a new `WebRowSet` object or into the same `WebRowSet` object that called the `writeXml` method. In our scenario, where the price list information is being sent from headquarters to the web site, you would use a new `WebRowSet` object, as shown in the following lines of code.

```
WebRowSet recipient = new WebRowSetImpl();  
java.io.FileReader reader = new java.io.FileReader("priceList.xml");  
recipient.readXml(reader);
```

## What Is in the XML Document

`RowSet` objects are more than just the data they contain. They have properties and metadata about their columns as well. Therefore, an XML document representing a `WebRowSet` object includes this other information in addition to its data. Further, the data in an XML document includes both current values and original values. (Recall from the `CachedRowSet` chapter that original values are the values that existed immediately before the most recent changes to data were made. These values are necessary for checking whether the corresponding value in the database has been changed, thus creating a conflict over which value should be persisted—the new value you put in the `RowSet` object or the new value someone else put in the database.)

The “WebRowSet XML Schema,” itself an XML document, defines what an XML document representing a WebRowSet object will contain and also the format in which it must be presented. Both the sender and the recipient use this schema because it tells the sender how to write the XML and the recipient how to parse the XML. Because the actual writing and reading is done internally by the implementations of the methods `writeXml` and `readXml`, you, as a user, do not need to understand what is in the “WebRowSet XML Schema” document. For reference, however, you can find the schema at the end of this chapter [or in the Appendix??]. If you want to learn more about XML, you can also refer to the XML chapter in the *Java Web Services Tutorial*.

Any XML document contains elements and subelements in a hierarchical structure. The following are the three main elements in an XML document describing a WebRowSet object:

- properties
- metadata
- data

Element tags signal the beginning and end of an element. For example, `<properties>` signals the beginning of the properties element, and `</properties>` signals its end. `<map/>` is a shorthand way of saying that the `map` subelement (one of the subelements in the `properties` element) has not been assigned a value. The XML shown in this chapter uses spacing and indentation to make it easier to read, but they are not used in an actual XML document, where spacing does not mean anything.

The next three sections show you what the three main elements contain for the WebRowSet `priceList`, created earlier in this chapter. Let’s assume that the data in `priceList` corresponds to the data in Table 6–1.

**Table 6–1** PRICE\_LIST

COF_NAME	PRICE
Colombian	7.99
French_Roast	8.99
Espresso	9.99
Colombian_Decaf	8.99

Table 6-1 PRICE\_LIST

COF_NAME	PRICE
French_Roast_Decaf	9.99

## Properties

Calling the method `writeXml` on `priceList` would produce an XML document describing `priceList`. The properties section of this XML document would look like the following.

```

<properties>
  <command>select COF_NAME, PRICE from COFFEES</command>
  <concurrency>1</concurrency>
  <datasource/>
  <escape-processing>true</escape-processing>
  <fetch-direction>0</fetch-direction>
  <fetch-size>0</fetch-size>
  <isolation-level>1</isolation-level>
  <key-columns/>
  <map/>
  <max-field-size>0</max-field-size>
  <max-rows>0</max-rows>
  <query-timeout>0</query-timeout>
  <read-only>>false</read-only>
  <rowset-tyt>TRANSACTION_READ_UNCOMMITTED</rowset-type>
  <show-deleted>>false</show-deleted>
  <table-name/>
  <url>jdbc:thin:oracle</url>
  <sync-provider>
    <sync-provider-name>com.rowset.provider.RIOptimisticProvider</sync-provider-
      name>
    <sync-provider-vendor>Sun Microsystems</sync-provider-vendor>
    <sync-provider-version>1.0</sync-provider-version>
    <sync-provider-grade>LOW</sync-provider-grade>
    <data-source-lock>NONE</data-source-lock>
  </sync-provider>
</properties>

```

You will notice that some properties have no value. For example, the `datasource` property is indicated with `<datasource/>`, which is a shorthand way of saying `<datasource></datasource>`. No value is given because the `url` property is set. Any connections that are established will be done using this JDBC URL, so no `DataSource`

object needs to be set. Also, the username and password properties are not listed because they need to remain secret.

## Metadata

The metadata section of the XML document describing a `WebRowSet` object contains information about the columns in that `WebRowSet` object. The following shows what this section looks like for the `WebRowSet` object `priceList`. Because `priceList` has two columns, the XML document describing it has two `<column-definition>` elements. Each `<column-definition>` element has subelements giving information about the column being described.

```
<metadata>
  <column-count>2</column-count>
  <column-definition>
    <column-index>1</column-index>
    <auto-increment>>false</auto-increment>
    <case-sensitive>>true</case-sensitive>
    <currency>>false</currency>
    <nullable>1</nullable>
    <signed>>false</signed>
    <searchable>>true</searchable>
    <column-display-size>10</column-display-size>
    <column-label>COF_NAME</column-label>
    <column-name>COF_NAME</column-name>
    <schema-name/>
    <column-precision>10</column-precision>
    <column-scale>0</column-scale>
    <table-name/>
    <catalog-name/>
    <column-type>1</column-type>
    <column-type-name>VARCHAR</column-type-name>
  </column-definition>

  <column-definition>
    <column-index>2</column-index>
    <auto-increment>>false</auto-increment>
    <case-sensitive>>true</case-sensitive>
    <currency>>true</currency>
    <nullable>1</nullable>
    <signed>>false</signed>
    <searchable>>true</searchable>
    <column-display-size>10</column-display-size>
    <column-label>PRICE</column-label>
```

```

    <column-name>PRICE</column-name>
    <schema-name/>
    <column-precision>10</column-precision>
    <column-scale>2</column-scale>
    <table-name/>
    <catalog-name/>
    <column-type>7</column-type>
    <column-type-name>REAL</column-type-name>
  </column-definition>
</metadata>

```

From this metadata section, you can see that there are two columns in each row. The first column is `COF_NAME`, which holds values of type `VARCHAR`. The second column is `PRICE`, which holds values of type `REAL`, and so on. Note that the column types are the data types used in the data source, not types in the Java programming language. To get or update values in `COF_NAME`, you use the methods `getString` or `updateString`, and the driver makes the conversion to `VARCHAR`, as it normally does.

## Data

The data section gives the values for each column in each row of a `WebRowSet` object. If you have populated `priceList` and not made any changes to it, the data element of the XML document will look like the following. In the next section you will see how the XML document changes when you modify the data in `priceList`.

For each row there is a `<currentRow>` element, and because `priceList` has two columns, each `<currentRow>` element contains two `<columnValue>` elements.

```

<data>
  <currentRow>
    <columnValue>
      Colombian
    </columnValue>
    <columnValue>
      7.99
    </columnValue>
  </currentRow>

  <currentRow>
    <columnValue>
      French_Roast
    </columnValue>

```

```
<columnValue>
  8.99
</columnValue>
</currentRow>

<currentRow>
  <columnValue>
    Espresso
  </columnValue>
  <columnValue>
    9.99
  </columnValue>
</currentRow>

<currentRow>
  <columnValue>
    Colombian_Decaf
  </columnValue>
  <columnValue>
    8.99
  </columnValue>
</currentRow>

<currentRow>
  <columnValue>
    French_Roast_Decaf
  </columnValue>
  <columnValue>
    9.99
  </columnValue>
</currentRow>
</data>
```

## Making Changes to a WebRowSet Object

You make changes to a WebRowSet object the same way you do to a CachedRowSet object. Unlike a CachedRowSet object, however, a WebRowSet object keeps track of updates, insertions, and deletions so that the `writeXml` method can write both the current values and the original values. The three sections that follow demonstrate making changes to the data and show what the XML document describing the WebRowSet object looks like after each change. You do not need to do anything at all regarding the XML document; any change to it is made automatically behind the scenes, just as with writing and reading the XML document.

## Inserting a Row

If the owner of the Coffee Break chain wants to add a new coffee to his price list, the code might look like this.

```
priceList.absolute(3);
priceList.moveToInsertRow();
priceList.updateString(COF_NAME, "Kona");
priceList.updateFloat(PRICE, 8.99f);
priceList.insertRow();
priceList.moveToCurrentRow();
```

In the reference implementation, an insertion is made immediately following the current row. In the preceding code fragment, the current row is the third row, so the new row would be added after the third row and become the new fourth row. To reflect this insertion, the XML document would have the following `<insertRow>` element added to it after the third `<currentRow>` element in the `<data>` element.

The `<insertRow>` element will look similar to the following.

```
<insertRow>
  <columnValue>
    Kona
  </columnValue>
  <columnValue>
    8.99
  </columnValue>
</insertRow>
```

## Deleting a Row

The owner decides that Espresso is not selling enough and should be dropped from the coffees sold at the Coffee Break. He therefore wants to delete Espresso from the price list. Espresso is in the third row of *priceList*, so the following lines of code delete it.

```
priceList.absolute(3);
priceList.deleteRow();
```

The following `<deleteRow>` element will appear after the second row in the data section of the XML document, indicating that the third row has been deleted.

```
<deleteRow>
  <columnValue>
    Espresso
  </columnValue>
  <columnValue>
    9.99
  </columnValue>
</deleteRow>
```

## Modifying a Row

The owner further decides that the price of Colombian coffee is too expensive and wants to lower it to 6.99 a pound. The following code sets the new price for Colombian coffee, which is in the first row, to 6.99 a pound.

```
priceList.first();
priceList.updateFloat(PRICE, 6.99);
```

The XML document will reflect this change in a `<modifyRow>` element that gives both the old value (in the `<columnValue>` element) and the new value (in the `<updateValue>` element), as shown here. The value for the first column did not change, so there is an `<updateValue>` element for only the second column.

```
<modifyRow>
  <columnValue>
    Colombian
  </columnValue>
  <columnValue>
    7.99
  </columnValue>
  <updateValue>
    6.99
  </updateValue>
</modifyRow>
```

At this point, with the insertion of a row, the deletion of a row, and the modification of a row, the XML document for *priceList* would look like the following.

--->fill in what the data section reflecting these changes would look like

## WebRowSet Code Example

The following code sample shows how a WebRowSet object can be used. The code creates a WebRowSet object, sets its properties, populates it, and modifies its data. Then it does what only a WebRowSet object can do: It serializes the WebRowSet object into an XML file (by calling the method `writeXml`). Then it populates another WebRowSet object with the first WebRowSet object (by calling the method `readXML`). Finally, the code compares the size of the two WebRowSet objects to see if they are the same. The result of calling the method `readXml` on the XML document created by `writeXml` is a WebRowSet object with the same data, metadata, and properties as those with which you started.

=====

```
import java.sql.*;
import java.io.*;
import javax.sql.rowset.*;
import com.sun.rowset.*;

public class WebRowSetSample {

    public static void main(String [] args) {
        String strUrl = "jdbc:inetora:129.158.229.21:1521:orcl9";
        String strUserId = "scott";
        String strPassword = "tiger";
        String className = "com.inet.ora.OraDriver";
        int [] keyCols = {1};
        FileReader fReader;
        FileWriter fWriter;

        try {
            Class.forName(className);
        } catch (java.lang.ClassNotFoundException e) {
            System.err.print("ClassNotFoundException: ");
            System.err.println(e.getMessage());
        }
        try {
            Connection con = DriverManager.getConnection(
                strUrl, strUserId, strPassword);
            Statement stmt = con.createStatement();
            stmt.executeUpdate("drop table coffees");
            Statement stmt1 = con.createStatement();
            stmt1.executeUpdate("create table coffees(" +
                "cof_name varchar(30), price real)");
            Statement stmt2 = con.createStatement();
            stmt2.executeUpdate("insert into coffees values( Colombian , 7.99)");
```

```
Statement stmt3 = con.createStatement();
stmt3.executeUpdate("insert into coffees values( French_Roast , 8.99)");
Statement stmt4 = con.createStatement();
stmt4.executeUpdate("insert into coffees values( Espresso , 9.99)");
Statement stmt5 = con.createStatement();
stmt5.executeUpdate("insert into coffees values( Colombian_Decaf , 8.99)");
Statement stmt6 = con.createStatement();
stmt6.executeUpdate("insert into coffees values( French_Roast_Decaf , 9.99)");

con.commit();

// Create a WebRowSet and set its properties.
WebRowSet sender = new WebRowSetImpl();
sender.setUrl(strUrl);
sender.setUsername(strUserId);
sender.setPassword(strPassword);
sender.setCommand("select * from coffees");
sender.setKeyColumns(keyCols);

// Populate the WebRowSet
sender.execute();
System.out.println("Size of the WebRowSet is: " + sender.size());

// Insert a new row
sender.moveToInsertRow();
sender.updateString(1, "Kona");
sender.updateFloat(2, 8.99f);
sender.insertRow();
sender.moveToCurrentRow();
System.out.println("New row inserted");
System.out.println("Size of the WebRowSet is: "+sender.size());

//Delete the row with "Espresso"
sender.beforeFirst();
while(sender.next()) {
    if(sender.getString(1).equals( Espresso )) {
        System.out.println( Deleting row with Espresso... );
        sender.deleteRow();
        break;
    }
}

// Update price of Colombian
sender.beforeFirst();
while(sender.next()) {
    if(sender.getString(1).equals("Colombian")) {
        System.out.println("Updating row with Colombian...");
        sender.updateFloat(2, 6.99f);
    }
}
```



[Needs to be updated with the latest version. Jonathan, please send this to me, or let me know that the version in CVS is the latest one. Also, the formatting for the schema, especially toward the end, needs to be fixed.]

```
<?xml version= 1.0 encoding= UTF-8 ?>

<!-- WebRowSet XML Schema by Jonathan Bruce (Sun Microsystems Inc.) -->

<xs:schema targetNamespace= http://java.sun.com/xml/ns/jdbc xmlns:wrs= http://
java.sun.com/xml/ns/jdbc xmlns:xs= http://www.w3.org/2001/XMLSchema
elementFormDefault= qualified >

  <xs:element name= webRowSet >
    <xs:complexType>
      <xs:sequence>
        <xs:element ref= wrs:properties />
        <xs:element ref= wrs:metadata />
        <xs:element ref= wrs:data />
      </xs:sequence>
    </xs:complexType>
  </xs:element>

  <xs:element name= columnValue type= xs:anyType />
  <xs:element name= updateValue type= xs:anyType />

  <xs:element name= properties >
    <xs:complexType>
      <xs:sequence>
        <xs:element name= command type= xs:string />
        <xs:element name= concurrency type= xs:string />
        <xs:element name= datasource type= xs:string />
        <xs:element name= escape-processing type= xs:string />
        <xs:element name= fetch-direction type= xs:string />
        <xs:element name= fetch-size type= xs:string />
        <xs:element name= isolation-level type= xs:string />
        <xs:element name= key-columns >
          <xs:complexType>
            <xs:sequence minOccurs= 0 maxOccurs= unbounded >
              <xs:element name= column type= xs:string />
            </xs:sequence>
          </xs:complexType>
        </xs:element>
        <xs:element name= map >
          <xs:complexType>
            <xs:sequence minOccurs= 0 maxOccurs= unbounded >
              <xs:element name= type type= xs:string />
              <xs:element name= class type= xs:string />
            </xs:sequence>
          </xs:complexType>
        </xs:element>
      </xs:sequence>
    </xs:complexType>
  </xs:element>

```

```

        </xs:sequence>
      </xs:complexType>
    </xs:element>
    <xs:element name= max-field-size type= xs:string />
    <xs:element name= max-rows type= xs:string />
    <xs:element name= query-timeout type= xs:string />
    <xs:element name= read-only type= xs:string />
    <xs:element name= rowset-type type= xs:string />
    <xs:element name= show-deleted type= xs:string />
    <xs:element name= table-name type= xs:string />
    <xs:element name= url type= xs:string />
    <xs:element name= sync-provider >
      <xs:complexType>
        <xs:sequence>
          <xs:element name= sync-provider-name type= xs:string />
          <xs:element name= sync-provider-vendor type= xs:string />
          <xs:element name= sync-provider-version type= xs:string />
          <xs:element name= sync-provider-grade type= xs:string />
          <xs:element name= data-source-lock type= xs:string />
        </xs:sequence>
      </xs:complexType>
    </xs:element>
  </xs:sequence>
</xs:complexType>
</xs:element>
</xs:sequence>
</xs:complexType>
</xs:element>
<xs:element name= metadata >
  <xs:complexType>
    <xs:sequence>
      <xs:element name= column-count type= xs:string />
      <xs:choice>
        <xs:element name= column-definition minOccurs= 0
          maxOccurs= unbounded >
          <xs:complexType>
            <xs:sequence>
              <xs:element name= column-index type= xs:string />
              <xs:element name= auto-increment type= xs:string />
              <xs:element name= case-sensitive type= xs:string />
              <xs:element name= currency type= xs:string />
              <xs:element name= nullable type= xs:string />
              <xs:element name= signed type= xs:string />
              <xs:element name= searchable type= xs:string />
              <xs:element name= column-display-size type= xs:string />
              <xs:element name= column-label type= xs:string />
              <xs:element name= column-name type= xs:string />
              <xs:element name= schema-name type= xs:string />
              <xs:element name= column-precision type= xs:string />
              <xs:element name= column-scale type= xs:string />
              <xs:element name= table-name type= xs:string />
            </xs:sequence>
          </xs:complexType>
        </xs:choice>
      </xs:sequence>
    </xs:complexType>
  </xs:element>
</xs:sequence>
</xs:complexType>
</xs:element>

```

```

        <xs:element name= catalog-name type= xs:string />
        <xs:element name= column-type type= xs:string />
        <xs:element name= column-type-name type= xs:string />
    </xs:sequence>
</xs:complexType>
</xs:element>
</xs:choice>
</xs:sequence>
</xs:complexType>
</xs:element>

<xs:element name= data >
    <xs:complexType>
        <xs:sequence minOccurs= 0 maxOccurs= unbounded >
            <xs:element name= currentRow minOccurs= 0 maxOccurs= unbounded >
                <xs:complexType>
                    <xs:sequence minOccurs= 0 maxOccurs= unbounded >
                        <xs:element ref= wrs:columnValue />
                    </xs:sequence>
                </xs:complexType>
            </xs:element>
            <xs:element name= insertRow minOccurs= 0 maxOccurs= unbounded >
                <xs:complexType>
                    <xs:choice minOccurs= 0 maxOccurs= unbounded >
                        <xs:element ref= wrs:columnValue />
                        <xs:element ref= wrs:updateValue />
                    </xs:choice>
                </xs:complexType>
            </xs:element>
            <xs:element name= deleteRow minOccurs= 0 maxOccurs= unbounded >
                <xs:complexType>
                    <xs:sequence minOccurs= 0 maxOccurs= unbounded >
                        <xs:element ref= wrs:columnValue />
                        <xs:element ref= wrs:updateValue />
                    </xs:sequence>
                </xs:complexType>
            </xs:element>
            <xs:element name= modifyRow minOccurs= 0 maxOccurs= unbounded >
                <xs:complexType>
                    <xs:sequence minOccurs= 0 maxOccurs= unbounded >
                        <xs:element ref= wrs:columnValue />
                        <xs:element ref= wrs:updateValue />
                    </xs:sequence>
                </xs:complexType>
            </xs:element>
        </xs:sequence>
    </xs:complexType>
</xs:element>

```

```
        </xs:sequence>  
      </xs:complexType>  
    </xs:element>  
  </xs:schema>
```