

DATABASE CONNECTIVITY WITH JDBC

TODAY'S TOPIC

A common requirement for most of the applications that we use is that they need to maintain **persistent state**. This means that certain interactions with the application have lasting effects that can be recalled hours, days, or weeks later.

Examples:

- Order history at Amazon.com
- LinkedIn profile information
- Email messages in GMail

TODAY'S TOPIC

This data often needs to be searched and updated in order for the application to fulfill its purpose. One of the most common ways an application stores persistent data is by using a database.

We've already seen how we can interact with a database directly by typing SQL commands into a GUI client (i.e. DbVisualizer). Today we'll learn how to write application code that can interact with a database in order to read and write persistent data.

WHAT WE'LL COVER TODAY

- What JDBC is and how Java abstracts database functionality
- Managing database connections
- Using SpringJdbc to simplify cumbersome aspects of JDBC
- How to create and use SpringJdbc's JdbcTemplate to query and update data
- How to use query parameters and why we should do so
- What the DAO pattern is and why it is useful

SO MANY DATABASE FLAVORS... WHAT TO DO?

- Application code that we write to interact with a database is a **client** of the database in the same way DbVisualizer is.
- There are many different database vendors (e.g. PostgreSQL, SQL Server, Oracle, etc) that a Java application may want to integrate with.
- Each vendor's database implementation is likely to be quite different which would make it a huge task to switch to a different database vendor (which actually happens fairly frequently).

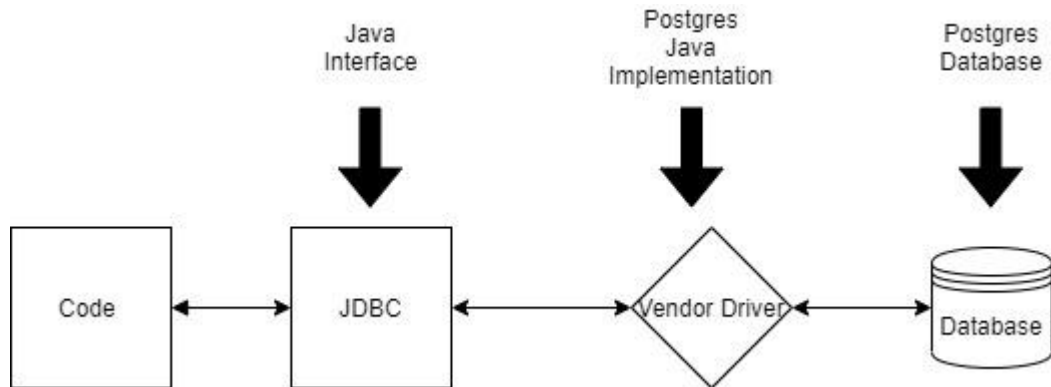
JDBC TO THE RESCUE!

- Java uses a database interface called **JDBC** (Java Database Connectivity) to abstract database operations away from the actual database implementation.
- Each vendor provides an implementation of the interface specific to its code.
- The vendor's implementation is known as a **driver**.

.

JDBC TO THE RESCUE!

- We use the JDBC interface to communicate with the vendor's driver.
- This makes it fairly easy to swap out one vendor's database for another by swapping out the JDBC vendor driver.



MANAGING CONNECTIONS

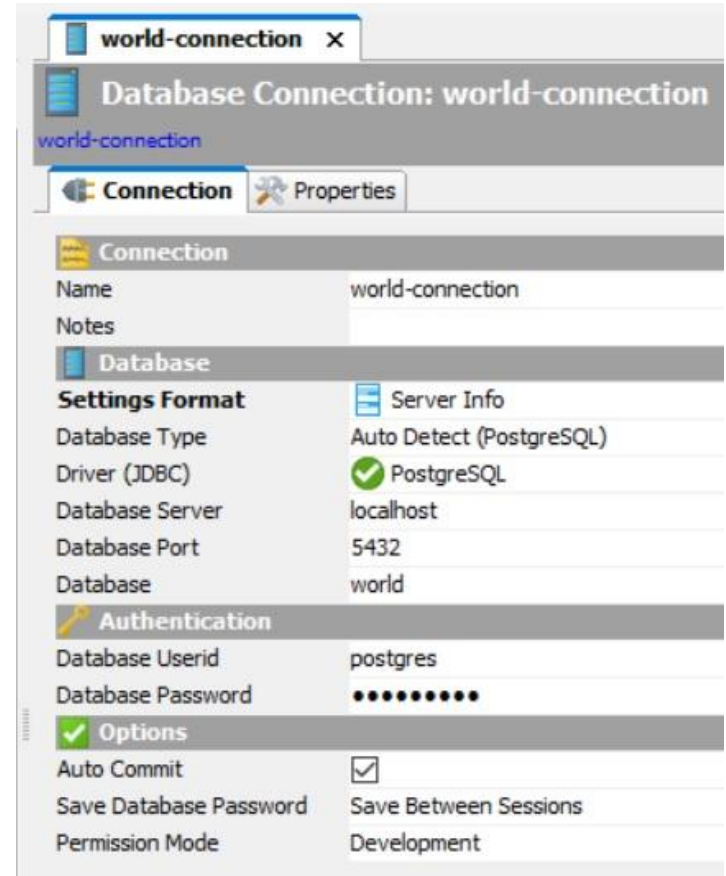
When we interact with a database, we need to create a connection.

- Connections remain open until they are closed or time out.
- Connections have overhead when created and opened, thus there is often a finite number of connections.
- A **connection pool** can be used to reuse a few connections to conserve resources within an application by allowing the application to acquire a connection and release it when it is no longer needed so it can be reused.

MANAGING CONNECTIONS

A **connection string** specifies the name of the driver to use, the host and any port, the database name, and a username and password.

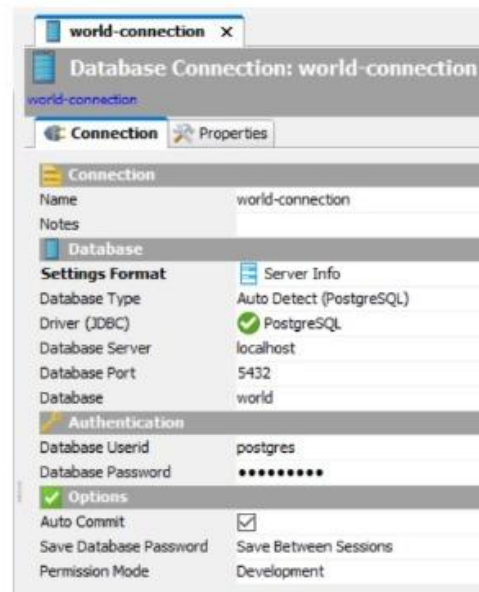
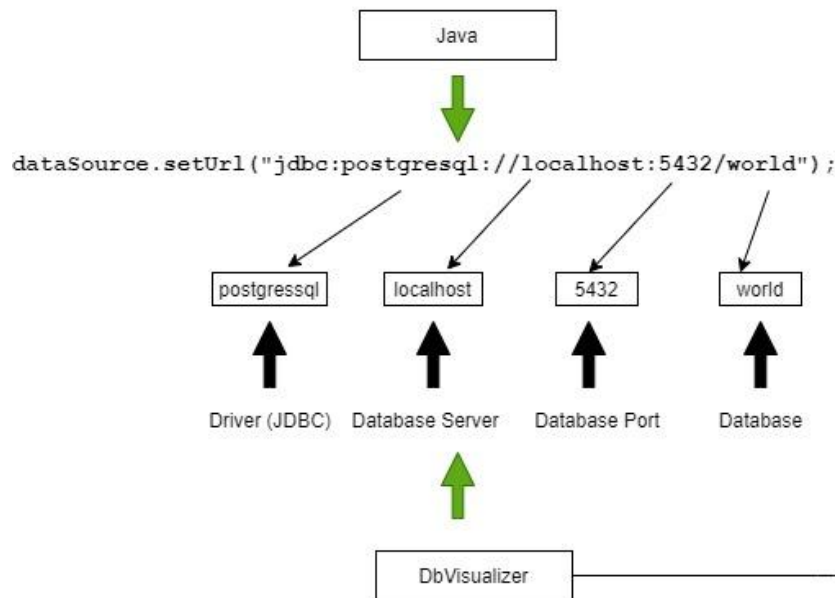
This is the graphic representation of the connection string to the world database in DbVisualizer.



MANAGING CONNECTIONS

Java Example:

```
BasicDataSource dataSource = new BasicDataSource();  
dataSource.setUrl("jdbc:postgresql://localhost:5432/world");  
dataSource.setUsername("postgres");  
dataSource.setPassword("postgres1");
```



MANAGING CONNECTIONS

- Connection strings should not be written directly in our code. Why?
- Connections are valuable resources. It may not seem like a big deal if we leave it running in our single application, but what about a larger-scale application?

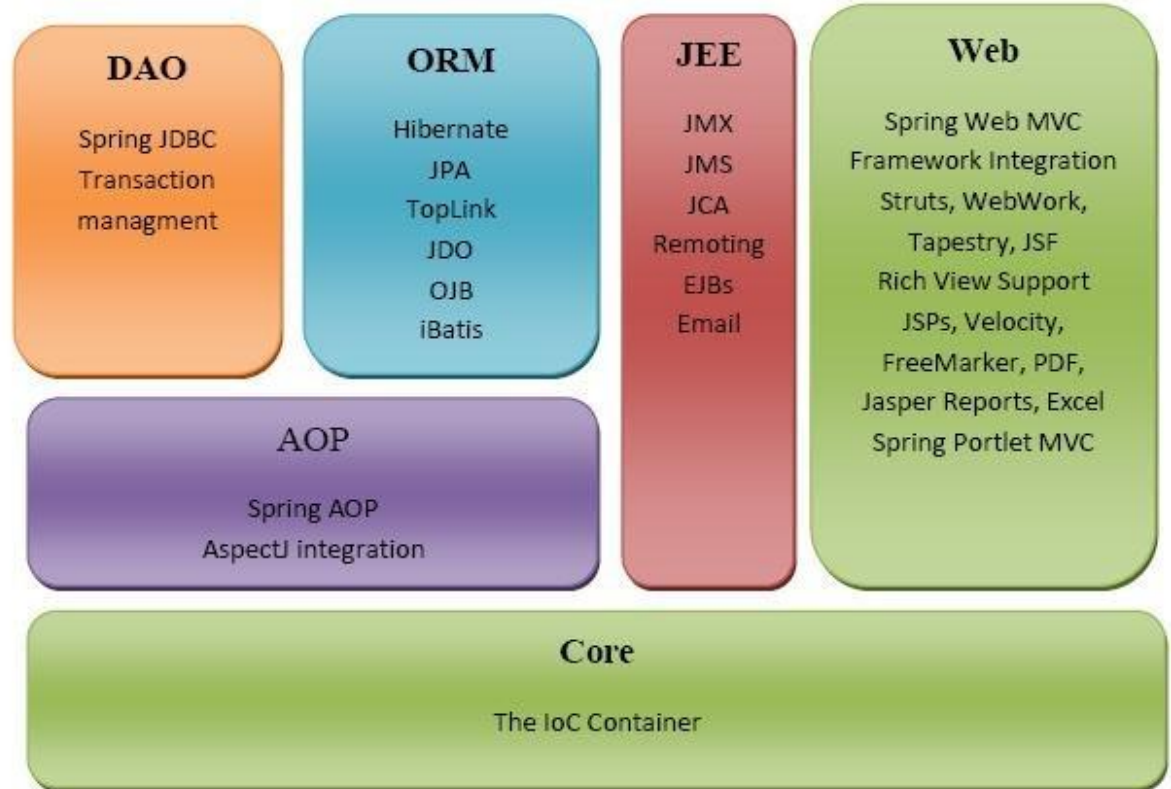
WORKING WITH JDBC

The JDBC interface provides a standard way of working with databases in Java, but using it can be very cumbersome:

- In order to accomplish things you need to rewrite the same boilerplate code over and over.
- You must pay attention to cleaning up properly (closing database connections for instance).
- There are many exceptions that can occur when working with JDBC and handling them properly can result in a lot of extra code.

SPRING JDBC TO THE RESCUE!

Spring is a popular Java framework. It is made up of many modules including **Spring JDBC**, which is intended to solve some of the problems with using JDBC we mentioned before.

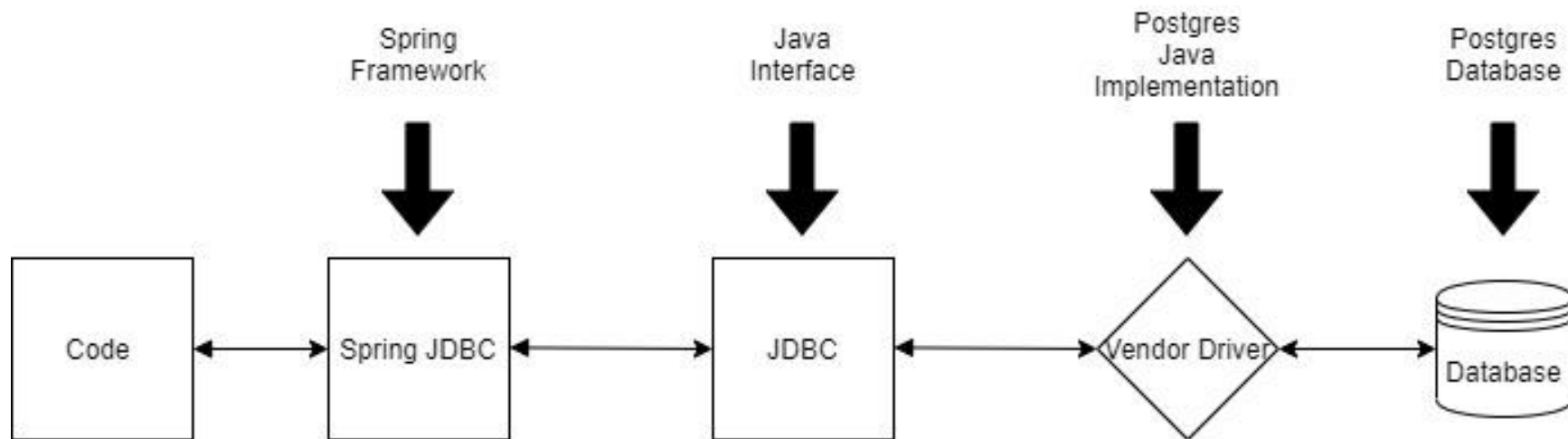


SPRING JDBC

Spring JDBC makes things easier:

- Abstracts away boilerplate code so you can focus on YOUR code rather than all the nuts and bolts of interfacing with JDBC.
- Does most of the clean-up “automagically” for you.
- Simplifies SQL Exceptions in a way that makes them much easier to handle without a lot of extra code.
- Greatly simplifies working with Transactions.

SPRING JDBC



DIVING INTO CODE

INTRODUCING... JDBCTEMPLATE

The Spring JDBC `JdbcTemplate` class provides methods for working with many aspects of JDBC all in one class.

- `queryForRowSet` is used to **SELECT** data sets from the database
- `queryForObject` is used to **SELECT** a single value from the database
- `update` is used for writing data in the database
 - **INSERT**
 - **UPDATE**
 - **DELETE**

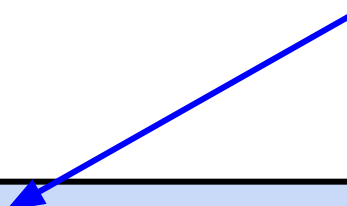
CREATING A JDBCTEMPLATE

```
// Create BasicDataSource (remember that diagram?)
BasicDataSource dataSource = new BasicDataSource();
dataSource.setUrl("jdbc:postgresql://localhost:5432/world");
dataSource.setUsername("postgres");
dataSource.setPassword("postgres1");

// Create a JdbcTemplate using the DataSource
private JdbcTemplate jdbcTemplate =
    new JdbcTemplate(dataSource);
```

CREATING A JDBCTEMPLATE

Datasource
creation code we
saw before

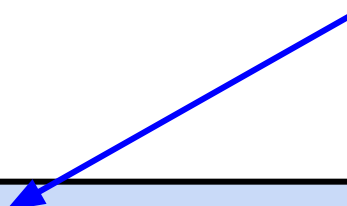


```
// Create BasicDataSource (remember that diagram?)
BasicDataSource dataSource = new BasicDataSource();
dataSource.setUrl("jdbc:postgresql://localhost:5432/world");
dataSource.setUsername("postgres");
dataSource.setPassword("postgres1");

// Create a JdbcTemplate using the Datasource
private JdbcTemplate jdbcTemplate =
    new JdbcTemplate(dataSource);
```

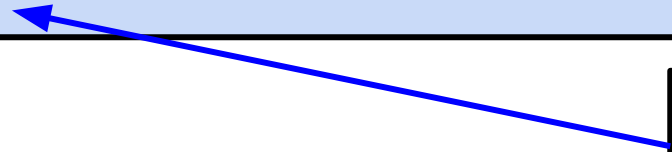
CREATING A JDBCTEMPLATE

Datasource
creation code we
saw before



```
// Create BasicDataSource (remember that diagram?)
BasicDataSource dataSource = new BasicDataSource();
dataSource.setUrl("jdbc:postgresql://localhost:5432/world");
dataSource.setUsername("postgres");
dataSource.setPassword("postgres1");

// Create a JdbcTemplate using the Datasource
private JdbcTemplate jdbcTemplate =
    new JdbcTemplate(dataSource);
```



Create JdbcTemplate with
the datasource as the
parameter

SELECTING DATA WITH JDBCTEMPLATE

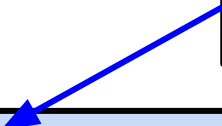
The JdbcTemplate queryForRowSet method allows you to pass a string that contains the SQL of the query and get back a SqlRowSet, which represents the rows returned by the queries. We'll look at how to work with SQLRowSets shortly...

```
SqlRowSet results = jdbcTemplate.queryForRowSet("SELECT  
name, countrycode FROM city");
```

SELECTING DATA WITH JDBCTEMPLATE

The JdbcTemplate queryForRowSet method allows you to pass a string that contains the SQL of the query and get back a SqlRowSet, which represents the rows returned by the queries. We'll look at how to work with SQLRowSets shortly...

The result will be
returned in a
`SqlRowSet` object.

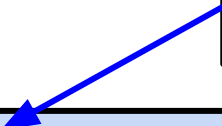


```
SqlRowSet results = jdbcTemplate.queryForRowSet("SELECT  
name, countrycode FROM city");
```

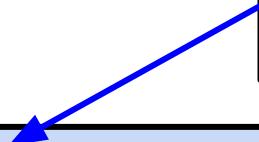
SELECTING DATA WITH JDBCTEMPLATE

The JdbcTemplate queryForRowSet method allows you to pass a string that contains the SQL of the query and get back a SqlRowSet, which represents the rows returned by the queries. We'll look at how to work with SQLRowSets shortly...

The result will be returned in a `SqlRowSet` object.



`queryForRowSet` is used to get back a data set.



```
SqlRowSet results = jdbcTemplate.queryForRowSet("SELECT  
name, countrycode FROM city");
```

SELECTING DATA WITH JDBCTEMPLATE

The JdbcTemplate queryForRowSet method allows you to pass a string that contains the SQL of the query and get back a SqlResultSet, which represents the rows returned by the queries. We'll look at how to work with SQLRowSets shortly...

The result will be returned in a `SqlResultSet` object.

`queryForRowSet` is used to get back a data set.

```
SqlResultSet results = jdbcTemplate.queryForRowSet("SELECT  
name, countrycode FROM city");
```

The parameter is a `String` with the query SQL.

WORKING WITH SQLROWSETS

A SQLRowSet contains a data set representing the results of our query.

```
SqlRowSet results =  
    jdbcTemplate.queryForRowSet("SELECT  
        id, name, countrycode FROM city");
```

id	name	countrycode
1	Kabul	AFG
2	Qandahar	AFG
3	Herat	AFG
4	Mazar-e-Sharif	AFG
5	Amsterdam	NLD
6	Rotterdam	NLD
7	Haag	NLD

WORKING WITH SQLROWSETS

```
SqlRowSet results =  
    jdbcTemplate.queryForRowSet("SELECT  
    id, name, countrycode FROM city");
```

id	name	countrycode
1	Kabul	AFG
2	Qandahar	AFG
3	Herat	AFG
4	Mazar-e-Sharif	AFG
5	Amsterdam	NLD
6	Rotterdam	NLD
7	Haag	NLD

Cursor **does NOT start at beginning of data**. You must call the **next()** method to get to first row.

results will return a set of rows that uses a **cursor** to move through the data. Each time we call the **SqlRowSet** method **next()**, the **SqlRowSet** checks if there is more data and, if so, **moves the cursor** to next **SqlRow** in the set and **returns true**. Otherwise, it **returns false**.

GETTING DATA FROM SQLROWSET

Remember that we must call `next()` method in order to advance to the **FIRST** row as well.

As the `next()` method is called, the cursor moves forward and represents the next row in the set.

We can query the current row by using get methods like `getLong`, `getInt`, and `getString` that take the column name as a parameter.

```
while(results.next()) {  
    String name = results.getString("name");  
    Long id = results.getLong("id");  
    System.out.println(id + " " + name + " ");  
}
```


GETTING DATA FROM SQLROWSET

Remember that we must call `next()` method in order to advance to the **FIRST** row as well.

As the `next()` method is called, the cursor moves forward and represents the next row in the set.

We can query the current row by using get methods like `getLong`, `getInt`, and `getString` that take the column name as a parameter.

The `next()` method advances the cursor to the next row. If a row exists, it returns `true`, otherwise `false`



```
while(results.next()) {  
    String name = results.getString("name");  
    Long id = results.getLong("id");  
    System.out.println(id + " " + name + " ");  
}
```

GETTING DATA FROM SQLROWSET

Remember that we must call `next()` method in order to advance to the **FIRST** row as well.

As the `next()` method is called, the cursor moves forward and represents the next row in the set.

We can query the current row by using get methods like `getLong`, `getInt`, and `getString` that take the column name as a parameter.

The `next()` method advances the cursor to the next row. If a row exists, it returns `true`, otherwise `false`

Get the current row's `name` column as a `String`

```
while(results.next()) {  
    String name = results.getString("name");  
    Long id = results.getLong("id");  
    System.out.println(id + " " + name + " ");  
}
```

GETTING DATA FROM SQLROWSET

Remember that we must call `next()` method in order to advance to the **FIRST** row as well.

As the `next()` method is called, the cursor moves forward and represents the next row in the set.

We can query the current row by using get methods like `getLong`, `getInt`, and `getString` that take the column name as a parameter.

The `next()` method advances the cursor to the next row. If a row exists, it returns `true`, otherwise `false`

Get the current row's `name` column as a `String`

```
while(results.next()) {  
    String name = results.getString("name");  
    Long id = results.getLong("id");  
    System.out.println(id + " " + name + ")");  
}
```

Get the current row's `id` column as a `Long`

USING QUERY PARAMS

The `queryForRowSet` method can take parameterized queries. We replace each value in the query with a `?` and then provide a list of parameters to populate the data. This makes our queries reusable but also helps prevent SQL injection, which can be a huge security risk (more on this shortly...)

Here is how we use parameters with `queryForRowSet`:


```
// with queryForRowSet
SqlResultSet results =
    jdbcTemplate.queryForRowSet("SELECT id, name, countrycode
    FROM city WHERE id = ?", id);
```

USING QUERY PARAMS

The `queryForRowSet` method can take parameterized queries. We replace each value in the query with a `?` and then provide a list of parameters to populate the data. This makes our queries reusable but also helps prevent SQL injection, which can be a huge security risk (more on this shortly...)

Here is how we use parameters with `queryForRowSet`:

```
// with queryForRowSet
SqlResultSet results =
    jdbcTemplate.queryForRowSet("SELECT id, name, countrycode
    FROM city WHERE id = ?", id);
```



The `?` represents a query parameter that will be provided.

USING QUERY PARAMS

The `queryForRowSet` method can take parameterized queries. We replace each value in the query with a `?` and then provide a list of parameters to populate the data. This makes our queries reusable but also helps prevent SQL injection, which can be a huge security risk (more on this shortly...)

Here is how we use parameters with `queryForRowSet`:

```
// with queryForRowSet
SqlResultSet results =
    jdbcTemplate.queryForRowSet("SELECT id, name, countrycode
    FROM city WHERE id = ?", id);
```

The `?` represents a query parameter that will be provided.

The parameters following the SQL replace the `?`'s in the query

USING QUERY PARAMS VS CONCATENATION

It may be tempting to use String concatenation rather than using query params. For instance:

```
// with queryForRowSet
SqlResultSet results =
    jdbcTemplate.queryForRowSet("SELECT id, name, countrycode
    FROM city WHERE id = " + id);
```

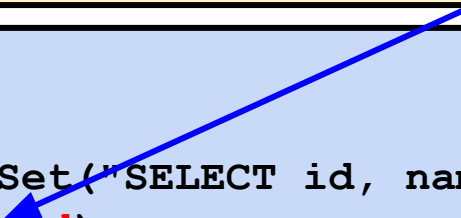
However, using concatenation can open us up to SQL Injection which is a major security issue and should be avoided. If we concatenate we have no way of ensuring that the param passed in is actually data and not malicious SQL code that will be executed with the query. Hackers can exploit injecting code instead of data. By using params, we allow Java to make sure all params are treated as data and not as code.

USING QUERY PARAMS VS CONCATENATION

It may be tempting to use String concatenation rather than using query params. For instance:

Concatenation should be avoided. Use query parameters instead.

```
// with queryForRowSet
SqlResultSet results =
    jdbcTemplate.queryForRowSet("SELECT id, name, countrycode
    FROM city WHERE id = " + id);
```



However, using concatenation can open us up to SQL Injection which is a major security issue and should be avoided. If we concatenate we have no way of ensuring that the param passed in is actually data and not malicious SQL code that will be executed with the query. Hackers can exploit injecting code instead of data. By using params, we allow Java to make sure all params are treated as data and not as code.

SELECTING A SINGLE VALUE WITH JDBCTEMPLATE

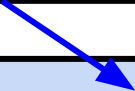
The JdbcTemplate queryForObject method allows you to pass a string that contains the SQL of the query and get back a single object, which will be an object that can hold the type of data you are querying for.

```
Integer result = jdbcTemplate.queryForObject("SELECT  
COUNT(*) FROM city", Integer.class);
```

SELECTING A SINGLE VALUE WITH JDBCTEMPLATE

The JdbcTemplate queryForObject method allows you to pass a string that contains the SQL of the query and get back a single object, which will be an object that can hold the type of data you are querying for.

The result will be returned in an `Integer` object.



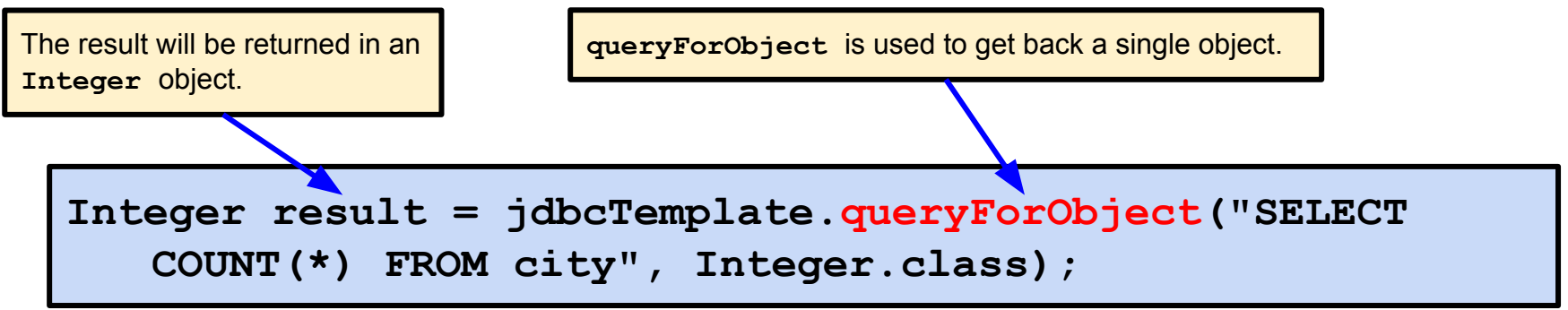
```
Integer result = jdbcTemplate.queryForObject("SELECT  
COUNT(*) FROM city", Integer.class);
```

SELECTING A SINGLE VALUE WITH JDBCTEMPLATE

The JdbcTemplate queryForObject method allows you to pass a string that contains the SQL of the query and get back a single object, which will be an object that can hold the type of data you are querying for.

The result will be returned in an `Integer` object.

`queryForObject` is used to get back a single object.



```
Integer result = jdbcTemplate.queryForObject("SELECT  
COUNT(*) FROM city", Integer.class);
```

SELECTING A SINGLE VALUE WITH JDBCTEMPLATE

The JdbcTemplate queryForObject method allows you to pass a string that contains the SQL of the query and get back a single object, which will be an object that can hold the type of data you are querying for.

The result will be returned in an `Integer` object.

`queryForObject` is used to get back a single object.

```
Integer result = jdbcTemplate.queryForObject("SELECT  
COUNT(*) FROM city", Integer.class);
```

The first parameter is a `String` with the query SQL.

SELECTING A SINGLE VALUE WITH JDBCTEMPLATE

The JdbcTemplate queryForObject method allows you to pass a string that contains the SQL of the query and get back a single object, which will be an object that can hold the type of data you are querying for.

The result will be returned in an `Integer` object.

`queryForObject` is used to get back a single object.

```
Integer result = jdbcTemplate.queryForObject("SELECT  
COUNT(*) FROM city", Integer.class);
```

The first parameter is a `String` with the query SQL.

The second parameter is the type of class to return as result. The `.class` extension indicates a class type.

USING QUERY PARAMS WITH QUERYFOROBJECT

The `queryForObject` method of `JdbcTemplate` can also use parameterized queries. The only difference from the other methods is that the parameter indicating the class type to return comes before the query parameters,

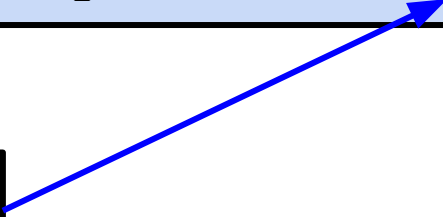
```
Integer result = jdbcTemplate.queryForObject("SELECT  
COUNT(*) FROM city WHERE id = ?", Integer.class, id);
```

USING QUERY PARAMS WITH QUERYFOROBJECT

The `queryForObject` method of `JdbcTemplate` can also use parameterized queries. The only difference from the other methods is that the parameter indicating the class type to return comes before the query parameters,

```
Integer result = jdbcTemplate.queryForObject("SELECT  
COUNT(*) FROM city WHERE id = ?", Integer.class, id);
```

The `?` represents a query parameter that will be provided.



USING QUERY PARAMS WITH QUERYFOROBJECT

The `queryForObject` method of `JdbcTemplate` can also use parameterized queries. The only difference from the other methods is that the parameter indicating the class type to return comes before the query parameters,

```
Integer result = jdbcTemplate.queryForObject("SELECT  
COUNT(*) FROM city WHERE id = ?", Integer.class, id);
```

The `?` represents a query parameter that will be provided.

The second parameter is the type of class to return as result. The `.class` extension indicates a class type.

USING QUERY PARAMS WITH QUERYFOROBJECT

The `queryForObject` method of `JdbcTemplate` can also use parameterized queries. The only difference from the other methods is that the parameter indicating the class type to return comes before the query parameters,

```
Integer result = jdbcTemplate.queryForObject("SELECT  
COUNT(*) FROM city WHERE id = ?", Integer.class, id);
```

The `?` represents a query parameter that will be provided.

The second parameter is the type of class to return as result. The `.class` extension indicates a class type.

The parameters to replace the `?`'s in the query follow the class type parameter

UPDATING DATA WITH JDBCTEMPLATE

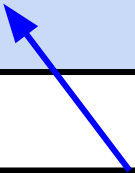
The JdbcTemplate **update** method allows you to pass a string that contains the SQL of an update statement which will be executed in the database.

```
jdbcTemplate.update("UPDATE city SET population=600000  
WHERE id=3825");
```

UPDATING DATA WITH JDBCTEMPLATE

The JdbcTemplate **update** method allows you to pass a string that contains the SQL of an update statement which will be executed in the database.

```
jdbcTemplate.update("UPDATE city SET population=600000  
WHERE id=3825");
```



The **update** method takes the **String** with the SQL as a parameter

USING QUERY PARAMETERS WITH UPDATE

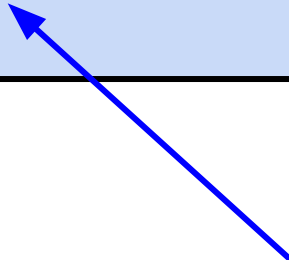
We can use query parameters with update the same way we do with queryForRowSet:

```
jdbcTemplate.update("UPDATE city SET population=600000  
WHERE id= ? ", id);
```

USING QUERY PARAMETERS WITH UPDATE

We can use query parameters with update the same way we do with queryForRowSet:

```
jdbcTemplate.update("UPDATE city SET population=600000  
WHERE id= ? ", id);
```



The `update` method takes the `String` with the SQL as a parameter

USING QUERY PARAMETERS WITH UPDATE

We can use query parameters with update the same way we do with queryForRowSet:

```
jdbcTemplate.update("UPDATE city SET population=600000  
WHERE id= ? ", id);
```

The ? represents a query parameter that will be provided.

The `update` method takes the `String` with the SQL as a parameter

USING QUERY PARAMETERS WITH UPDATE

We can use query parameters with update the same way we do with queryForRowSet:

```
jdbcTemplate.update("UPDATE city SET population=600000  
WHERE id= ? ", id);
```

The ? represents a query parameter that will be provided.

The parameters to replace the ?'s in the query follow the class type parameter

The `update` method takes the `String` with the SQL as a parameter

INTRODUCING DTOS

INTRODUCING... DTOS

Data Transfer Objects are also known as **DTOs** (as well as many other names... ever heard of a POJO?)

These contain the data that represents some business concept in our code (such as City in the world database).

Usually, these will only have data members and getters/setters.

CREATING A DTO FROM SQLROWSET ROW

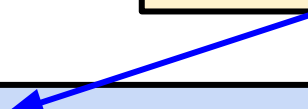
We can use the SqlRowSet get methods to read all the columns of a row and use them to populate a DTO that has meaning in our code.

```
City city = new City();  
city.setId(rowSet.getLong("id"));  
city.setName(rowSet.getString("name"));  
city.setCode(rowSet.getString("countrycode"));
```

CREATING A DTO FROM SQLROWSET ROW

We can use the SqlRowSet get methods to read all the columns of a row and use them to populate a DTO that has meaning in our code.

Create a city object



```
City city = new City();  
city.setId(rowSet.getLong("id"));  
city.setName(rowSet.getString("name"));  
city.setCode(rowSet.getString("countrycode"));
```

CREATING A DTO FROM SQLROWSET ROW

We can use the `SqlRowSet` get methods to read all the columns of a row and use them to populate a DTO that has meaning in our code.

Create a `City` object

Set the `City` object's `id` data member by calling the appropriate `rowSet` get method (`getLong` in this case because `id` is a `long`) with the column name as a parameter

```
City city = new City();  
city.setId(rowSet.getLong("id"));  
city.setName(rowSet.getString("name"));  
city.setCode(rowSet.getString("countrycode"));
```

CREATING A DTO FROM SQLROWSET ROW

We can use the `SqlRowSet` get methods to read all the columns of a row and use them to populate a DTO that has meaning in our code.

Create a `City` object

Set the `City` object's `id` data member by calling the appropriate `rowSet` get method (`getLong` in this case because `id` is a `long`) with the column name as a parameter

```
City city = new City();  
city.setId(rowSet.getLong("id"));  
city.setName(rowSet.getString("name"));  
city.setCode(rowSet.getString("countrycode"));
```

Set the `City` object's `name` data member using `rowSet.getString` in the same manner

CREATING A MAPPING METHOD

We can create a method that can be called to map the current row in the `SqlRowSet` to a `DTO`.

```
private City mapRowToCity(SqlRowSet rowSet) {  
    City city = new City();  
    city.setId(rowSet.getLong("id"));  
    city.setName(rowSet.getString("name"));  
    city.setCode(rowSet.getString("countrycode"));  
    return city;  
}
```

This is the previous code in the context of a method that takes a `SqlRowSet` and returns a `City`.

WORKING WITH SQLROWSET AND DTOS

```
public List<City> getUsaCities() {  
  
    // query code that returns a SqlRowSet  
  
    // need to ADVANCE cursor to get FIRST row  
    while(resultSet.next()) {  
        // use our method mapRowToCity to map a  
        // SqlRow to a City object - we'll see  
        // how  
        City city =  
            mapRowToCity(resultSet);  
        if (city != null) {  
            result.add(city );  
        }  
    }  
    return result;  
}
```

Cursor **does NOT start at beginning of data**. You must call the **next()** method to get to first row.

id	name	countrycode	district	population
3793	New York	USA	New York	8008278
3794	Los Angeles	USA	California	3694820
3795	Chicago	USA	Illinois	2896016
3796	Houston	USA	Texas	1953631
3797	Philadelphia	USA	Pennsylvania	1517550
3798	Phoenix	USA	Arizona	1321045
3799	San Diego	USA	California	1223400
3800	Dallas	USA	Texas	1188580
3801	San Antonio	USA	Texas	1144646
3802	Detroit	USA	Michigan	951270
3803	San Jose	USA	California	894943
3804	Indianapolis	USA	Indiana	791926
3805	San Francisco	USA	California	776733

WORKING WITH SQLROWSET AND DTOS

Cursor **does NOT start at beginning of data**. You must call the **next()** method to get to first row.

Returns a
List of
City
objects

```
public List<City> getUsaCities() {  
    // query code that returns a SqlRowSet  
  
    // need to ADVANCE cursor to get FIRST row  
    while(resultSet.next()) {  
        // use our method mapRowToCity to map a  
        // SqlRow to a City object - we'll see  
        // how  
        City city =  
            mapRowToCity(resultSet);  
        if (city != null) {  
            result.add(city);  
        }  
    }  
    return result;  
}
```

id	name	countrycode	district	population
3793	New York	USA	New York	8008278
3794	Los Angeles	USA	California	3694820
3795	Chicago	USA	Illinois	2896016
3796	Houston	USA	Texas	1953631
3797	Philadelphia	USA	Pennsylvania	1517550
3798	Phoenix	USA	Arizona	1321045
3799	San Diego	USA	California	1223400
3800	Dallas	USA	Texas	1188580
3801	San Antonio	USA	Texas	1144646
3802	Detroit	USA	Michigan	951270
3803	San Jose	USA	California	894943
3804	Indianapolis	USA	Indiana	791926
3805	San Francisco	USA	California	776733

WORKING WITH SQLROWSET AND DTOS

Cursor **does NOT start at beginning of data**. You must call the **next()** method to get to first row.

```
public List<City> getUsaCities() {  
    // query code that returns a SqlRowSet  
  
    // need to ADVANCE cursor to get FIRST row  
    while(resultSet.next()) {  
        // use our method mapRowToCity to map a  
        // SqlRow to a City object - we'll see  
        // how  
        City city =  
            mapRowToCity(resultSet);  
        if (city != null) {  
            result.add(city);  
        }  
    }  
    return result;  
}
```

Returns a
List of
City
objects

resultSet
contains our
SqlRowSet

id	name	countrycode	district	population
3793	New York	USA	New York	8008278
3794	Los Angeles	USA	California	3694820
3795	Chicago	USA	Illinois	2896016
3796	Houston	USA	Texas	1953631
3797	Philadelphia	USA	Pennsylvania	1517550
3798	Phoenix	USA	Arizona	1321045
3799	San Diego	USA	California	1223400
3800	Dallas	USA	Texas	1188580
3801	San Antonio	USA	Texas	1144646
3802	Detroit	USA	Michigan	951270
3803	San Jose	USA	California	894943
3804	Indianapolis	USA	Indiana	791926
3805	San Francisco	USA	California	776733

WORKING WITH SQLROWSET AND DTOS

Cursor **does NOT start at beginning of data**. You must call the **next()** method to get to first row.

```
public List<City> getUsaCities() {  
    // query code that returns a SqlRowSet  
    // need to ADVANCE cursor to get FIRST row  
    while(resultSet.next()) {  
        // use our method mapRowToCity to map a  
        // SqlRow to a City object - we'll see  
        // how  
        City city =  
            mapRowToCity(resultSet);  
        if (city != null) {  
            result.add(city);  
        }  
    }  
    return result;  
}
```

Returns a
List of
City
objects

resultSet
contains our
SqlRowSet

Call
next() to
get to
first/next
record

id	name	countrycode	district	population
3793	New York	USA	New York	8008278
3794	Los Angeles	USA	California	3694820
3795	Chicago	USA	Illinois	2896016
3796	Houston	USA	Texas	1953631
3797	Philadelphia	USA	Pennsylvania	1517550
3798	Phoenix	USA	Arizona	1321045
3799	San Diego	USA	California	1223400
3800	Dallas	USA	Texas	1188580
3801	San Antonio	USA	Texas	1144646
3802	Detroit	USA	Michigan	951270
3803	San Jose	USA	California	894943
3804	Indianapolis	USA	Indiana	791926
3805	San Francisco	USA	California	776733

WORKING WITH SQLROWSET AND DTOS

Cursor **does NOT start at beginning of data**. You must call the **next()** method to get to first row.

```
public List<City> getUsaCities() {  
    // query code that returns a SqlRowSet  
    // need to ADVANCE cursor to get FIRST row  
    while(resultSet.next()) {  
        // use our method mapRowToCity to map a  
        // SqlRow to a City object - we'll see  
        // how  
        City city =  
            mapRowToCity(resultSet);  
        if (city != null) {  
            result.add(city);  
        }  
    }  
    return result;  
}
```

Returns a
List of
City
objects

resultSet
contains our
SqlRowSet

Call
next() to
get to
first/next
record

Create City
object using
the mapping
method we
created..

id	name	countrycode	district	population
3793	New York	USA	New York	8008278
3794	Los Angeles	USA	California	3694820
3795	Chicago	USA	Illinois	2896016
3796	Houston	USA	Texas	1953631
3797	Philadelphia	USA	Pennsylvania	1517550
3798	Phoenix	USA	Arizona	1321045
3799	San Diego	USA	California	1223400
3800	Dallas	USA	Texas	1188580
3801	San Antonio	USA	Texas	1144646
3802	Detroit	USA	Michigan	951270
3803	San Jose	USA	California	894943
3804	Indianapolis	USA	Indiana	791926
3805	San Francisco	USA	California	776733

WORKING WITH SQLROWSET AND DTOS

Cursor **does NOT start at beginning of data**. You must call the **next()** method to get to first row.

```
public List<City> getUsaCities() {  
    // query code that returns a SqlRowSet  
    // need to ADVANCE cursor to get FIRST row  
    while(resultSet.next()) {  
        // use our method mapRowToCity to map a  
        // SqlRow to a City object - we'll see  
        // how  
        City city =  
            mapRowToCity(resultSet);  
        if (city != null) {  
            result.add(city);  
        }  
    }  
    return result;  
}
```

Returns a
List of
City
objects

resultSet
contains our
SqlRowSet

Call
next() to
get to
first/next
record

Create City
object using
the mapping
method we
created..

Add City
object to
result List

id	name	countrycode	district	population
3793	New York	USA	New York	8008278
3794	Los Angeles	USA	California	3694820
3795	Chicago	USA	Illinois	2896016
3796	Houston	USA	Texas	1953631
3797	Philadelphia	USA	Pennsylvania	1517550
3798	Phoenix	USA	Arizona	1321045
3799	San Diego	USA	California	1223400
3800	Dallas	USA	Texas	1188580
3801	San Antonio	USA	Texas	1144646
3802	Detroit	USA	Michigan	951270
3803	San Jose	USA	California	894943
3804	Indianapolis	USA	Indiana	791926
3805	San Francisco	USA	California	776733

WORKING WITH SQLROWSET AND DTOS

Cursor **does NOT start at beginning of data**. You must call the **next()** method to get to first row.

```
public List<City> getUsaCities() {  
    // query code that returns a SqlRowSet  
    // need to ADVANCE cursor to get FIRST row  
    while(resultSet.next()) {  
        // use our method mapRowToCity to map a  
        // SqlRow to a City object - we'll see  
        // how  
        City city =  
            mapRowToCity(resultSet);  
        if (city != null) {  
            result.add(city);  
        }  
    }  
    return result;  
}
```

Returns a
List of
City
objects

resultSet
contains our
SqlRowSet

Return the result List

Call
next() to
get to
first/next
record

Create City
object using
the mapping
method we
created..

Add City
object to
result List

id	name	countrycode	district	population
3793	New York	USA	New York	8008278
3794	Los Angeles	USA	California	3694820
3795	Chicago	USA	Illinois	2896016
3796	Houston	USA	Texas	1953631
3797	Philadelphia	USA	Pennsylvania	1517550
3798	Phoenix	USA	Arizona	1321045
3799	San Diego	USA	California	1223400
3800	Dallas	USA	Texas	1188580
3801	San Antonio	USA	Texas	1144646
3802	Detroit	USA	Michigan	951270
3803	San Jose	USA	California	894943
3804	Indianapolis	USA	Indiana	791926
3805	San Francisco	USA	California	776733

GETTING THE NEXT VALUE FROM A SEQUENCE WITH JDBCTEMPLATE

In order to get the next value from a sequence, we query for the results of nextval for the sequence. We can use the `queryForObject` of the `JdbcTemplate` and specify the appropriate class since we know we will get only one result back.


```
private long getNextCityId() {  
    SqlRowSet nextIdResult = jdbcTemplate.queryForRowSet("SELECT  
        nextval('seq_city_id')");  
    if(nextIdResult.next()) {  
        return nextIdResult.getLong(1);  
    } else {  
        throw new RuntimeException("Something went wrong while getting an  
id for the new city");  
    }  
}
```

GETTING THE NEXT VALUE FROM A SEQUENCE WITH JDBCTEMPLATE

In order to get the next value from a sequence, we query for the results of nextval for the sequence. We can use the `queryForObject` of the `JdbcTemplate` and specify the appropriate class since we know we will get only one result back.

`queryForRowset` is used to query for nextval of the `seq_city_id` sequence.

```
private long generateId() {  
    SqlRowSet nextIdResult = jdbcTemplate.queryForRowset("SELECT  
        nextval('seq_city_id')");  
    if(nextIdResult.next()) {  
        return nextIdResult.getLong(1);  
    } else {  
        throw new RuntimeException("Something went wrong while getting an  
id for the new city");  
    }  
}
```



GETTING THE NEXT VALUE FROM A SEQUENCE WITH JDBCTEMPLATE

In order to get the next value from a sequence, we query for the results of nextval for the sequence. We can use the `queryForObject` of the `JdbcTemplate` and specify the appropriate class since we know we will get only one result back.

`queryForRowset` is used to query for nextval of the `seq_city_id` sequence.

```
private long generateId() {  
    SqlRowSet nextIdResult = jdbcTemplate.queryForRowSet("SELECT  
        nextval('seq_city_id')");  
    if(nextIdResult.next()) {  
        return nextIdResult.getLong(1);  
    } else {  
        throw new RuntimeException("Something went wrong while getting an  
id for the new city");  
    }  
}
```

Since the `SqlRowSet` should only have one row, we use `if` rather than `while` to check whether there is data to read

GETTING THE NEXT VALUE FROM A SEQUENCE WITH JDBCTEMPLATE

In order to get the next value from a sequence, we query for the results of nextval for the sequence. We can use the `queryForObject` of the `JdbcTemplate` and specify the appropriate class since we know we will get only one result back.

```
private long generateId() {  
    SqlRowSet nextIdResult = jdbcTemplate.queryForRowSet("SELECT  
        nextval('seq_city_id')");  
    if(nextIdResult.next()) {  
        return nextIdResult.getLong(1);  
    } else {  
        throw new RuntimeException("Something went wrong while getting an  
id for the new city");  
    }  
}
```

`queryForRowSet` is used to query for nextval of the seq_city_id sequence.

If there is data, we get and return the Long value in column 1 of the data. It is possible to use the column's position in result data rather than accessing it by column name.

Since the `SqlRowSet` should only have one row, we use `if` rather than `while` to check whether there is data to read

INTRODUCING THE DAO PATTERN

FOLLOWING THE DAO PATTERN

Although JDBC makes it easier for us to swap one database implementation for another, it often involves some internal changes to work with the features that aren't part of the ANSI SQL Standard. Sometimes we may even want to use different database implementations for different tasks (i.e. one database is Postgres and one is Oracle).

The **Data Access Object (DAO) pattern** allows us to add abstraction our own data objects so that we can write code that is not database implementation dependant.

FOLLOWING THE DAO PATTERN

The DAO pattern uses a **data access interface** to add an abstraction layer to data objects. The pattern consists of:

- Data Access Object Interface
- Data Access Implementation Class
- Model (or Value) Objects - the DTOs or POJOs we mentioned previously.

FOLLOWING THE DAO PATTERN

The **DAO pattern** promotes best practices and principles including:

- **Encapsulation**
 - DAO classes keep the logic for communicating with a database separate from the rest of the application logic.
- **Loosely coupled**
 - DAO interface abstracts away the specifics of the underlying data storage, so that the application and DAO have no knowledge of each other. This allows you to replace the DAO with one that accesses a different data source with little to no change to other code.
- **Single responsibility principle**
 - This principle states that every class or function of an application should have responsibility over a single part of that program's functionality. DAO classes have responsibility over a single type of object, such as a relational database table.

LET'S SEE HOW THE
PATTERN WORKS...

CITY DTO

We create a DTO class called City.

```
public class City {  
    private Long id;  
    private String name;  
    private String countryCode;  
    private String district;  
    private int population;  
  
    public Long getId() {  
        return id;  
    }  
  
    public void setId(Long id) {  
        this.id = id;  
    }  
  
    public String getName() {  
        return name;  
    }  
  
    public void setName(String name) {  
        this.name = name;  
    }  
  
    public String getCountryCode() {  
        return countryCode;  
    }  
  
    public void setCountryCode(String countryCode) {  
        this.countryCode = countryCode;  
    }  
  
    // rest of code omitted  
}
```

DATA ACCESS INTERFACE

We create an interface for the CityDAO.

```
public interface CityDAO {  
  
    public void save(City newCity);  
    public City findCityById(long id);  
    public List<City> findCityByCountryCode(String countryCode);  
    public List<City> findCityByDistrict(String district);  
    public List<City> getUsaCities();  
    public void update(City city);  
    public void delete(long id);  
}
```

All objects that implement CityDAO must implement these methods.

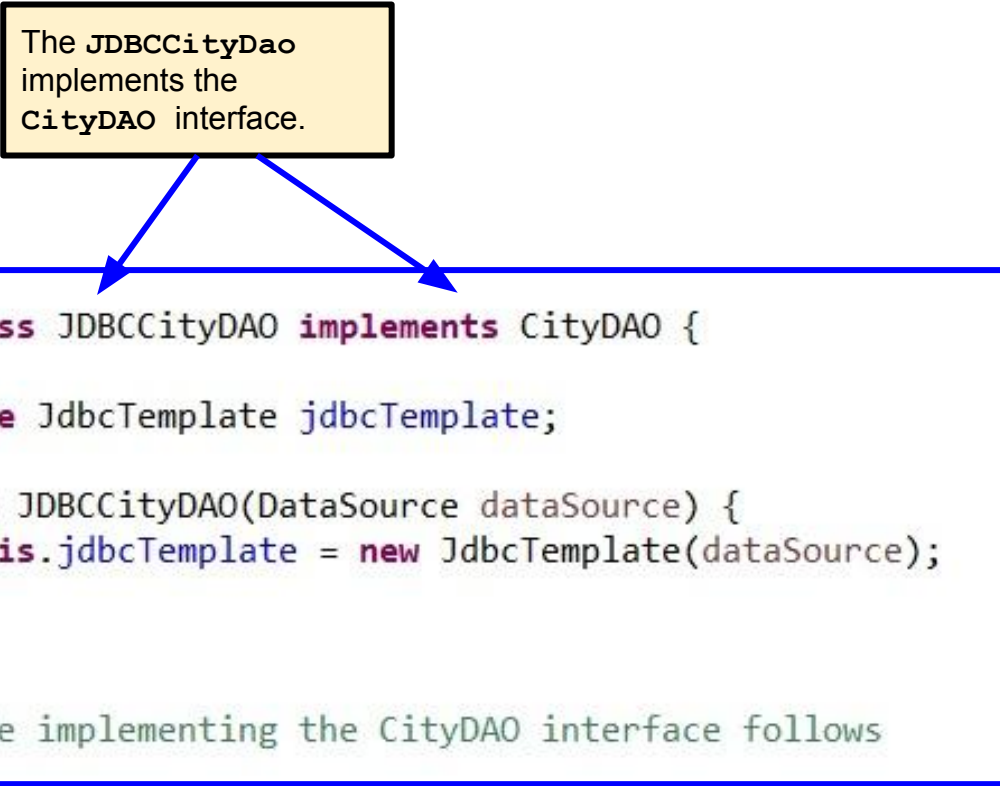
DAO IMPLEMENTATION CLASS

We create a JDBC implementation of the CityDAO interface

```
public class JDBCCityDAO implements CityDAO {  
  
    private JdbcTemplate jdbcTemplate;  
  
    public JDBCCityDAO(DataSource dataSource) {  
        this.jdbcTemplate = new JdbcTemplate(dataSource);  
    }  
  
    // Code implementing the CityDAO interface follows
```

DAO IMPLEMENTATION CLASS

The JDBCCityDao implements the CityDAO interface.



We create a JDBC implementation of the CityDAO interface

```
public class JDBCCityDAO implements CityDAO {  
  
    private JdbcTemplate jdbcTemplate;  
  
    public JDBCCityDAO(DataSource dataSource) {  
        this.jdbcTemplate = new JdbcTemplate(dataSource);  
    }  
  
    // Code implementing the CityDAO interface follows
```

DAO IMPLEMENTATION CLASS

We create a JDBC implementation of the CityDAO interface

The JDBCCityDao implements the CityDAO interface.

The constructor takes a DataSource which will be used to create the JdbcTemplate..

```
public class JDBCCityDAO implements CityDAO {  
    private JdbcTemplate jdbcTemplate;  
    public JDBCCityDAO(DataSource dataSource) {  
        this.jdbcTemplate = new JdbcTemplate(dataSource);  
    }  
  
    // Code implementing the CityDAO interface follows
```

PUTTING IT ALL TOGETHER

Now we can use our DAO to query for all the City objects with countryCode 'USA'. Note that we use the CityDAO interface for the dao - if we do it this way, all we have to do is swap the implementation class and all else will be the same.

```
public class DAOExample {  
  
    public static void main(String[] args) {  
  
        BasicDataSource worldDataSource = new BasicDataSource();  
        worldDataSource.setUrl("jdbc:postgresql://localhost:5432/world");  
        worldDataSource.setUsername("postgres");  
        worldDataSource.setPassword("postgres1");  
  
        CityDAO dao = new JDBCCityDAO(worldDataSource);  
  
        List<City> cities = dao.getUsaCities();  
        System.out.println(cities);  
    }  
}
```

PUTTING IT ALL TOGETHER

Now we can use our DAO to query for all the City objects with countryCode 'USA'. Note that we use the CityDAO interface for the dao - if we do it this way, all we have to do is swap the implementation class and all else will be the same.

```
public class DAOExample {  
  
    public static void main(String[] args) {  
  
        BasicDataSource worldDataSource = new BasicDataSource();  
        worldDataSource.setUrl("jdbc:postgresql://localhost:5432/world");  
        worldDataSource.setUsername("postgres");  
        worldDataSource.setPassword("postgres1");  
  
        CityDAO dao = new JDBCCityDAO(worldDataSource);  
  
        List<City> cities = dao.getUsaCities();  
        System.out.println(cities);  
    }  
}
```



Create the
JDBCCityDao

PUTTING IT ALL TOGETHER

Now we can use our DAO to query for all the City objects with countryCode 'USA'. Note that we use the CityDAO interface for the dao - if we do it this way, all we have to do is swap the implementation class and all else will be the same.

```
public class DAOExample {  
  
    public static void main(String[] args) {  
  
        BasicDataSource worldDataSource = new BasicDataSource();  
        worldDataSource.setUrl("jdbc:postgresql://localhost:5432/world");  
        worldDataSource.setUsername("postgres");  
        worldDataSource.setPassword("postgres1");  
  
        CityDAO dao = new JDBCCityDAO(worldDataSource);  
  
        List<City> cities = dao.getUsaCities();  
        System.out.println(cities);  
    }  
}
```

Create the JDBCCityDao

Use CityDAO methods

LET'S CODE!!!!!!

SETUP

Open you DbVisualizer and connect to any of the database connections we have already created. Then create the addressbook database:

```
CREATE DATABASE addressbook;
```

Once you have done that, disconnect from the connection you are using.

SETUP

- Connect to the new addressbook database
- Open the addressbook.sql file in your student-lecture folder
- Execute the script
- Open Eclipse and import dao-coding-activity from 99-Yoav-Extra-Stuff