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Full Stack Application Development  
Software Workshop 2

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## Assignment 3: *Database Client-Server*

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Set by  
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Submission Deadline:  
**Monday 16th May 2022 4pm BST**

**Use Canvas for the definitive deadlines**

This assignment is worth  
**25 % (twenty-five percent)**  
of the overall course mark

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## 1 Introduction

This assignment will assess your JDBC and Java Networks skills. You are required to implement a Multi Client-Server application using the TCP protocol, where the user continuously inputs the name of an artist and the server replies with the number of albums for that particular artist, until the user types 'stop'. The SQL query is a simple inner join executed on the Music database.

Descriptions of the overall requirements are given in §4 Coding tasks and in the skeleton.

## 2 Marking scheme

Question	Description	Marks
1	Database.java	50
2	Client.java	15
3	Server.java	15
4	ClientHandler.java	20
<b>Total</b>		100



We are going to perform several tests on your code and most of your classes will be tested in isolation. Therefore, it is essential to leave the methods and the classes signatures in the skeleton unchanged. The text messages that should be printed to the console are also included in the skeleton code, please do not modify them, as your console output should match the sample output examples given in §5 Sample Outputs.

### 3 Setting up the database

For this assignment you will use the 'Music' database that you have created in Week 10. Please use the instructions and the tutorial video on Canvas for creating the database and for inserting data into the tables. The two files you need can be downloaded from Canvas and are called `music_create.sql` and `music_data.sql`. Import `music_create.sql` first and then import `music_data.sql`. 15

The command to import these files is as follows. Remember, you need to state the path on your own computer where you put the files. You might also need to put the path in quote marks. 20

```
\i /your_path/music_create.sql
\i /your_path/music_data.sql
```

Once you have imported the tables, you can list them by performing the following command in PostgreSQL: 25

```
\dt
```

Note that this will list all of the tables you may have created in this database. Run SQL commands to view the contents of each table by doing 'SELECT \* FROM *tablename*;' (replacing *tablename* with the name of the table you want to look at.) 30

### 4 Coding tasks

Only move to this stage when you have set up the database, as above. For this assignment you will create a Java Client-Server application **using TCP** that performs a query on the database and returns the result to the client.

The following sections describe the classes that you can find in the assignment pack. You must add the code to create the functionality required for each class. 35

#### 4.1 Server.java

The `Server.java` implements a basic multi-threaded server that continuously listens for connections and creates a new thread for each client connection. Note that the client-server communication is continuous and messages are exchanged until the user types 'stop'. 40

#### Functionality:

- Creates the server socket;

- Creates a Database object; 45
- Checks the database connectivity by calling the `establishDBConnection()` method from `Database.java`, which returns the connection status (boolean);
- Continuously listens for client requests and accepts multiple client connections, if the db connection is successful; 50
- Prints the appropriate text messages to the console (given in the skeleton), in the right order;
- Assigns a `clientId` for each client that connects to the server. The `clientId` starts from 1 and must not be reassigned once used;
- Creates a `ClientHandler` instance and starts a new thread for each client. 55

## 4.2 `Client.java`

The `Client.java` is a basic client program that **continuously** reads the name of the artist from the console and prints the response from the server, until the user types 'stop'. You are not supposed to deal with capitalisation or different versions of the word 'stop'. 60

### Functionality:

- Creates the client socket;
- Creates I/O streams to read data from the server and console and send data to the server; 65
- Reads text from the console continuously, until the user types 'stop';
- does not deal with capitalisation or different versions of the artist name and the 'stop' message, the name of the artist in the query should be the same as the entry in the 'Music' db, otherwise it will return 0 albums;
- Sends messages (artist names) to the server; 70
- Receives responses from the server (number of albums);
- Prints the appropriate text messages to the console (given in the skeleton), in the right order;
- Cleans up the environment, closes the socket and the I/O streams.

### 4.3 ClientHandler.java

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The `ClientHandler` class provides the client-server interaction in the `run()` method. It implements `Runnable` and deals with the multiple client communication.

#### Functionality:

- Implements `Runnable`;
- Has a constructor;
- Implements the functionality of the threads in the `run()` method;
- Creates I/O streams to read/write data from/to the client;
- Continuously receives messages from the clients and replies back, until the user types 'stop';
- Requests the number of titles from the database by calling the `getTitles()` method in the `Database.java` class and stores the result;
- Prints the appropriate text messages to the console (given in the skeleton), in the right order;
- Cleans up the environment, closes the socket and the I/O streams.

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### 4.4 Database.java

The `Database.java` class deals with the JDBC part of the assignment and has 2 methods: `getTitles()` and `establishDBConnection()`.

#### Functionality:

- It must prevent SQL injections;
- `getTitles()` method executes a query and returns an integer, the number of albums for the artist. This method is called in the `ClientHandler.java` class;
- `establishDBConnection()` method establishes a connection to the database and returns the status of the connection (boolean) with a timeout of 5 seconds. This method is called in the `Server.java` class to check the database connectivity.

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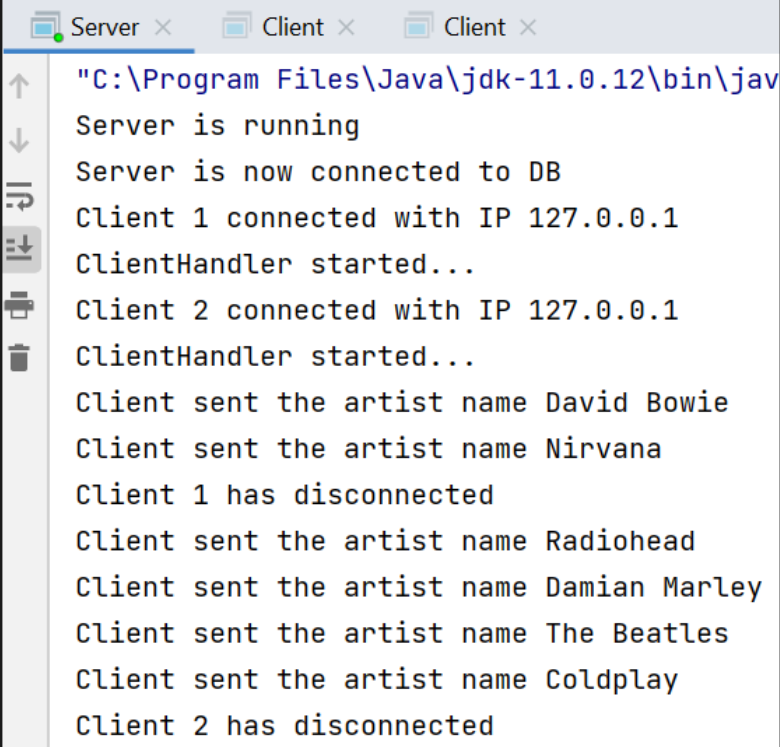
## 5 Sample Outputs

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Note that the text messages printed to the console are included in the skeleton code, as we are not assessing your abilities to write strings in Java. Your outputs should match the sample outputs images below, as long as you do not modify the output strings in the skeleton.

Figure 1 shows a sample output for the `Server.java` class. The database connectivity is successful, two clients connect to the server and send messages.

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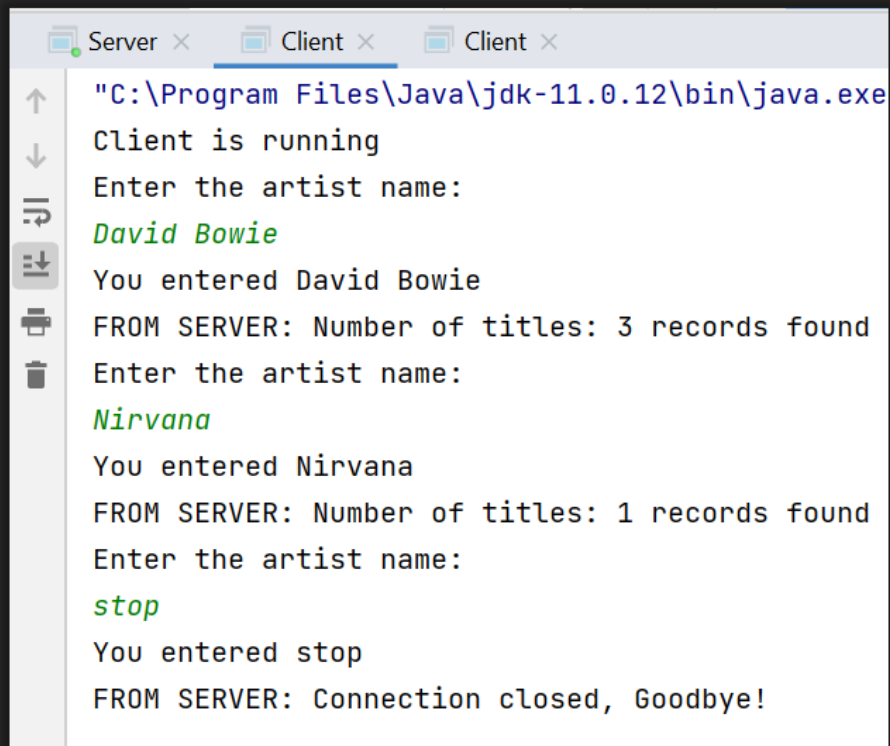


```
"C:\Program Files\Java\jdk-11.0.12\bin\jav
Server is running
Server is now connected to DB
Client 1 connected with IP 127.0.0.1
ClientHandler started...
Client 2 connected with IP 127.0.0.1
ClientHandler started...
Client sent the artist name David Bowie
Client sent the artist name Nirvana
Client 1 has disconnected
Client sent the artist name Radiohead
Client sent the artist name Damian Marley
Client sent the artist name The Beatles
Client sent the artist name Coldplay
Client 2 has disconnected
```

Figure 1 Server output.



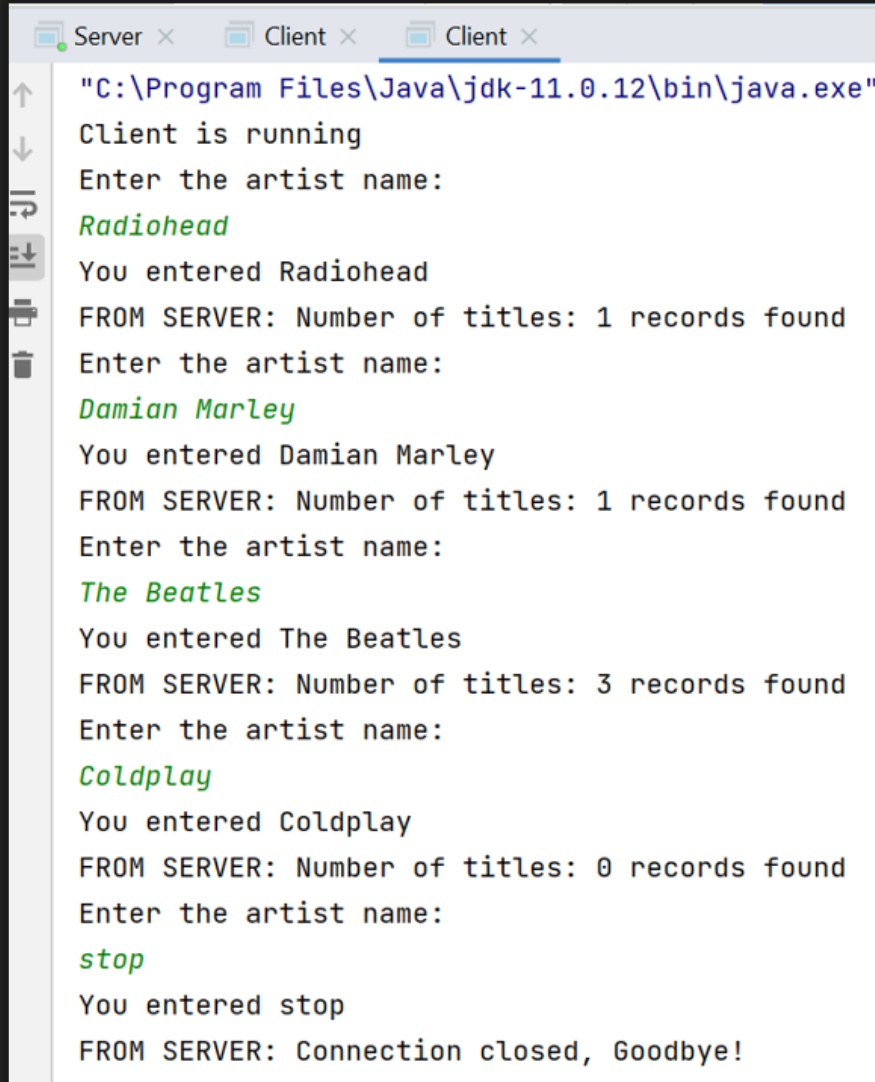
Figure 2 shows a sample output for the `Client.java` class. The client successfully connects to the server and sends artist names, until the user types 'stop'. The server replies with the number of album titles for each artist.



```
"C:\Program Files\Java\jdk-11.0.12\bin\java.exe
Client is running
Enter the artist name:
David Bowie
You entered David Bowie
FROM SERVER: Number of titles: 3 records found
Enter the artist name:
Nirvana
You entered Nirvana
FROM SERVER: Number of titles: 1 records found
Enter the artist name:
stop
You entered stop
FROM SERVER: Connection closed, Goodbye!
```

Figure 2 Client 1 output.

Figure 3 shows a sample output for a second client. Follow the instructions in Week 11 - Part 2 lecture on how to run multiple instances of the `Client.java` class in IntelliJ. Note that if the artist name is not found in the database, the server will return '0 records found'.

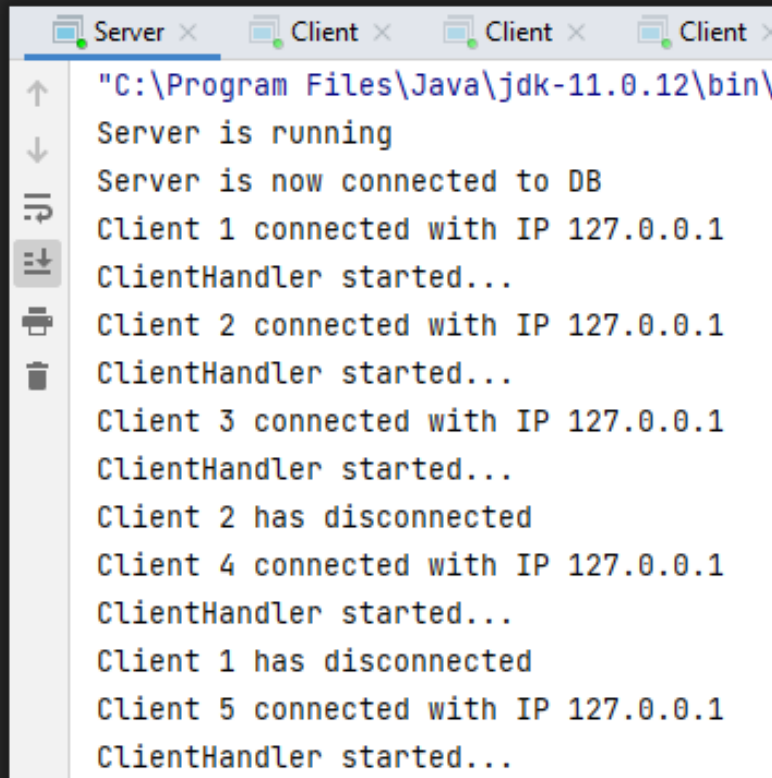


```
"C:\Program Files\Java\jdk-11.0.12\bin\java.exe"
Client is running
Enter the artist name:
Radiohead
You entered Radiohead
FROM SERVER: Number of titles: 1 records found
Enter the artist name:
Damian Marley
You entered Damian Marley
FROM SERVER: Number of titles: 1 records found
Enter the artist name:
The Beatles
You entered The Beatles
FROM SERVER: Number of titles: 3 records found
Enter the artist name:
Coldplay
You entered Coldplay
FROM SERVER: Number of titles: 0 records found
Enter the artist name:
stop
You entered stop
FROM SERVER: Connection closed, Goodbye!
```

Figure 3 Client 2 output.

Figure 4 shows the output of the `Server.java` class for multiple client connections. Note that the `clientID` starts from 1 and must not be reassigned once used, i.e. if there are 3 clients connected to the server and the client with `clientID` 2 disconnects, the next client that connects will have `clientID` 4.

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```
"C:\Program Files\Java\jdk-11.0.12\bin\
Server is running
Server is now connected to DB
Client 1 connected with IP 127.0.0.1
ClientHandler started...
Client 2 connected with IP 127.0.0.1
ClientHandler started...
Client 3 connected with IP 127.0.0.1
ClientHandler started...
Client 2 has disconnected
Client 4 connected with IP 127.0.0.1
ClientHandler started...
Client 1 has disconnected
Client 5 connected with IP 127.0.0.1
ClientHandler started...
```

**Figure 4** Server output for multiple client connections.

Figure 5 shows a sample output for the `Server.java` class, if the connection to the database failed (i.e the database password is wrong). The error will be caught in the Database and the Server will print 'DB connection fail, stopping.' The execution of the program will stop.

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```
Server x
"C:\Program Files\Java\jdk-11.0.12\bin\java.exe" "-javaagent:C:\Program Files\JetBrains\IntelliJ IDEA Community Edition\lib\idea_rt.jar=1300:C:\Program Files\Java\jdk-11.0.12\bin" -Dfile.encoding=UTF-8
Server is running
org.postgresql.util.PSQLException: Create breakpoint : FATAL: password authentication failed for user "postgres"
    at org.postgresql.core.v3.ConnectionFactoryImpl.doAuthentication(ConnectionFactoryImpl.java:646)
    at org.postgresql.core.v3.ConnectionFactoryImpl.tryConnect(ConnectionFactoryImpl.java:180)
    at org.postgresql.core.v3.ConnectionFactoryImpl.openConnectionImpl(ConnectionFactoryImpl.java:235)
    at org.postgresql.core.ConnectionFactory.openConnection(ConnectionFactory.java:49)
    at org.postgresql.jdbc.PgConnection.<init>(PgConnection.java:223)
    at org.postgresql.Driver.makeConnection(Driver.java:400)
    at org.postgresql.Driver.connect(Driver.java:259)
    at java.sql/java.sql.DriverManager.getConnection(DriverManager.java:677)
    at java.sql/java.sql.DriverManager.getConnection(DriverManager.java:228)
    at Database.establishDBConnection(Database.java:36)
    at Server.main(Server.java:18)
DB connection fail, stopping.
```

**Figure 5** Server output when the database connectivity fails.

## 6 About the project

You are given a .zip file containing the IntelliJ project with the skeleton code that you have to complete: this a framework that lacks functionality. You must expand this skeleton to complete the assignment according to the instructions in §4 Coding tasks.

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### 6.1 Obtaining the assignment project

Go to [Canvas](#), then go to the FSAD/SW2 course, then to Assignment 3.<sup>1</sup> There is a link to a .zip file. Download and unpack this file to its own folder and move the unpacked directory (folder) somewhere sensible. The folder contains an IntelliJ project with the skeletons of the five classes described in §4 Coding tasks.

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### 6.2 Loading the assignment project

Remember when you load this project into IntelliJ to open the directory itself rather than one of the files inside it. The .java files under the src folder contain a skeleton and method stubs for the required methods. Do not change the signatures of the classes and methods.

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In your project you will also need to make available the external jar file, postgresql-42.3.3.jar, or the latest version. This file contains the drivers that you need to connect to a PostgreSQL database using Java. If you don't know how to do that, there are instructions on Canvas (week 10). In essence, you need to add the driver as an external jar file in your project. Do not try and 'import' this file. You also don't need to open it to view its contents.

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### 6.3 Allowed imports

The allowed imports are found in the skeleton code.

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### 6.4 How to submit

1. **Build** ➤ **Rebuild Project** and fix any compilation errors.
2. **File** ➤ **Export** ➤ **Project to Zip file...** and rename the resulting .zip file to FSADAssign3\_Givenname\_Familyname\_studentIDnumber.zip  
If you officially have only one name then use X for the 'missing' name.
3. Check your .zip file contains everything it should under the src folder: Client.java, Server.java, ClientHandler.java and Database.java.

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<sup>1</sup> Direct link: <https://canvas.bham.ac.uk/courses/56081/assignments/343494>

4. If you wish, you may delete `Credentials.java` from the `src` folder of your `.zip` before uploading it on Canvas. We are going to replace this class and use our own credentials for testing your code. 165
5. Ensure you do not include a previous exported `.zip` file in the latest project export (a `.zip` inside a `.zip`) because this means you cannot guarantee the autotester will run the latest version of your code.
6. Upload the renamed `.zip` file to Canvas for the Java course Assignment 3.
7. Canvas will probably add some extra information to the end of the filename you have uploaded: do not worry about this. 170

Failure to comply with the submission requirements will result in penalties.