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Spark_DataSources_JDBC_PostgreSQL

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Spark_DataSources

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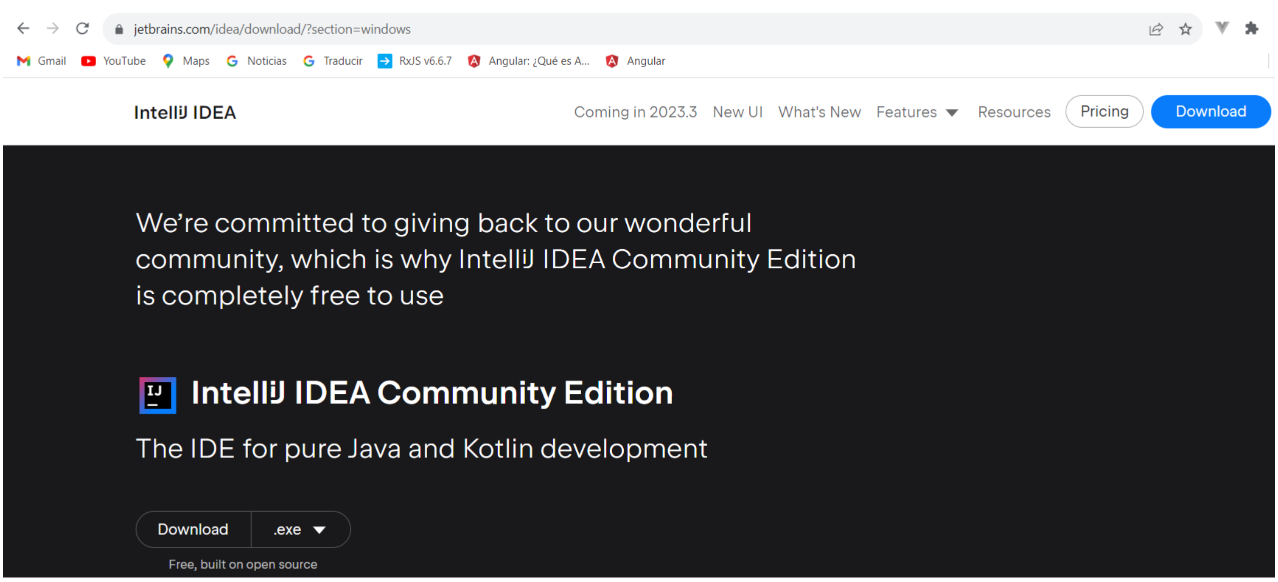
Spark DataSources JDBC PostgreSQL

README.md

plugin, Java 11, Spark and winutils in your computer

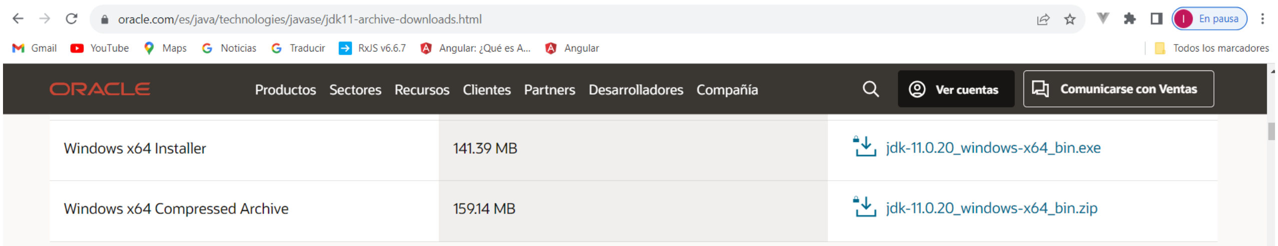
1.1. Install IntelliJ Community + Scala plugin

https://www.jetbrains.com/idea/download/?section=windows



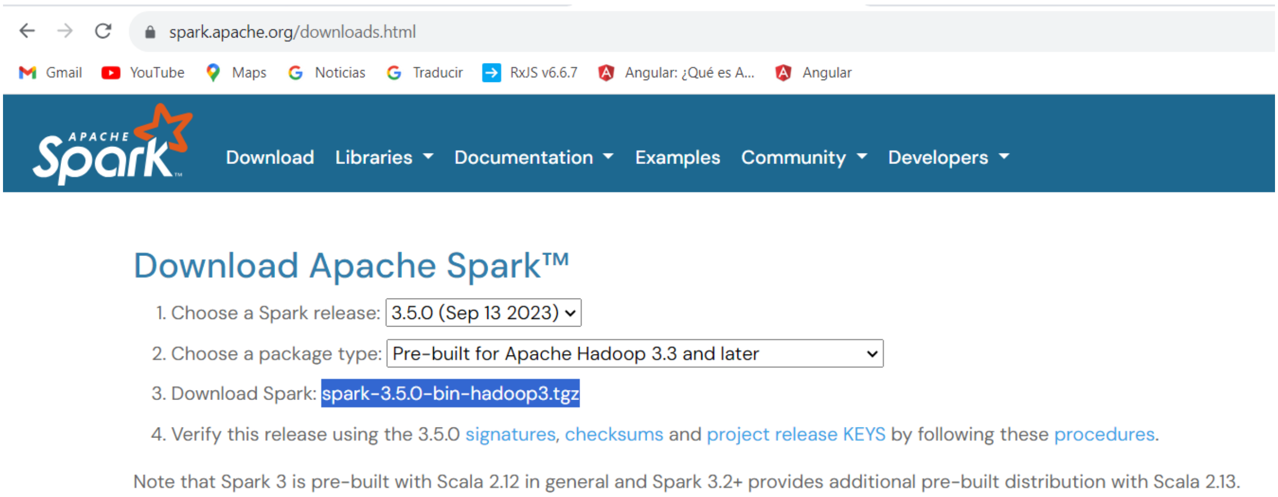
1.2. Install Java 11 (JDK) and set JAVA_HOME environmental variable

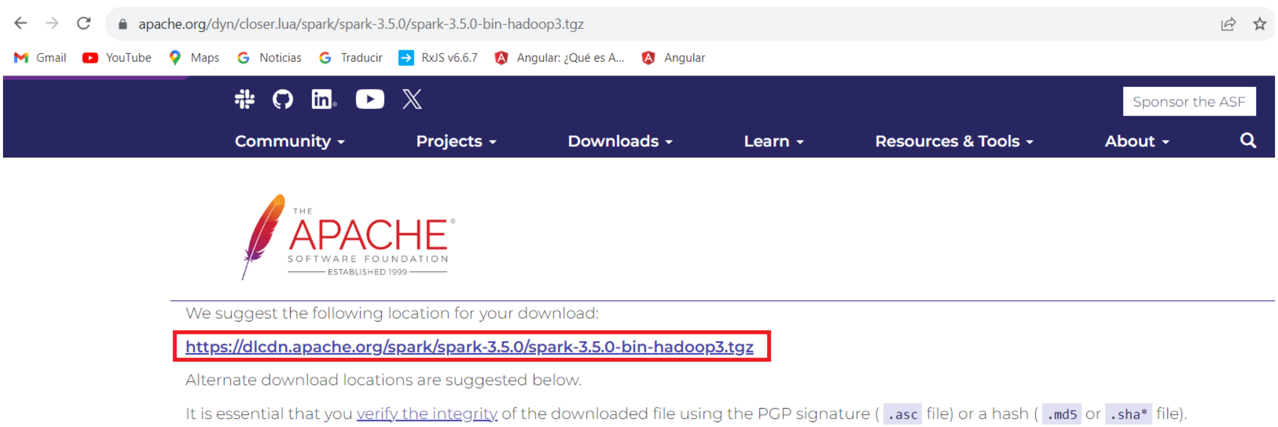
https://www.oracle.com/es/java/technologies/javase/jdk11-archive-downloads.html



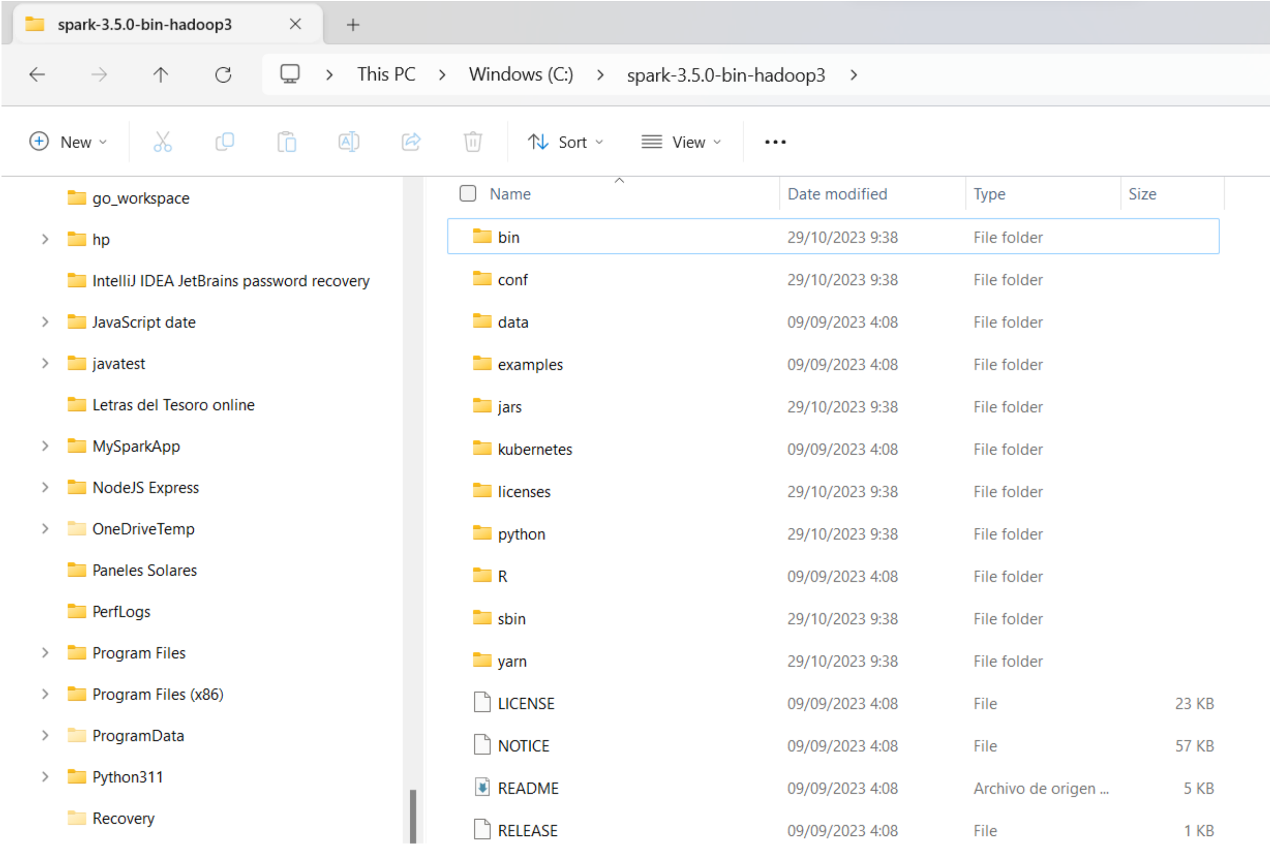
1.3. Install Spark and set SPARK_HOME environmental variable or directly add the bin folder path in the PATH environmental variable

https://spark.apache.org/downloads.html



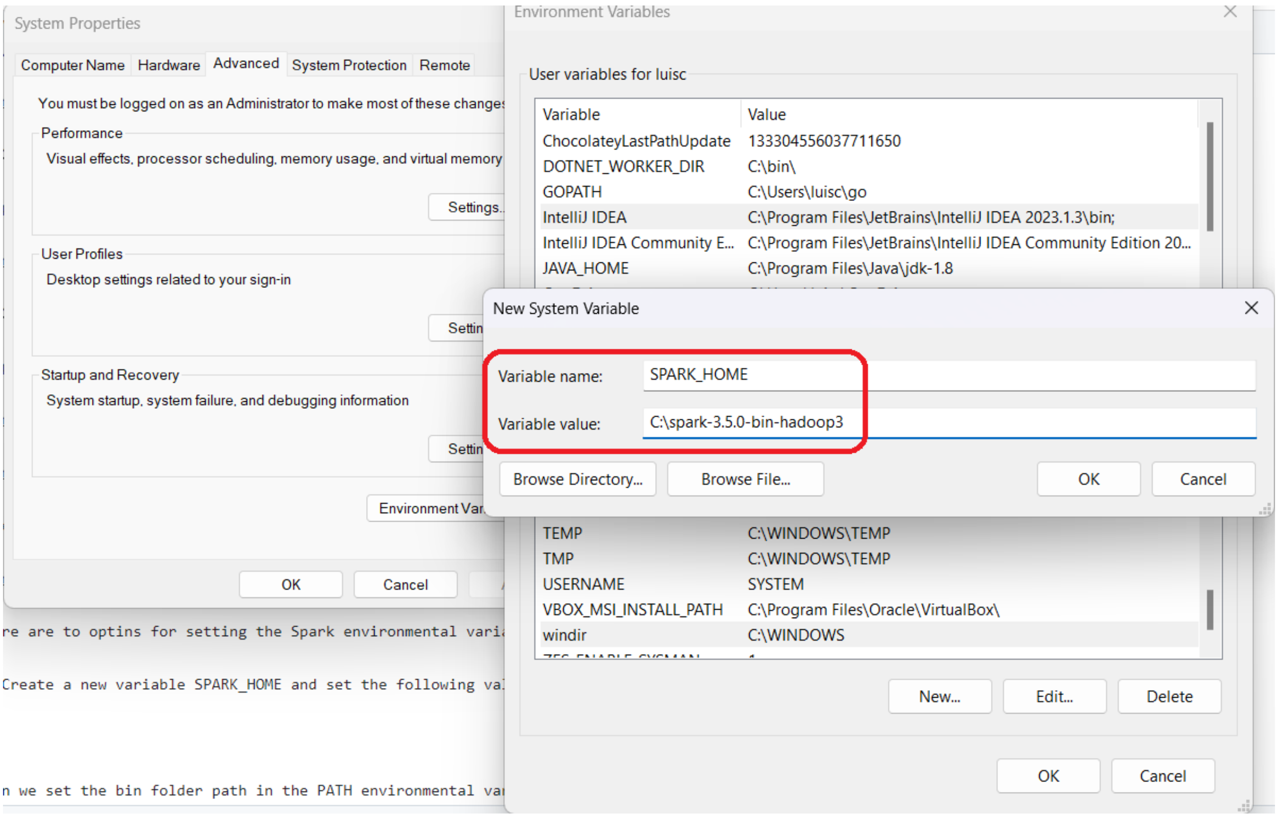


After unzipping the file "spark-3.5.0-bin-hadoop3" place the folder in your C: hard disk root.

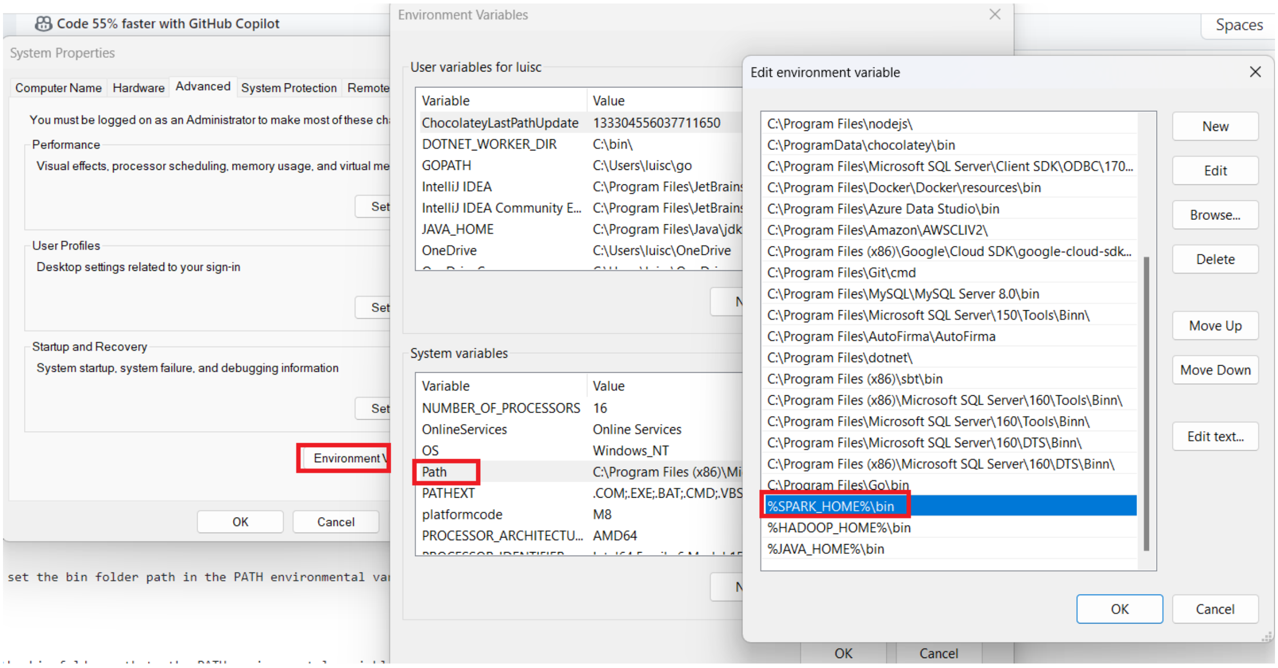


There are to optins for setting the Spark environmental variables:

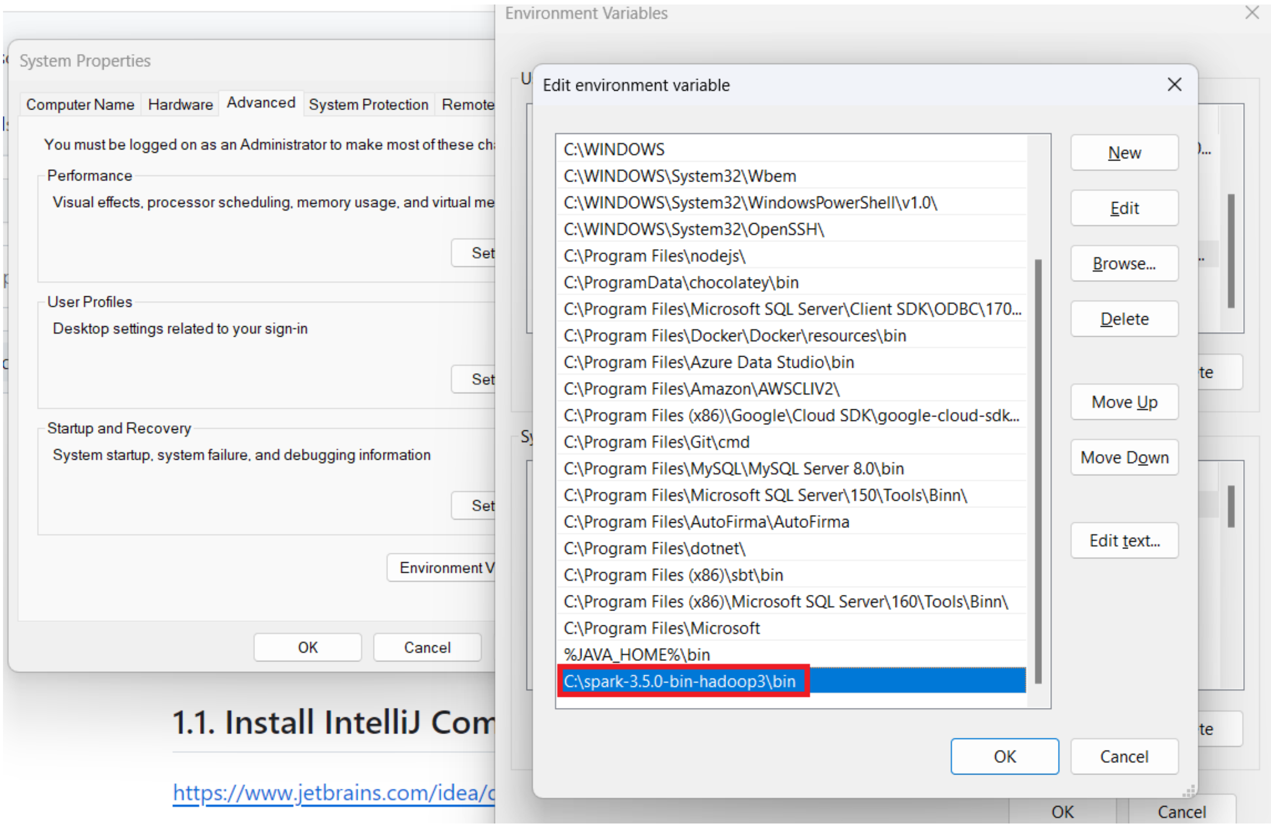
a) Create a new variable SPARK_HOME and set the following value: C:\spark-3.5.0-bin-hadoop3



Then we set the bin folder path in the PATH environmental variable.

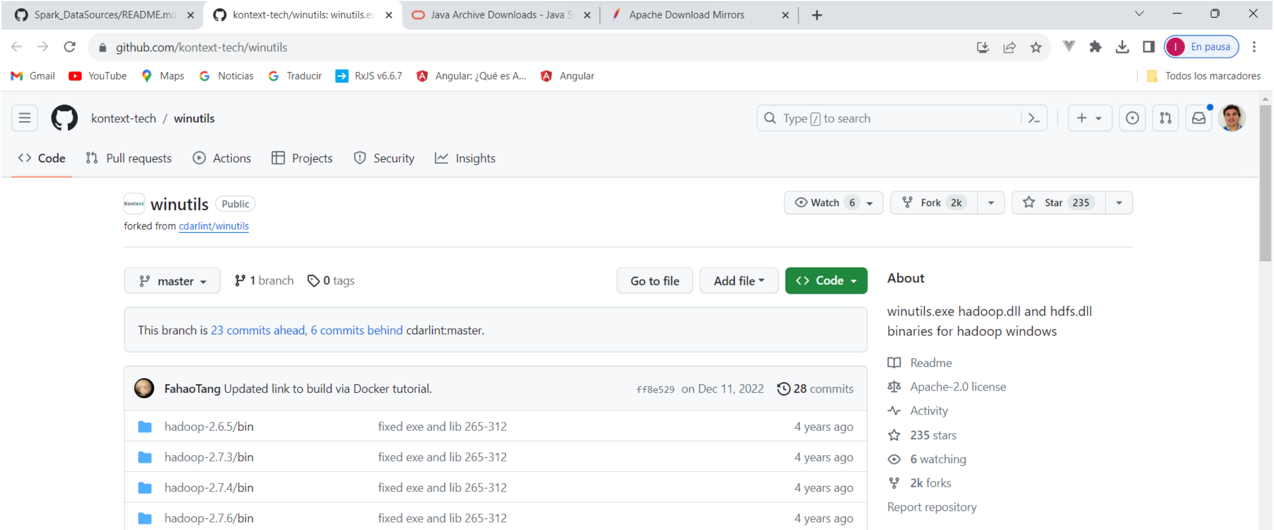


b) Add the bin folder path to the PATH environmental variable.

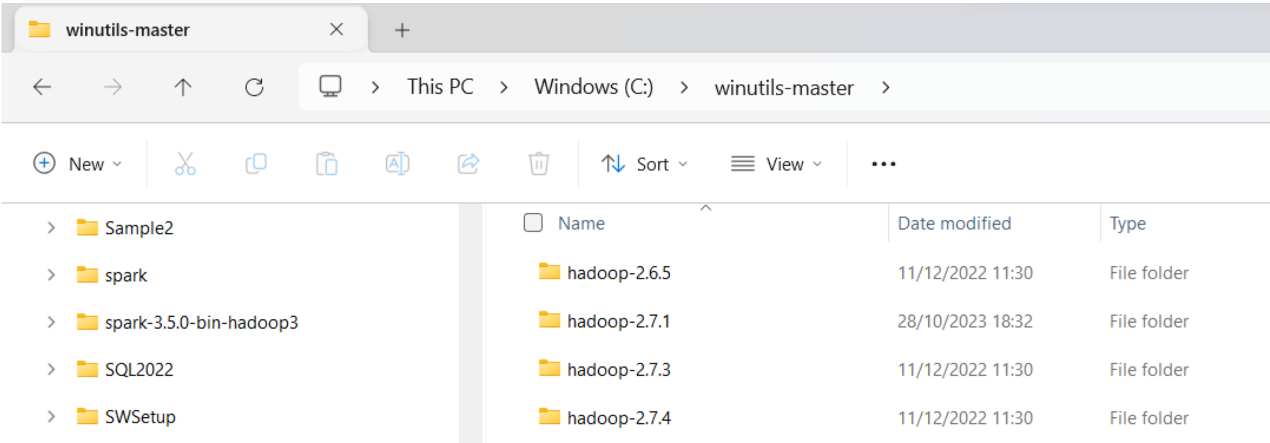


1.4. Install winutils and set HADOOP_HOME environmental variable

We download or clone this git repository: https://github.com/kontext-tech/winutils

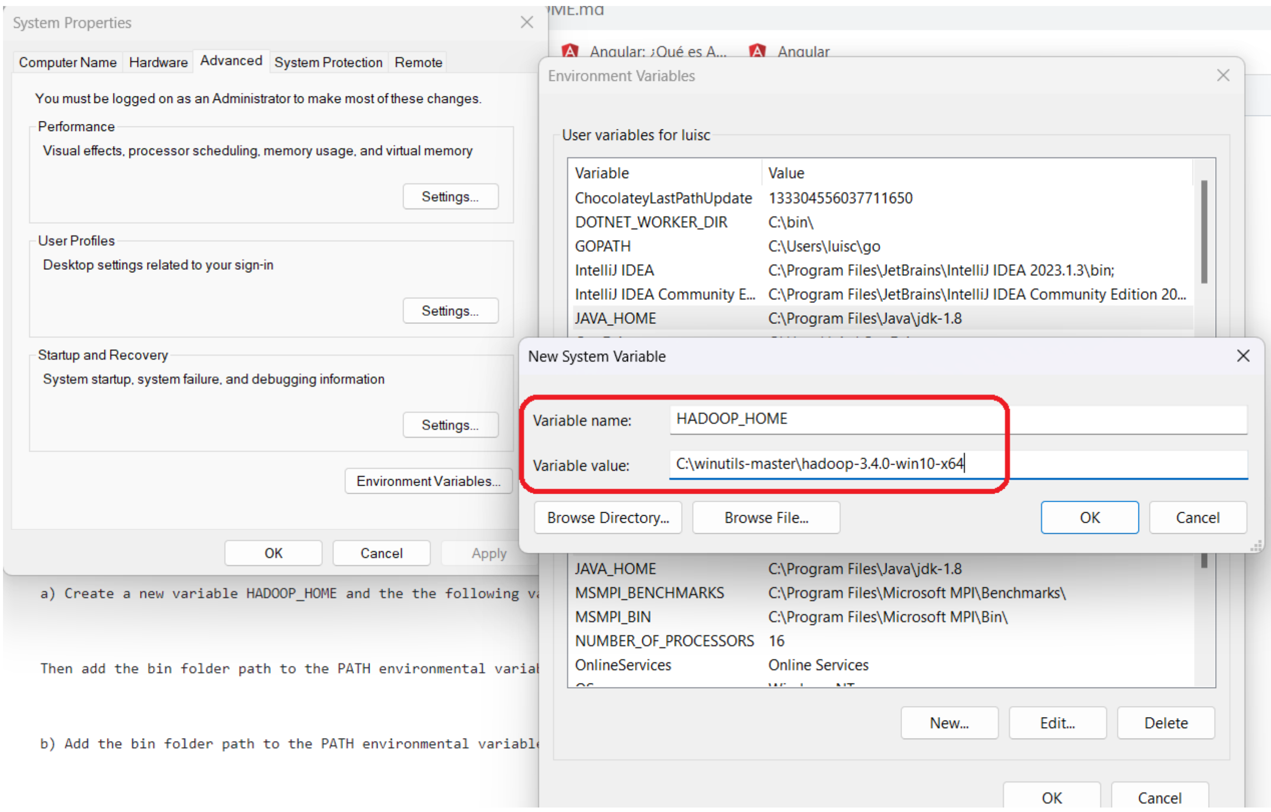


We place the winutils folder in C:

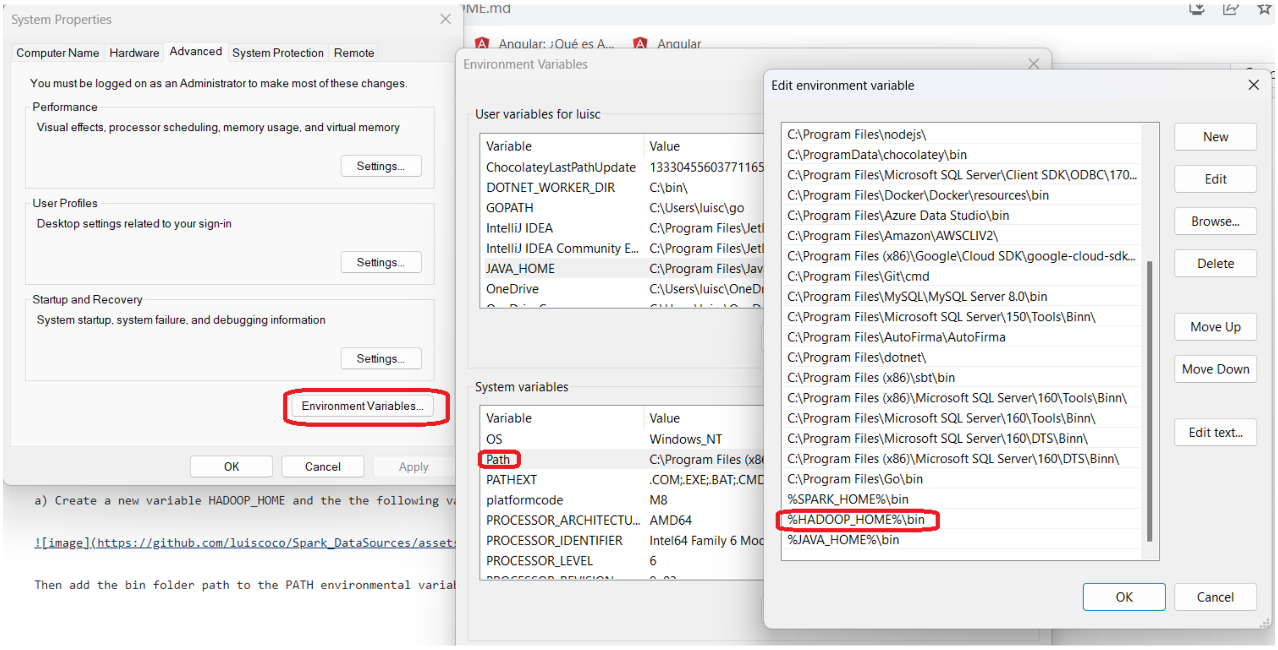


Set HADOOP_HOME environmental variable. There are two options:

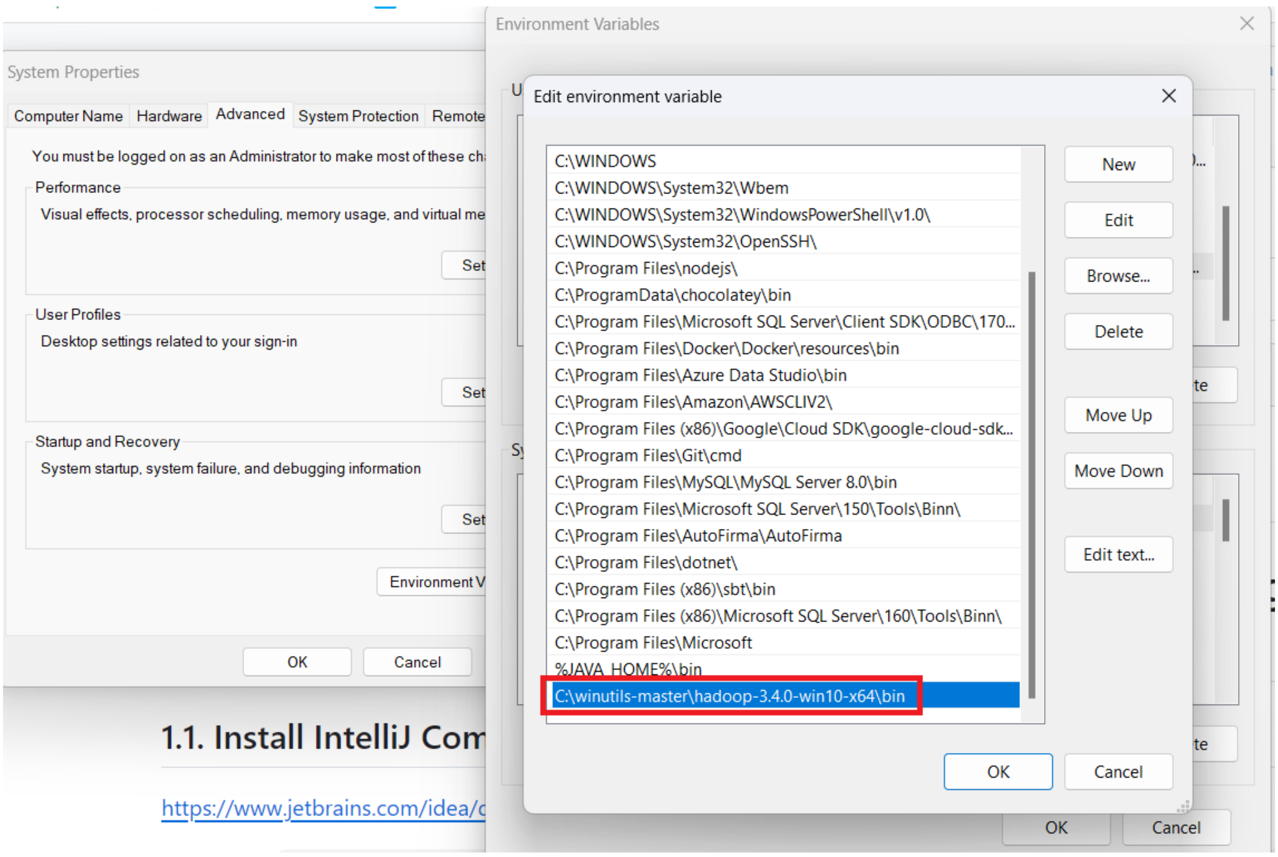
a) Create a new variable HADOOP_HOME and the the following value



Then add the bin folder path to the PATH environmental variable



b) Add the bin folder path to the PATH environmental variable.



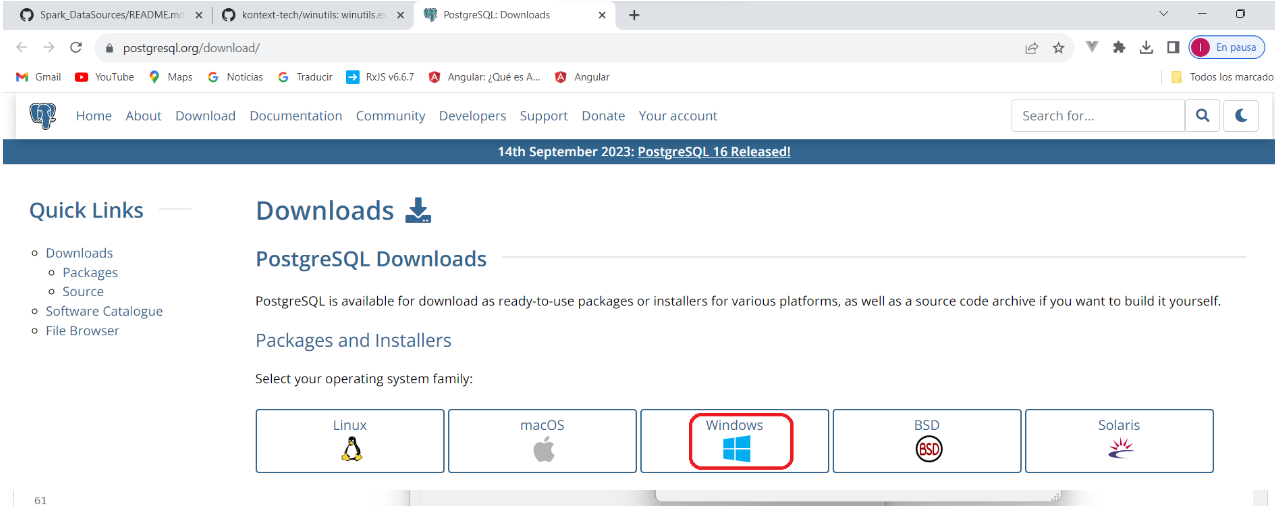
1.5. Install PostgreSQL and pgAdmin in you local laptop

How to Install PostgreSQL 15 on Windows 10 [2023 Update] Complete guide | pgAdmin 4

https://www.youtube.com/watch?v=0n41UTkOBb0

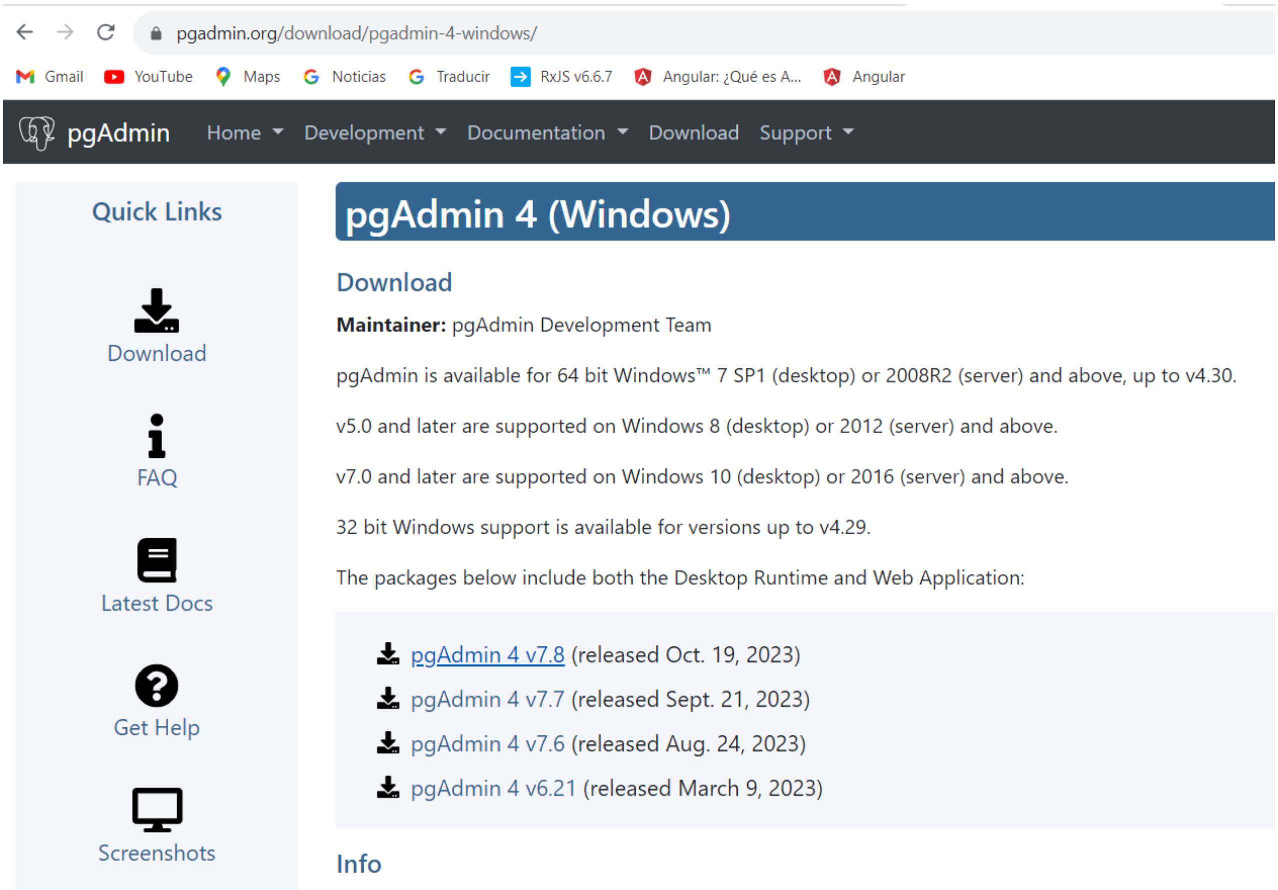
In the following URL you can downlaod postgreSQL

https://www.postgresql.org/download/



In the following URL you can download pgAdmin

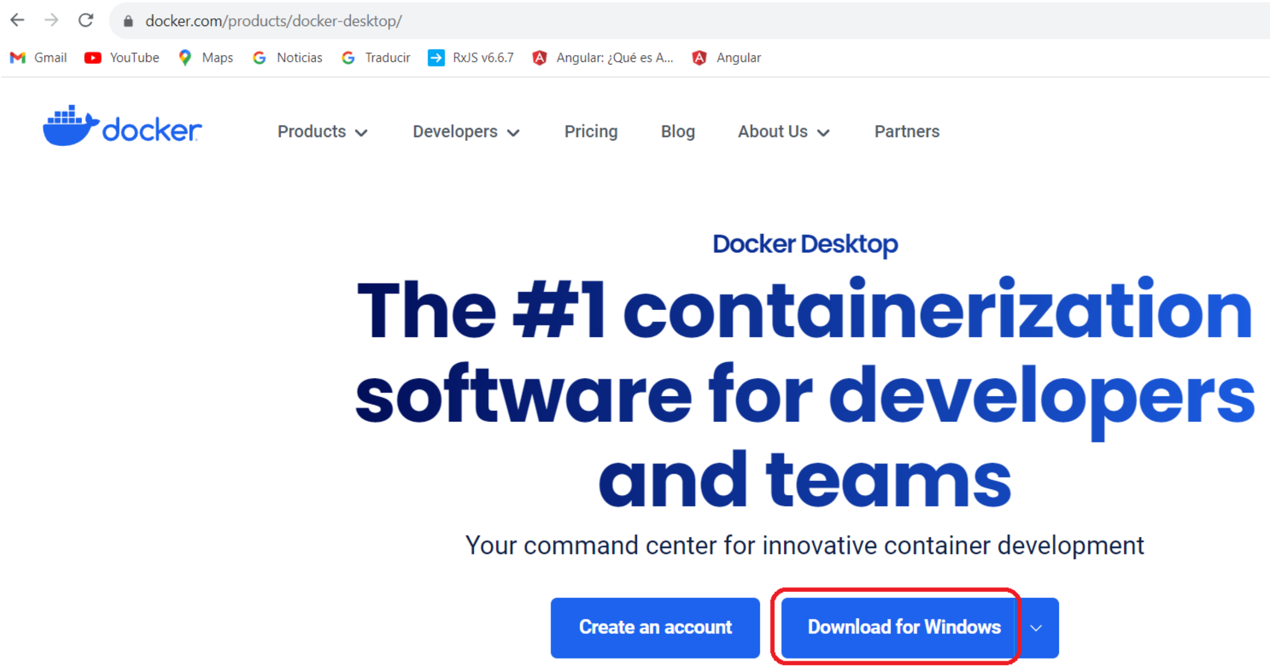
https://www.pgadmin.org/download/pgadmin-4-windows/



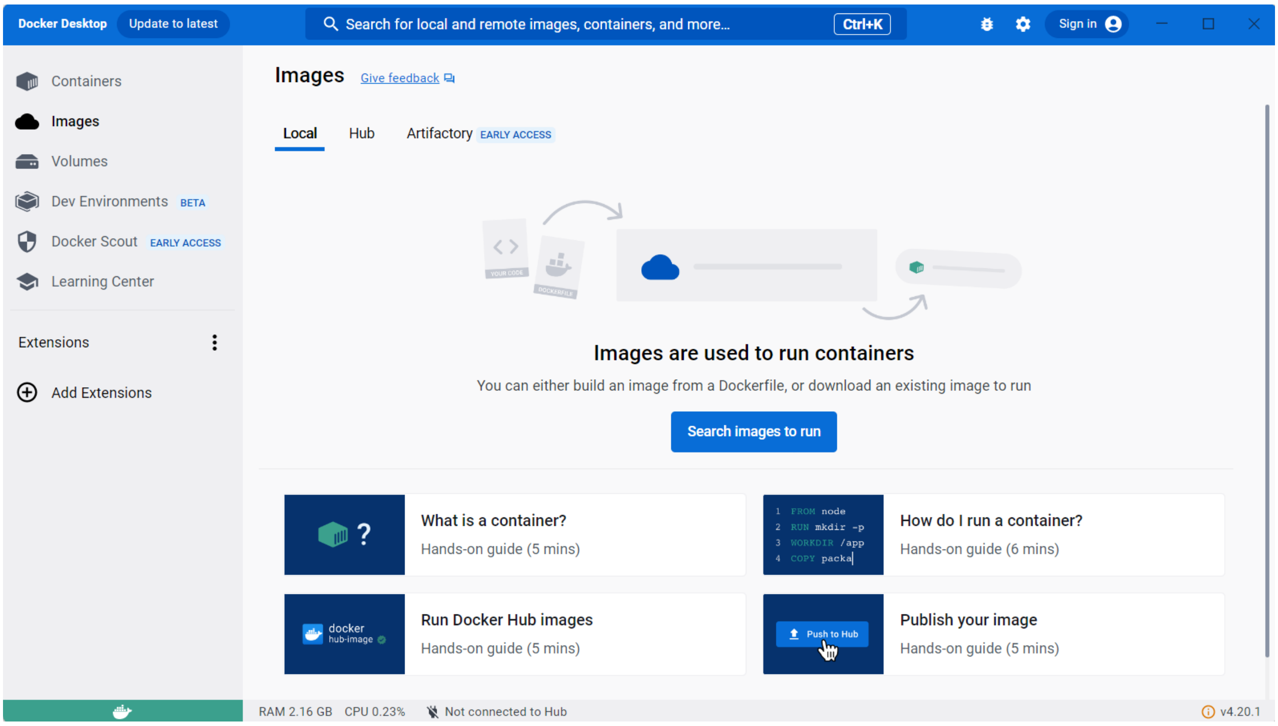
1.6. Run PostgreSQL in Docker container and create a database and populate a table

1. Download, install Docker Desktop

https://www.docker.com/products/docker-desktop/



Run Docker Desktop



2. Pull and run the PostgreSQL docker container.

For details see: https://hub.docker.com/_/postgres

Open command prompt as administrator and run the following command to run the PostgreSQL docker container.

```
docker run --name mypostgres -e POSTGRES_PASSWORD=password -p 5432:5432 -d postgres
```

Administrator: Command Prompt

```
C:\>docker run --name mypostgres -e POSTGRES_PASSWORD=password -p 5432:5432 -d postgres
Unable to find image 'postgres:latest' locally
latest: Pulling from library/postgres
a378f10b3218: Pull complete
2ebc5690e391: Pull complete
8fe57f734687: Pull complete
a2ddbb09cd9a: Pull complete
5a2499e87ab8: Pull complete
a45f5c4adf1b: Pull complete
178017fd978e: Pull complete
428dff1cb77d: Pull complete
4667364adfc4: Pull complete
4eea1f5281a9: Pull complete
369467411787: Pull complete
51184495a2bc: Pull complete
d3e246f01410: Pull complete
Digest: sha256:3d9ed832906091d609cfd6f283e79492ace01ba15866b21d8a262e8fd1cdfb55
Status: Downloaded newer image for postgres:latest
014275b34d8175f6f376b1bd481321cc007055ce4f8694ff108f59f2996b336d

C:\>_
```

This is a command to run a Docker container using the official PostgreSQL image from the Docker Hub. Let me break it down for you:

docker run: This is the command to run a Docker container.

--name mypostgres: This flag sets the name of the container to "mypostgres". You can use this name to refer to the container in other Docker commands.

-e POSTGRES_PASSWORD=password: This sets an environment variable within the container. In this case, it's setting the password for the PostgreSQL user to "password". You can change "password" to whatever you prefer.

-p 5432:5432: This flag maps the container's port 5432 (PostgreSQL's default port) to the host machine's port 5432. This means you can connect to the PostgreSQL database on the host machine using port 5432.

-d postgres: This specifies the Docker image to use. In this case, it's using the official PostgreSQL image from Docker Hub.

So, in summary, this Docker command is creating and running a PostgreSQL container named "mypostgres" with a specified password,

mapping the container's PostgreSQL port to the host machine's port, and running it in the background (-d flag).

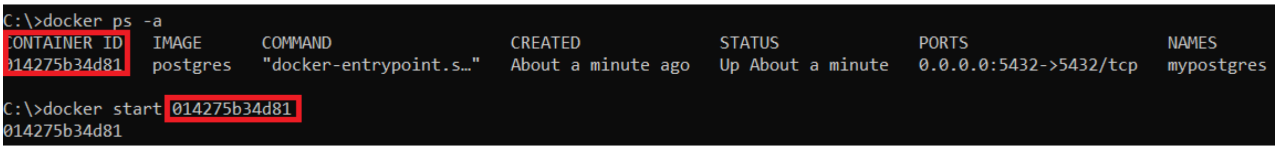
3. We check the postegreSQL docker container is runnng. We also copy the ContainerID to execute it later.

```
docker ps -a
```

```
C:\>docker ps -a
CONTAINER ID   IMAGE      COMMAND                  CREATED              STATUS             PORTS                    NAMES
014275b34d81   postgres   "docker-entrypoint.s…"   About a minute ago   Up About a minute  0.0.0.0:5432->5432/tcp   mypostgres
```

4. We execute the postgreSQL container.

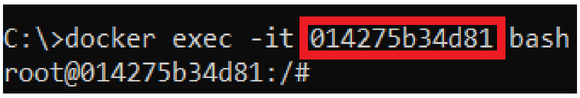
```
docker start dockerContainerID
```



```
C:\>docker ps -a
CONTAINER ID   IMAGE      COMMAND                  CREATED              STATUS              PORTS                    NAMES
014275b34d81   postgres   "docker-entrypoint.s…"   About a minute ago   Up About a minute   0.0.0.0:5432->5432/tcp   mypostgres

C:\>docker start 014275b34d81
014275b34d81
```

We enter in the command bash in the running PostgreSQL docker container

```
docker exec -it dockerContainerID bash
```



```
C:\>docker exec -it 014275b34d81 bash
root@014275b34d81:/#
```

5. We run this command

```
psql -U postgres -W
```

This is a command-line instruction for interacting with PostgreSQL, a popular open-source relational database management system. Let's break it down:

psql: This is the command-line client for PostgreSQL. It allows you to interact with the database using SQL queries and commands.

-U postgres: This specifies the username to connect to the database. In this case, it's set to "postgres." You're connecting as the user "postgres."

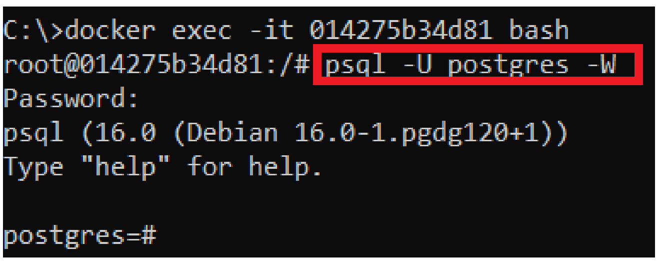
-W: This option prompts for the password. After entering the command, you'll be asked to enter the password for the specified user ("postgres" in this case).

It's a security measure to ensure that only authorized users can access the database.

So, when you run this command, it initiates a connection to a PostgreSQL database as the user "postgres" and prompts you for the password before allowing access.

6. In Password enter the password we set when running the docker container

```
Password: password
```



```
C:\>docker exec -it 014275b34d81 bash
root@014275b34d81:/# psql -U postgres -W
Password:
psql (16.0 (Debian 16.0-1.pgdg120+1))
Type "help" for help.

postgres=#
```

7. We create a new database called mydb

```
create database mydb;
```

```
postgres=# create database mydb;
CREATE DATABASE
```

8. For listing all the databases

```
\l
```

```
postgres=# \l
                                                          List of databases
   Name    |  Owner   | Encoding | Locale Provider |  Collate   |   Ctype    | ICU Locale | ICU Rules |   Access privileges
-----------+----------+----------+-----------------+------------+------------+------------+-----------+-----------------------
 mydb      | postgres | UTF8     | libc            | en_US.utf8 | en_US.utf8 |            |           |
 postgres  | postgres | UTF8     | libc            | en_US.utf8 | en_US.utf8 |            |           |
 template0 | postgres | UTF8     | libc            | en_US.utf8 | en_US.utf8 |            |           | =c/postgres          +
           |          |          |                 |            |            |            |           | postgres=CTc/postgres
 template1 | postgres | UTF8     | libc            | en_US.utf8 | en_US.utf8 |            |           | =c/postgres          +
           |          |          |                 |            |            |            |           | postgres=CTc/postgres
(4 rows)
```

9. Now we create a new table called t1 inside the mydb database

```
create table t1(id int);
```

```
postgres=# create table t1(id int);
CREATE TABLE
```

10. We select all rows and we check there is still no rows in the table

```
select * from t1;
```

```
postgres=# select * from t1;
 id
----
(0 rows)
```

11. We insert a row in the table

```
insert into t1 values(1);
```

```
postgres=# insert into t1 values(1);
INSERT 0 1
```

12. Again we run the select to see the rows items

```
select * from t1;
```

```
postgres=# select * from t1;
 id
----
  1
(1 row)
```

13. We create a new user "myuser" and set the password "mypass" for that user

```
create user myuser with encrypted password 'mypass';
```

```
postgres=# create user myuser with encrypted password 'mypass';
CREATE ROLE
```

14. We grant all privileges to the user for using the mydb database

```
grant all privileges on database mydb to myuser;
```

```
postgres=# grant all privileges on database mydb to myuser;
GRANT
```

15. We exit. Now we are in the root user

```
exit
```

```
postgres=# exit
root@014275b34d81:/# _
```

16. We clear the screen

```
clear
```

17. Connect to the database with the superuser

```
psql -U postgres -h localhost -p 5432 -d mydb
```

Try to create a table and insert a row running these commands:

```
Administrator: Command Prompt - docker  exec -it 014275b34d81 bash
root@014275b34d81:/# psql -U postgres -h localhost -p 5432 -d mydb
psql (16.0 (Debian 16.0-1.pgdg120+1))
Type "help" for help.

mydb=# create table t1(id int);
CREATE TABLE
mydb=# insert into t1 values(1);
INSERT 0 1
mydb=# _
```

18. If you cannot create the table then follow these steps:

Grant necessary privileges to the myuser on the public schema

```
GRANT USAGE, CREATE ON SCHEMA public TO myuser;
```

Connect as myuser

```
psql -U myuser -h localhost -p 5432 -d mydb
```

19. Now try creating the table again

```
create table t1(id int);
```

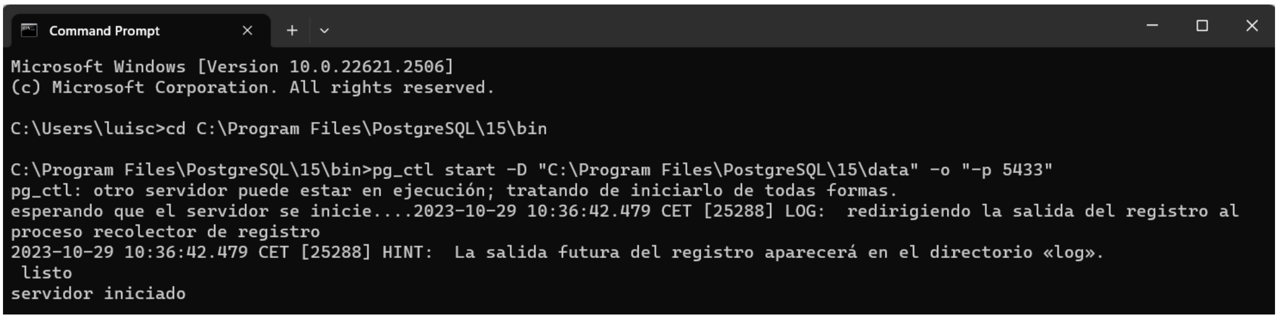
We insert a row in the table

```
insert into t1 values(1);
```

20. Now we check with pgAdmin 4 that the database mydb and the table exist with values

First we have to start the PostgreSQL server. Run this command to start the server:

```
C:\Program Files\PostgreSQL\15\bin>pg_ctl start -D "C:\Program Files\PostgreSQL\15\data" -o
5433"
```



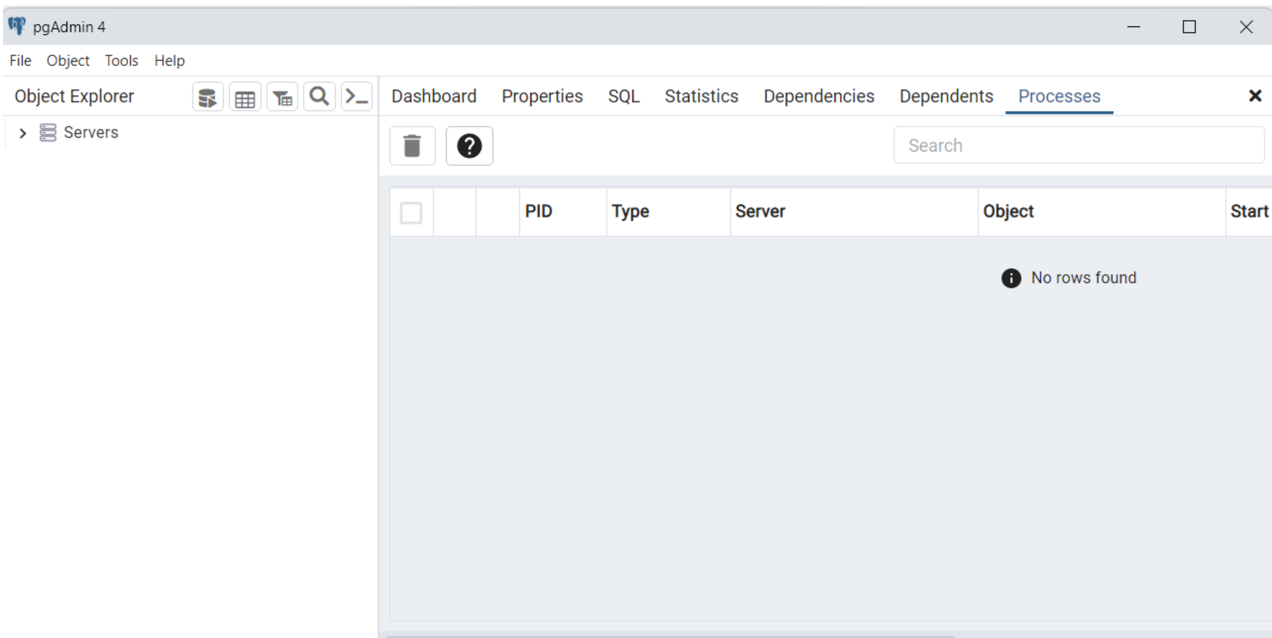
If you need to stop the server, you can use the following command:

```
C:\Program Files\PostgreSQL\15\bin>pg_ctl stop -D "C:\Program Files\PostgreSQL\15\data"
```

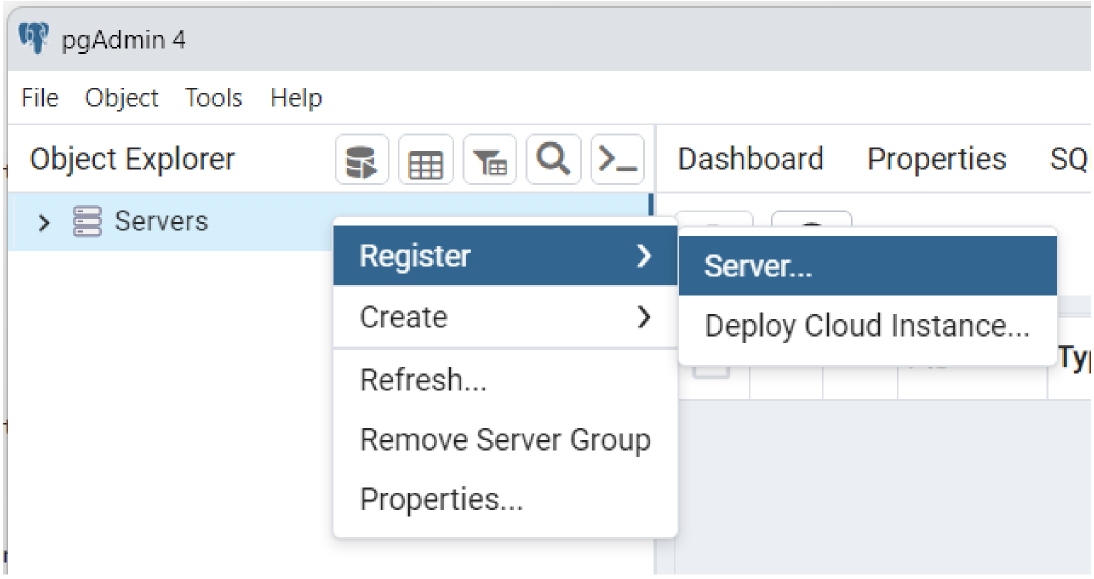
If you need to know the status

```
C:\Program Files\PostgreSQL\15\bin>pg_ctl status -D "C:\Program Files\PostgreSQL\15\data"
```

21. Now we run the application "pg Admin 4"

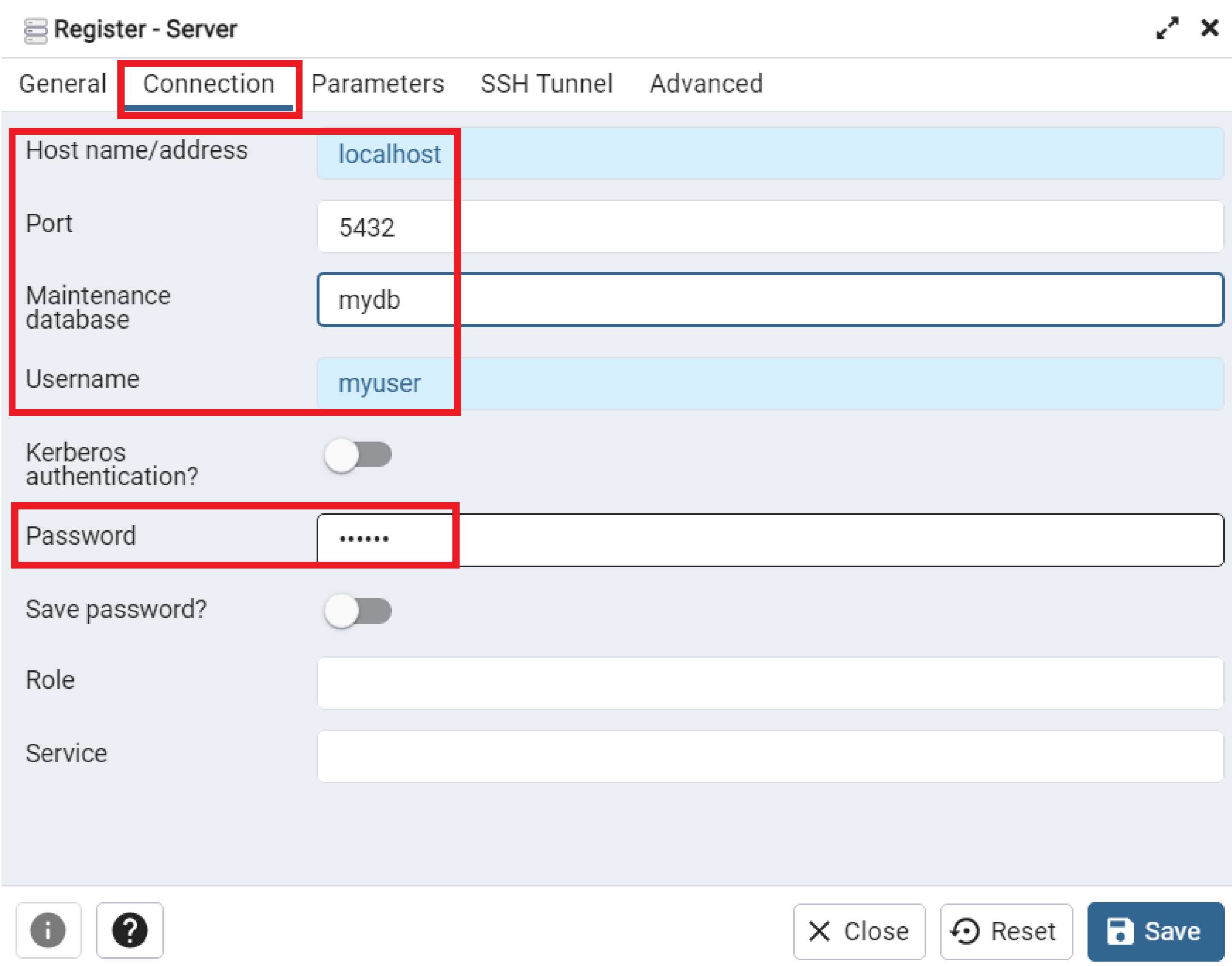


22. We right click on "Servers" and select the menu option "Register->Server..."

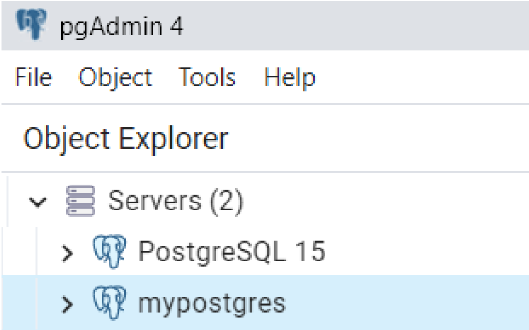


23. Set the server connection values

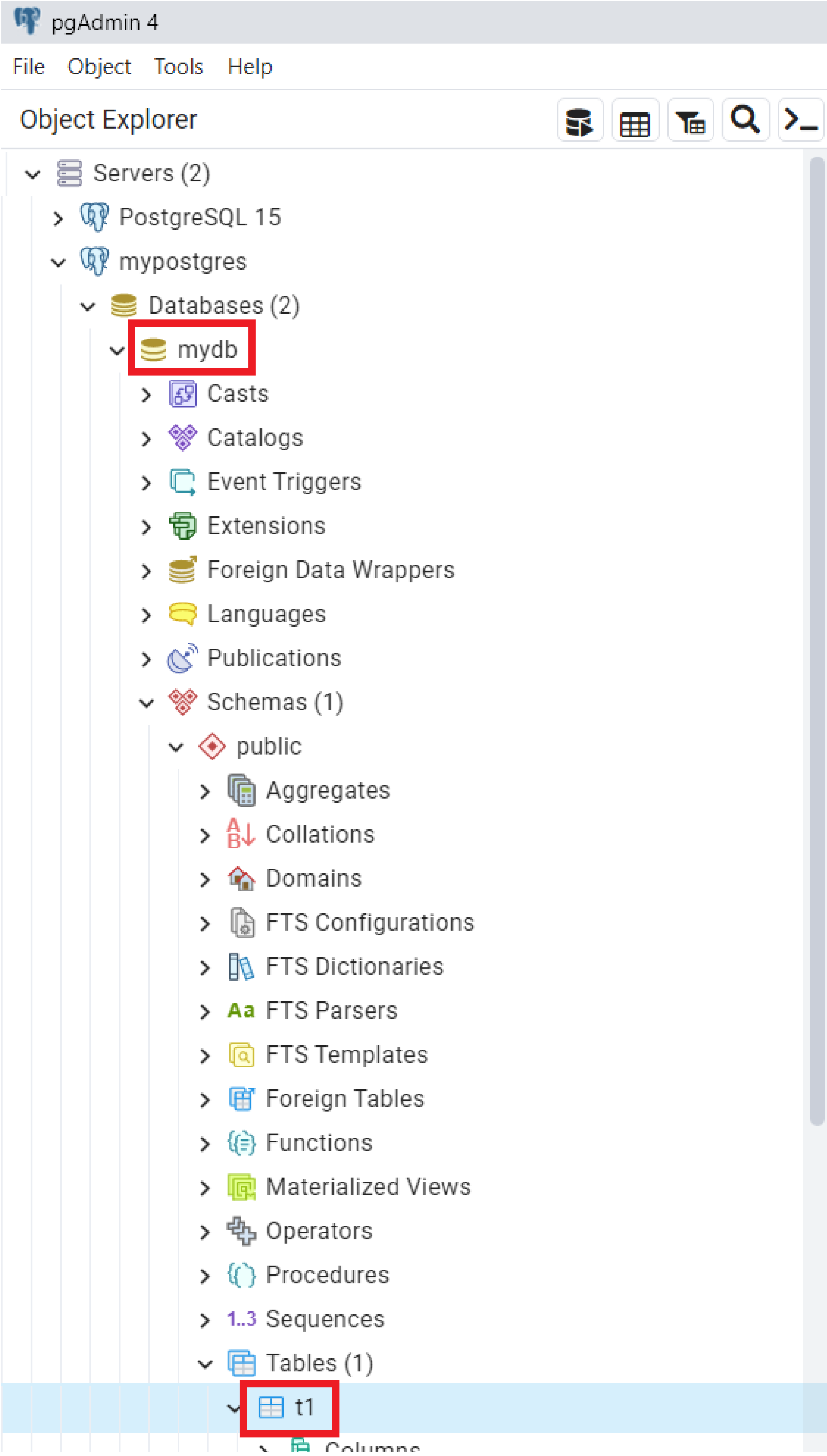
We enter the server name "localhost", the server port "5432", the database name "mydb", the username "myuser" and the user password "mypass".



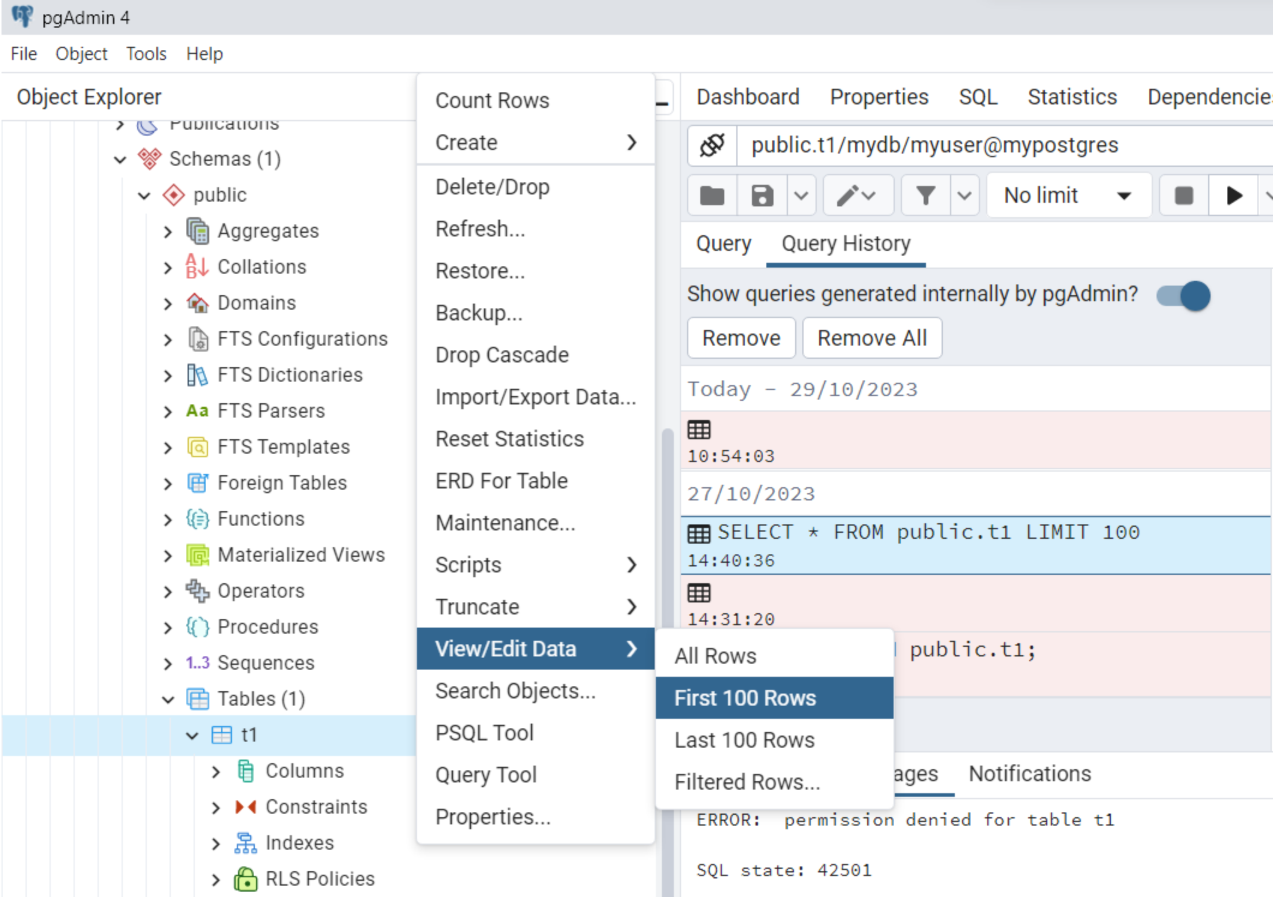
We also have to input the connection name "mypostgres"



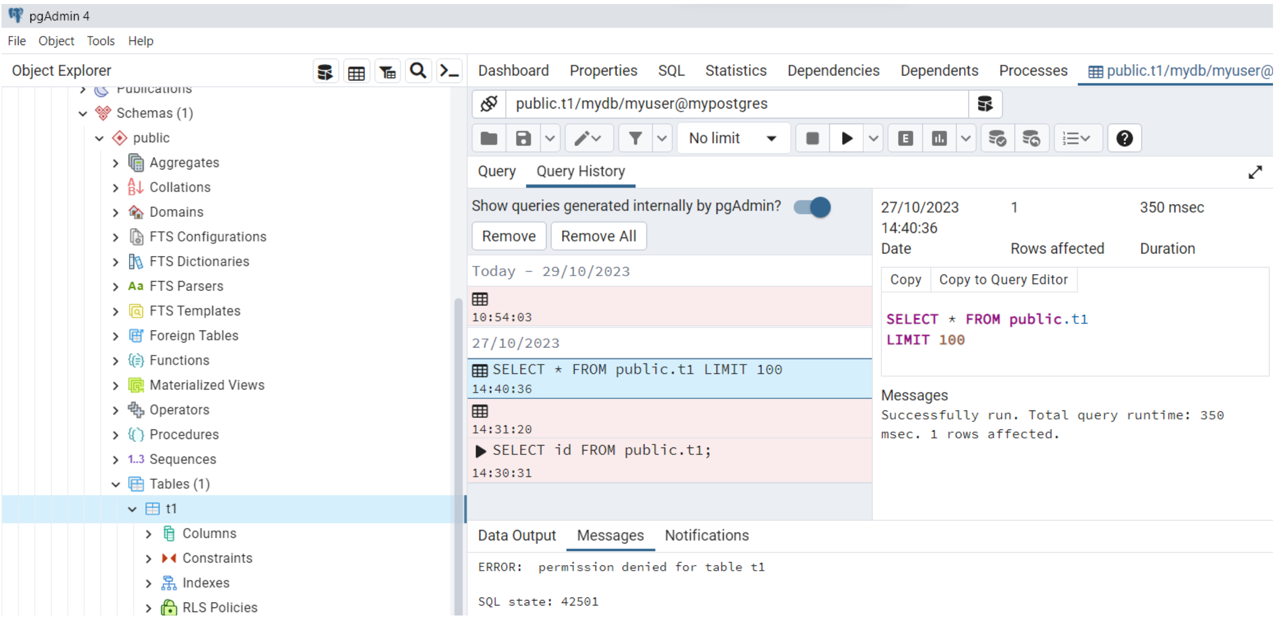
If you expand the tree you can see the database "mydb" and the table "t1"



You can run the select statement to see the first table rows



25. If any problem accessing to table t1 from PostgreSQL then:



It seems like the user myuser might not have the necessary privileges on the table t1.

Let's make sure myuser has the right permissions:

Connect to the database as the superuser:

```
psql -U postgres -h localhost -p 5432 -d mydb
```

```
C:\>docker exec -it 014275b34d81 bash
root@014275b34d81:/# psql -U postgres -h localhost -p 5432 -d mydb
psql (16.0 (Debian 16.0-1.pgdg120+1))
Type "help" for help.
```

Grant necessary privileges to myuser on the t1 table:

```
GRANT ALL PRIVILEGES ON TABLE t1 TO myuser;
```

Exit the PostgreSQL prompt:

```
\q
```

Now, connect to the database as myuser:

```
psql -U myuser -h localhost -p 5432 -d mydb
```

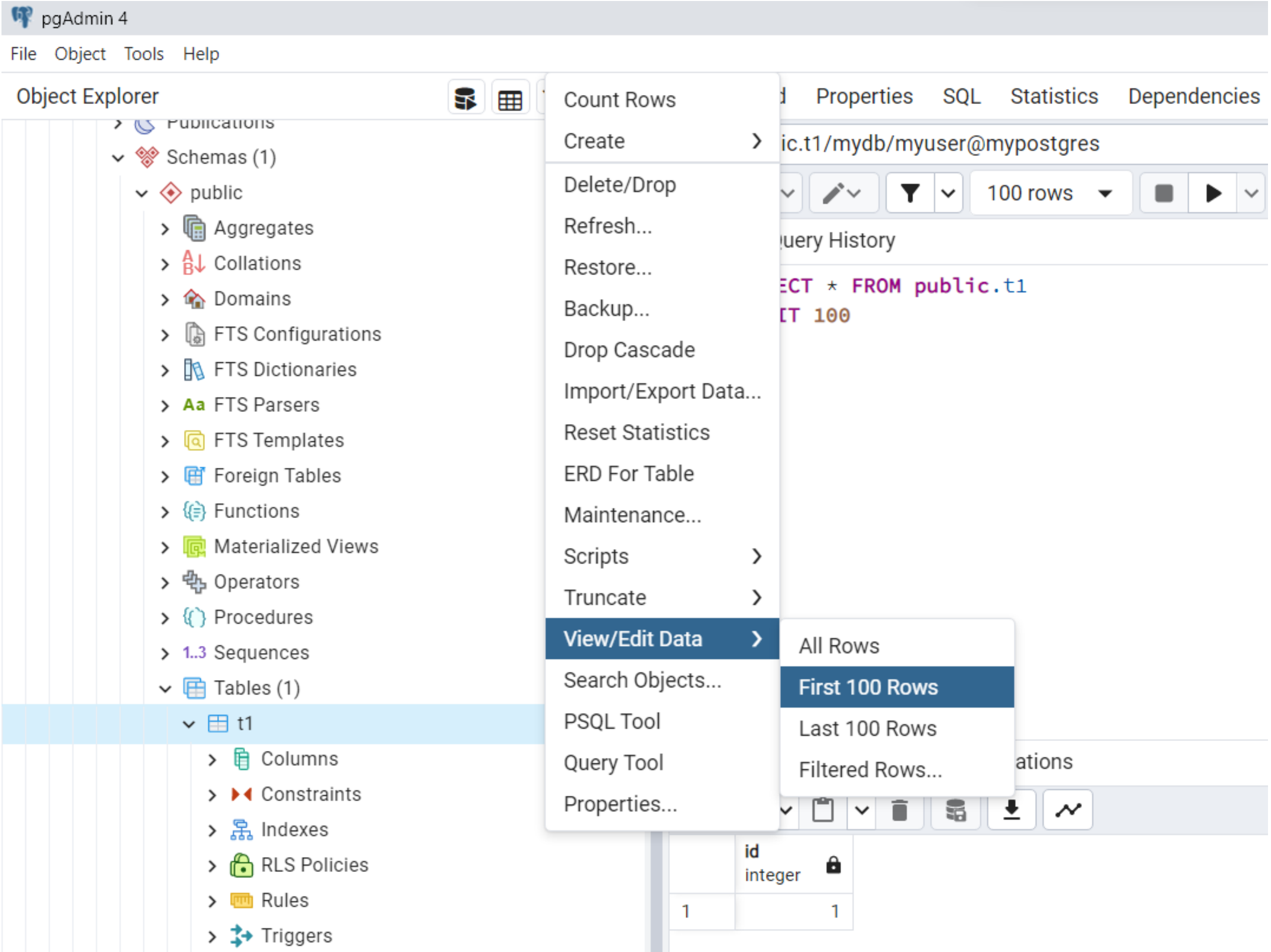
Try running the SELECT query again:

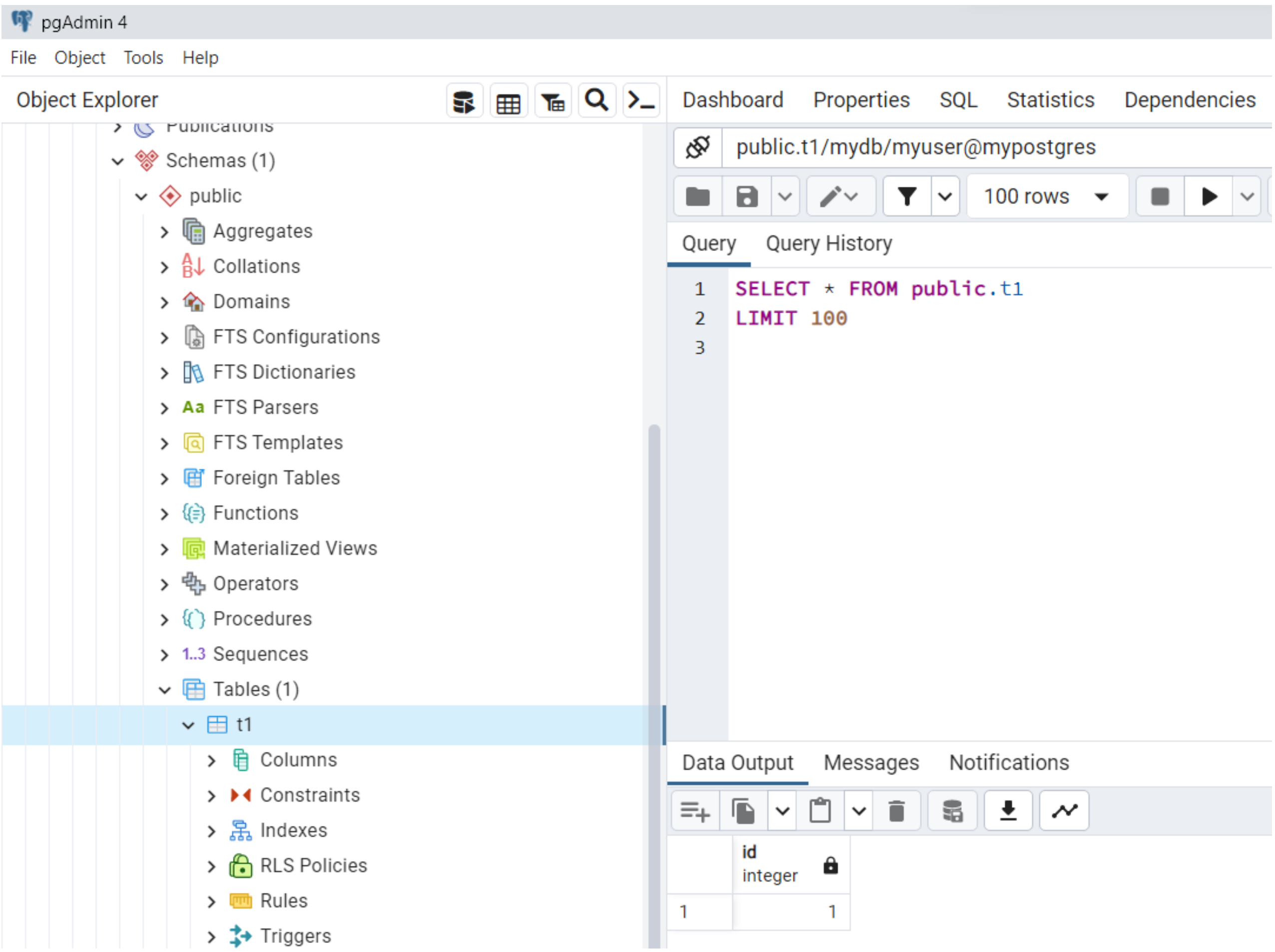
```
SELECT id FROM public.t1;
```

```
C:\>docker exec -it 014275b34d81 bash
root@014275b34d81:/# psql -U postgres -h localhost -p 5432 -d mydb
psql (16.0 (Debian 16.0-1.pgdg120+1))
Type "help" for help.

mydb=# GRANT ALL PRIVILEGES ON TABLE t1 TO myuser;
GRANT
mydb=# \q
root@014275b34d81:/# psql -U myuser -h localhost -p 5432 -d mydb
psql (16.0 (Debian 16.0-1.pgdg120+1))
Type "help" for help.

mydb=> SELECT id FROM public.t1;
 id
----
  1
(1 row)
```

22. Now connect to the PostgreSQL database and table with pgAdmin 4

We

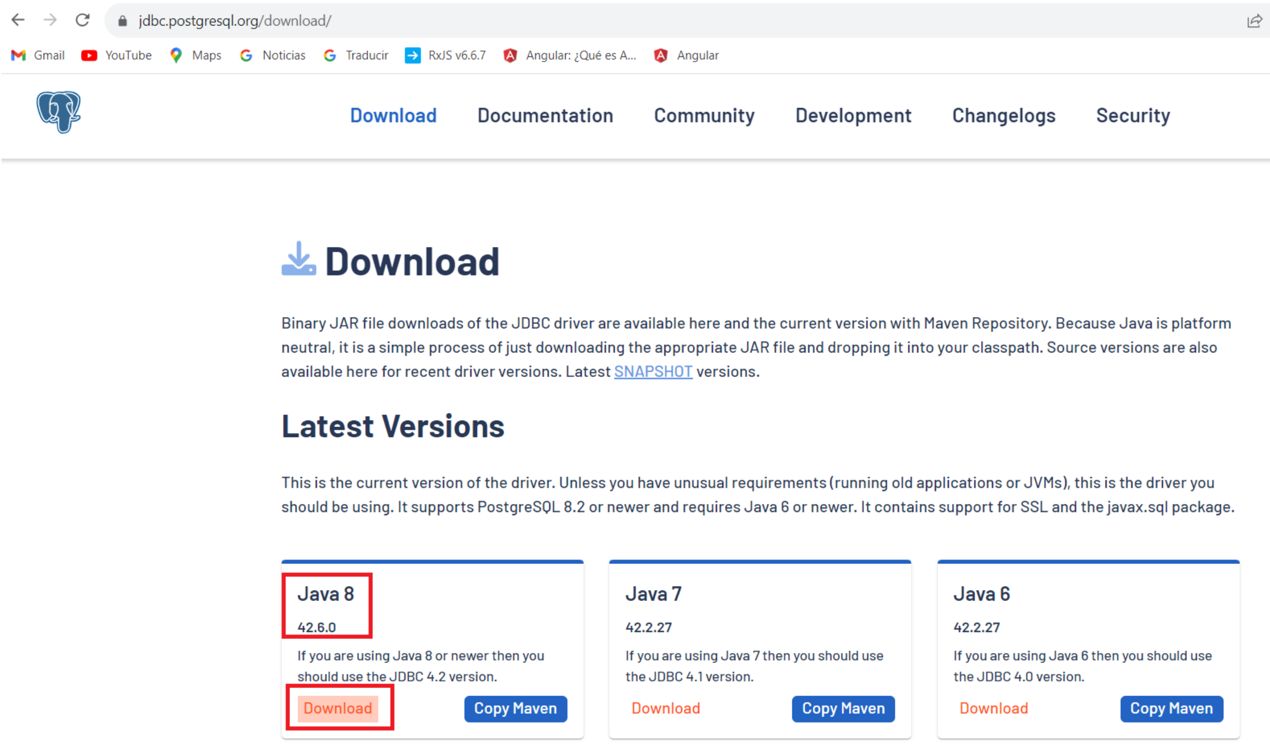

pgAdmin 4
File Object Tools Help
Object Explorer
Count Rows
Create
Delete/Drop
Refresh...
Restore...
Backup...
Drop Cascade
Import/Export Data...
Reset Statistics
ERD For Table
Maintenance...
Scripts
Truncate
View/Edit Data
Search Objects...
PSQL Tool
Query Tool
Properties...
All Rows
First 100 Rows
Last 100 Rows
Filtered Rows...
Properties SQL Statistics Dependencies
ic.t1/mydb/myuser@mypostgres
100 rows
Schemas (1)
public
Aggregates
Collations
Domains
FTS Configurations
FTS Dictionaries
FTS Parsers
FTS Templates
Foreign Tables
Functions
Materialized Views
Operators
Procedures
Sequences
Tables (1)
t1
Columns
Constraints
Indexes
RLS Policies
Rules
Triggers
id
integer

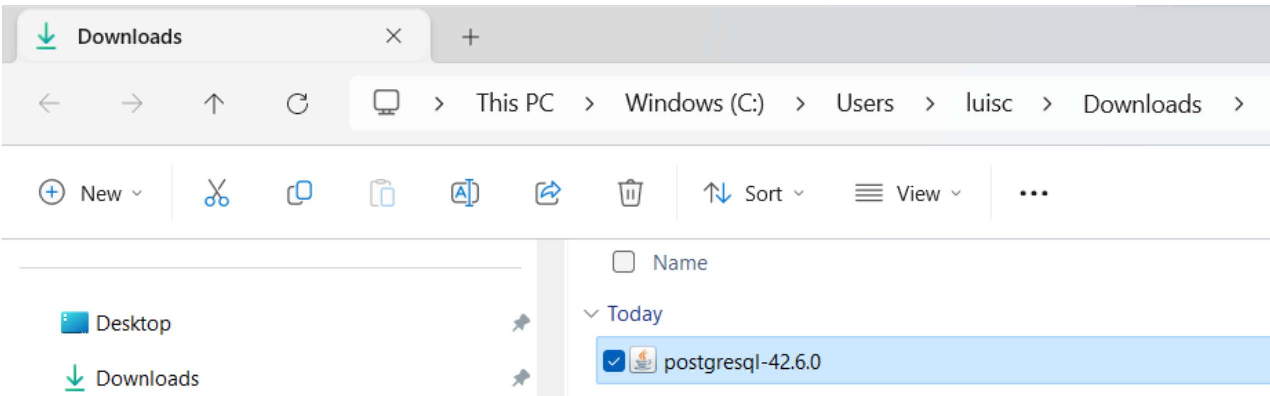

pgAdmin 4
File Object Tools Help
Object Explorer
Dashboard Properties SQL Statistics Dependencies
public.t1/mydb/myuser@mypostgres
100 rows
Query Query History
SELECT * FROM public.t1
LIMIT 100
Schemas (1)
public
Aggregates
Collations
Domains
FTS Configurations
FTS Dictionaries
FTS Parsers
FTS Templates
Foreign Tables
Functions
Materialized Views
Operators
Procedures
Sequences
Tables (1)
t1
Columns
Constraints
Indexes
RLS Policies
Rules
Triggers
Data Output Messages Notifications
id
integer

1.7. Install PostgreSQL JDBC driver in Spark folder

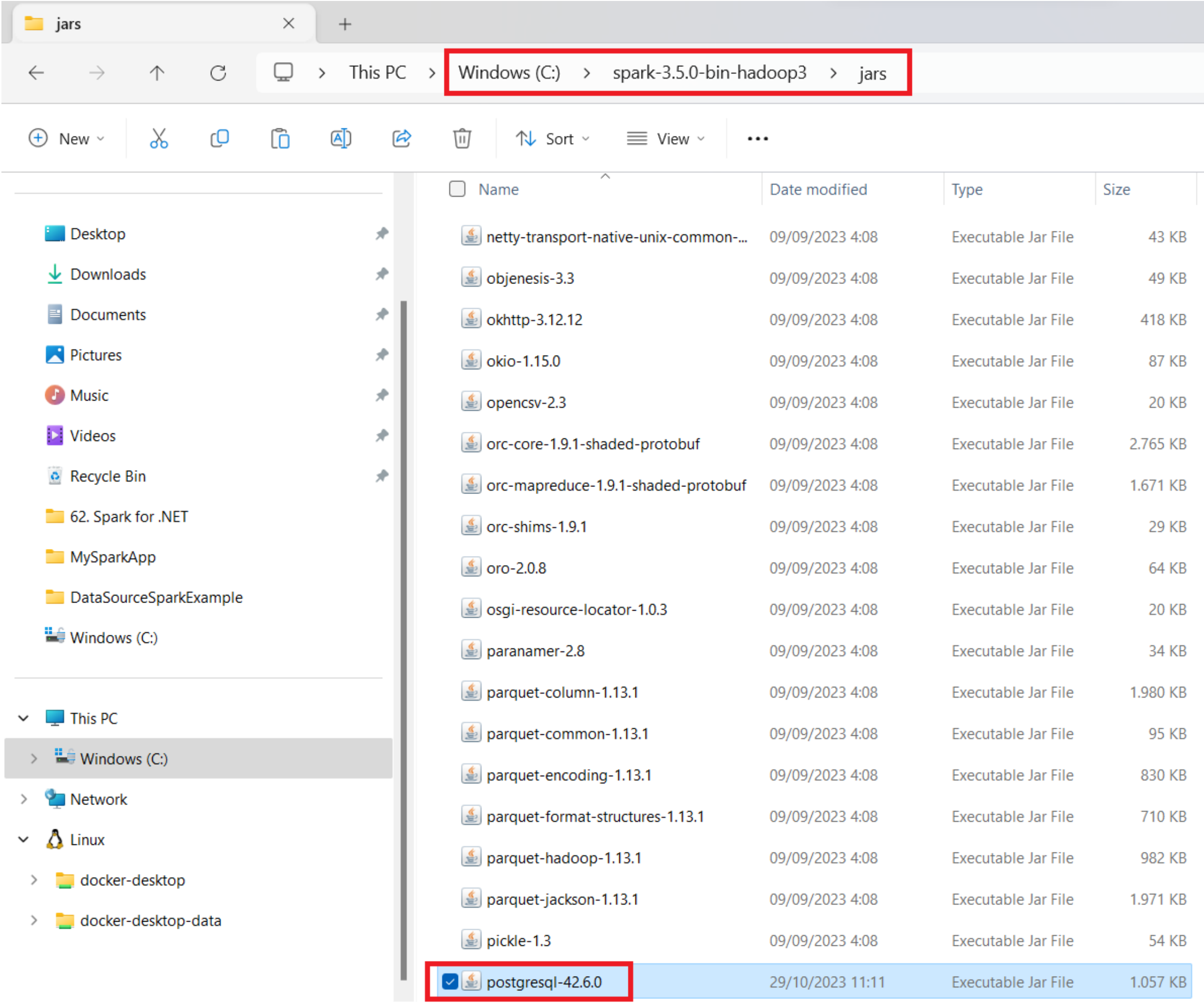
Download the PostgreSQL JDBC driver from internet

https://jdbc.postgresql.org/download/





Place the jar file "postgresql-42.6.0.jar" inside the path spark jars folder: C:\spark-3.5.0-bin-hadoop3\jars



2. Run the application in IngelliJ

2.1. Prerequisites

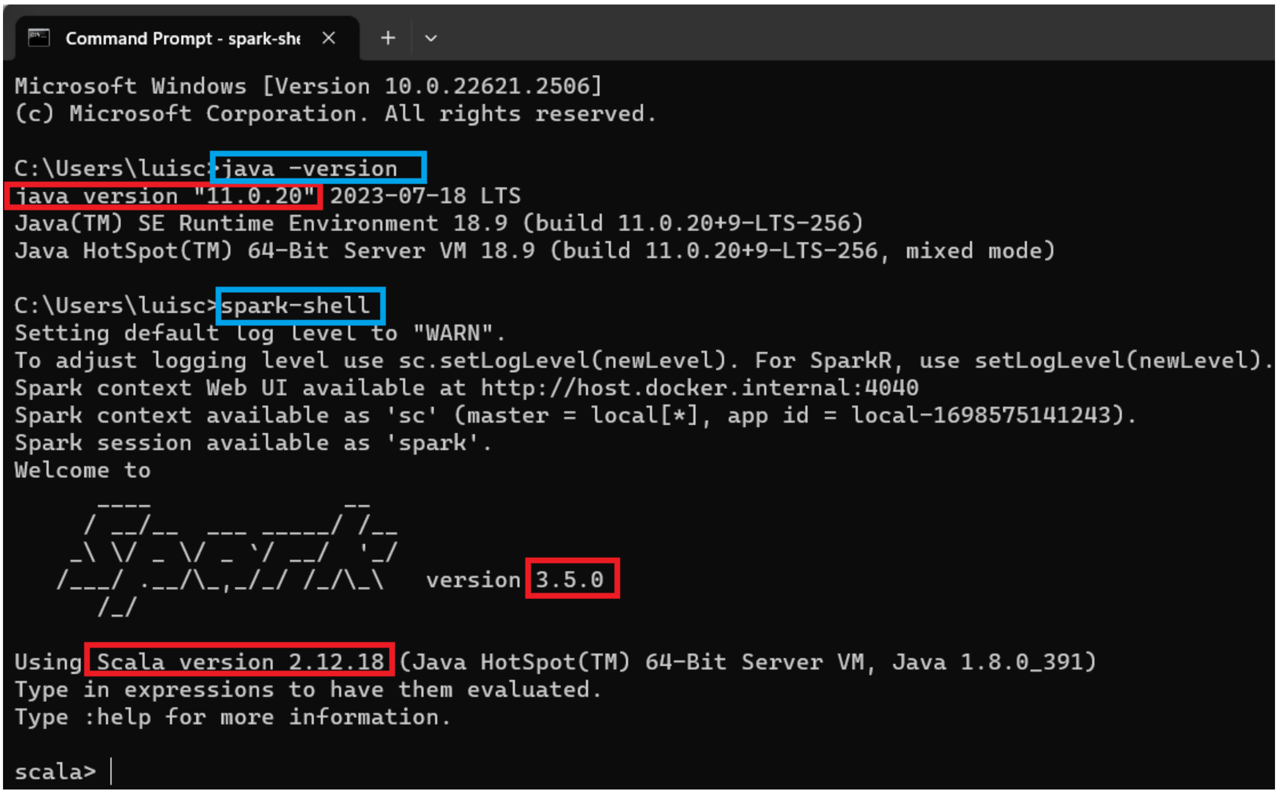
Before running IntelliJ we have to check the Java and Spark installations.

To see the Java version open a command prompt and run the command:

```
java -version
```

Then we also run the command:

```
spark-shell
```



We copy the Java, Spark and Scala versions in order to use this data later when creating out new Spark Scala project in IntelliJ.

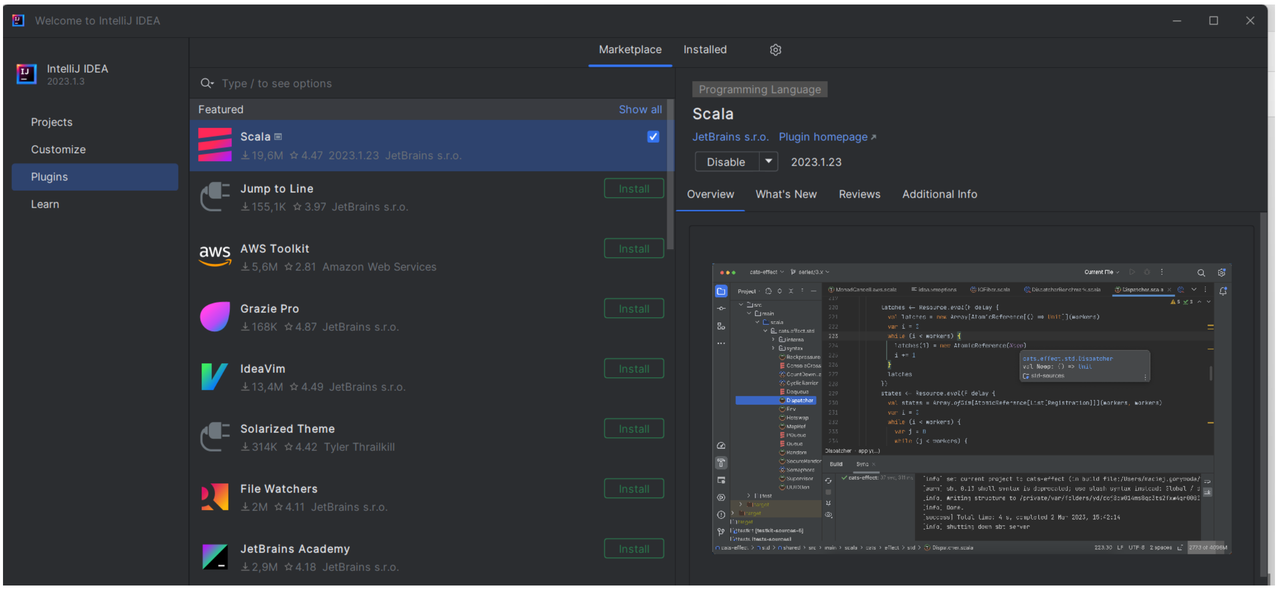
Java version: 11

Spark version: 3.5.0

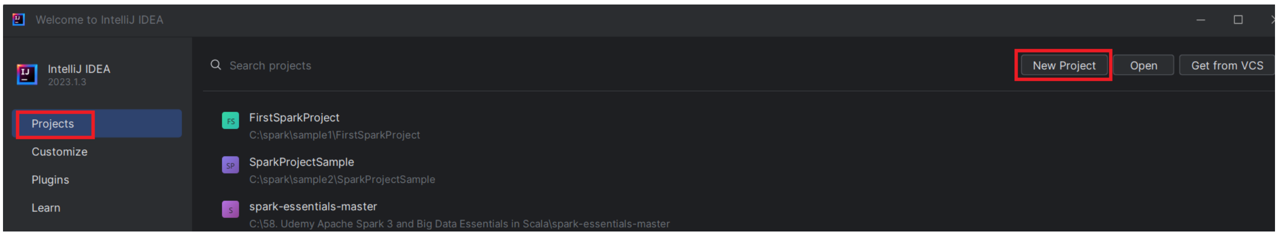
Scala version: 2.12.18

2.2. Run IngelliJ Community IDE.

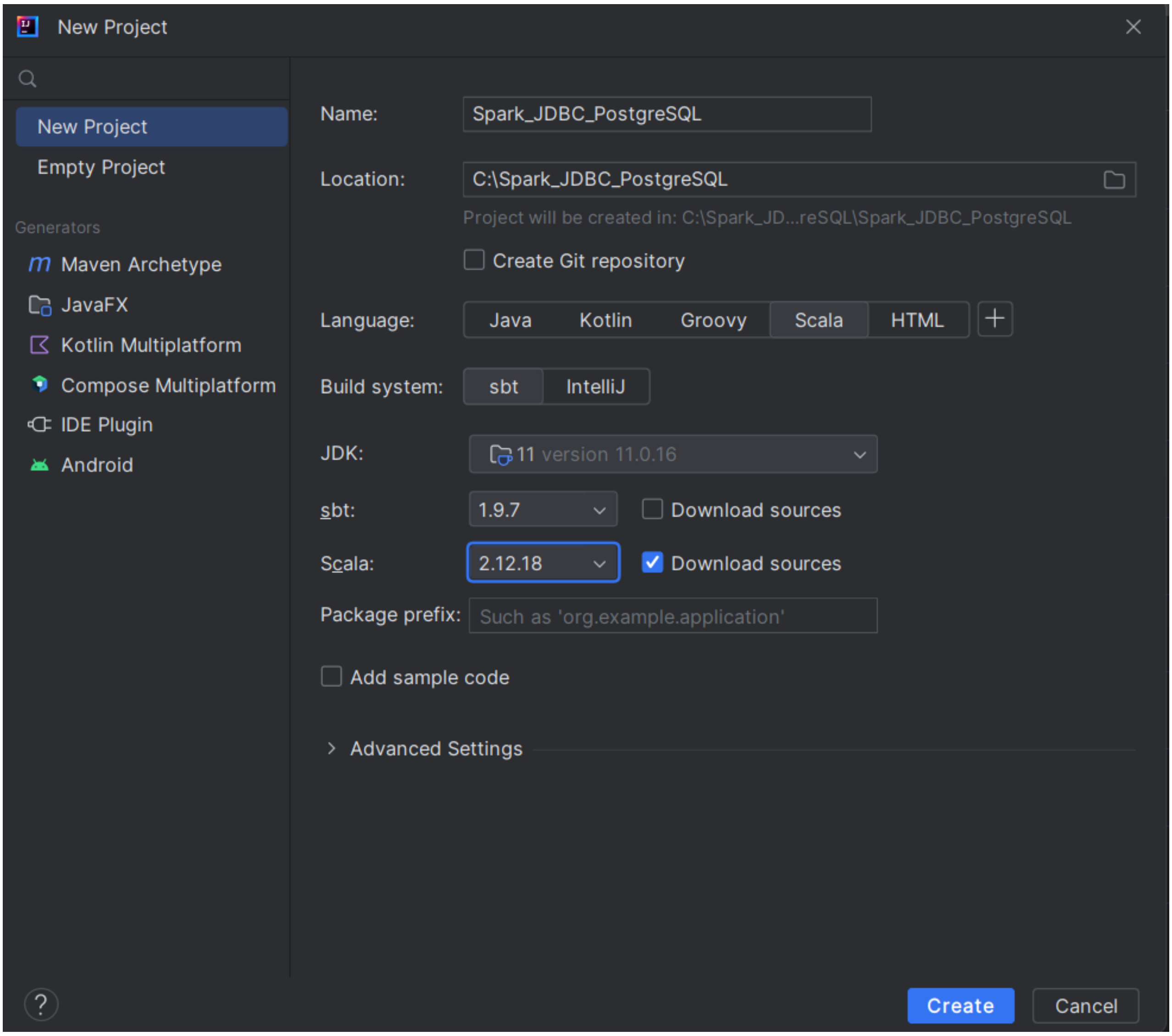
Install the "Scala" plugin



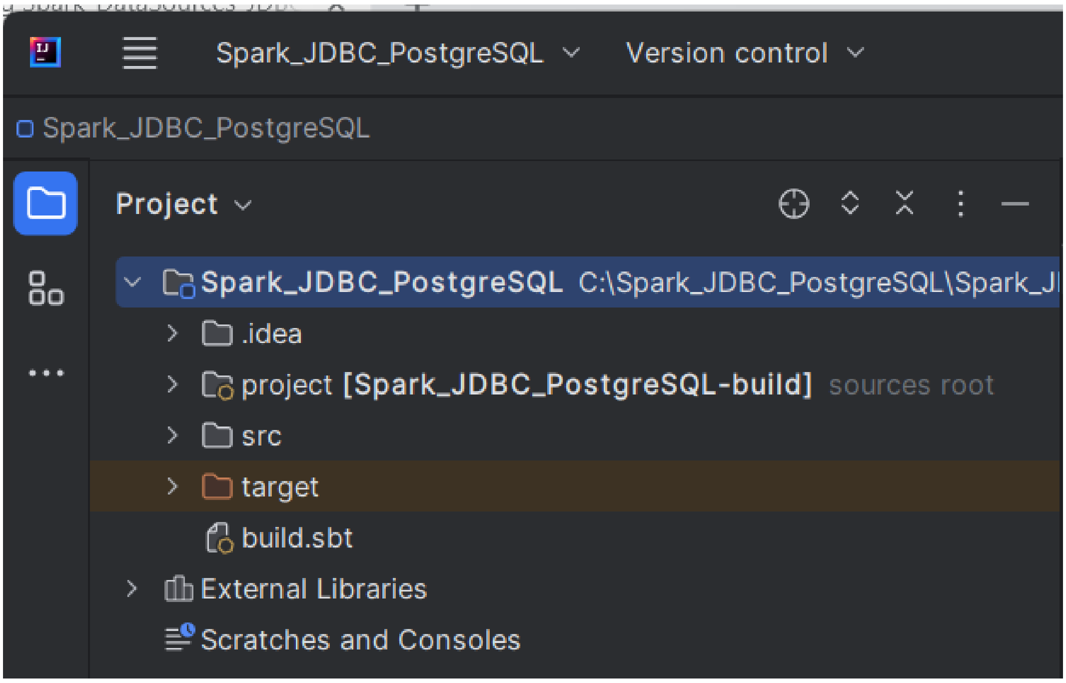
Create a new project



Ente the new project input data

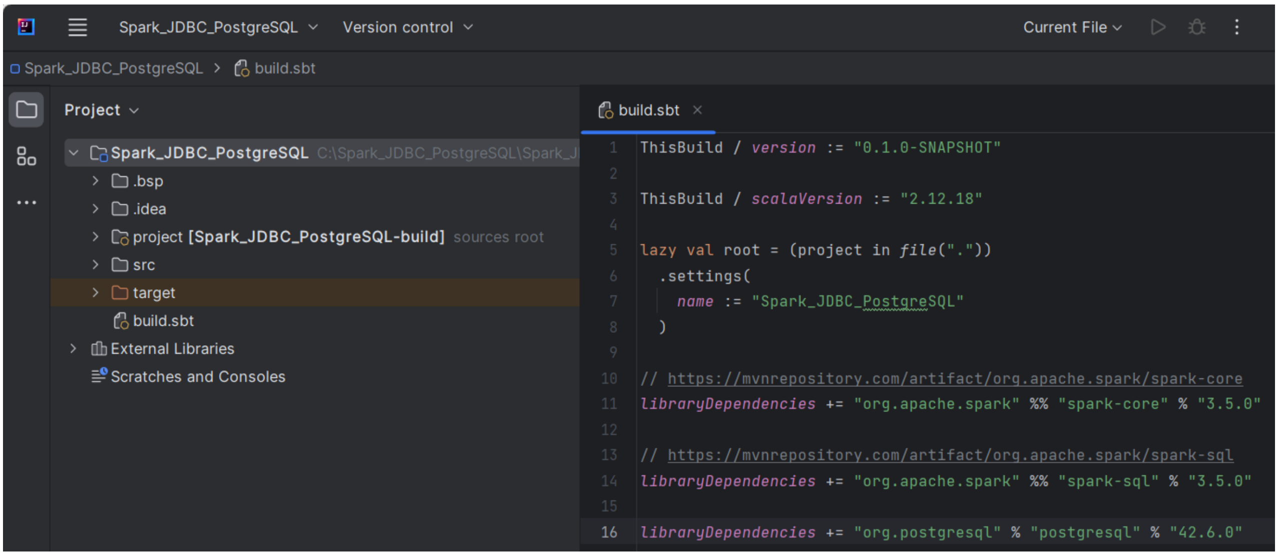


Then we can see the new project in IntelliJ

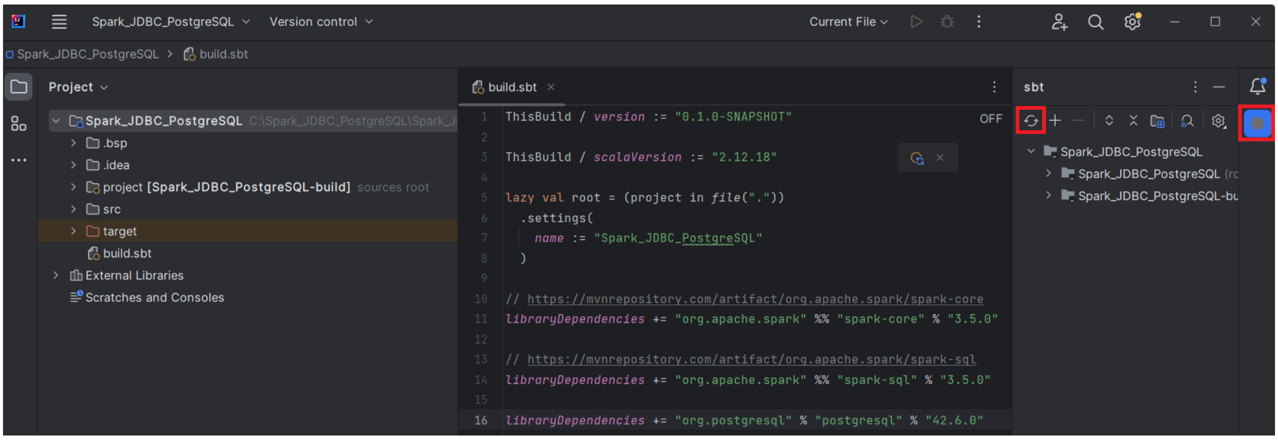


2.3. We input the bild.sbt file source code

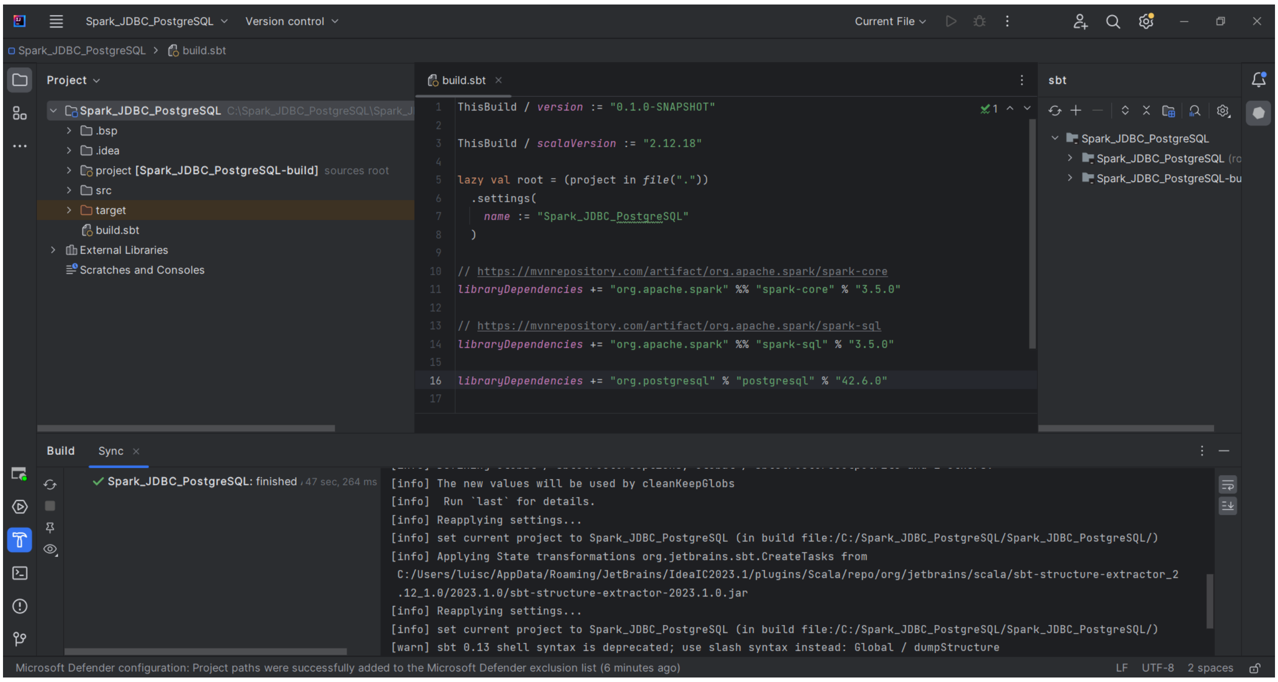
```
ThisBuild / version := "0.1.0-SNAPSHOT"

ThisBuild / scalaVersion := "2.12.18"

lazy val root = (project in file("."))
  .settings(
    name := "Spark_JDBC_PostgreSQL"
  )

// https://mvnrepository.com/artifact/org.apache.spark/spark-core
libraryDependencies += "org.apache.spark" %% "spark-core" % "3.5.0"

// https://mvnrepository.com/artifact/org.apache.spark/spark-sql
libraryDependencies += "org.apache.spark" %% "spark-sql" % "3.5.0"

libraryDependencies += "org.postgresql" % "postgresql" % "42.6.0"
```



Then we press the sbt button in the righ hand side menu and the reload project button

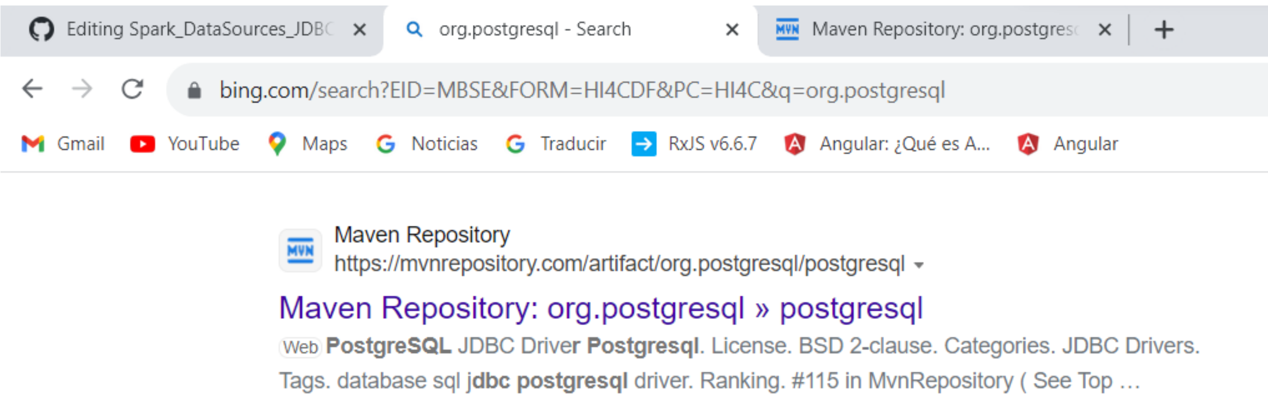


After reloading the project dependencies we will see this result

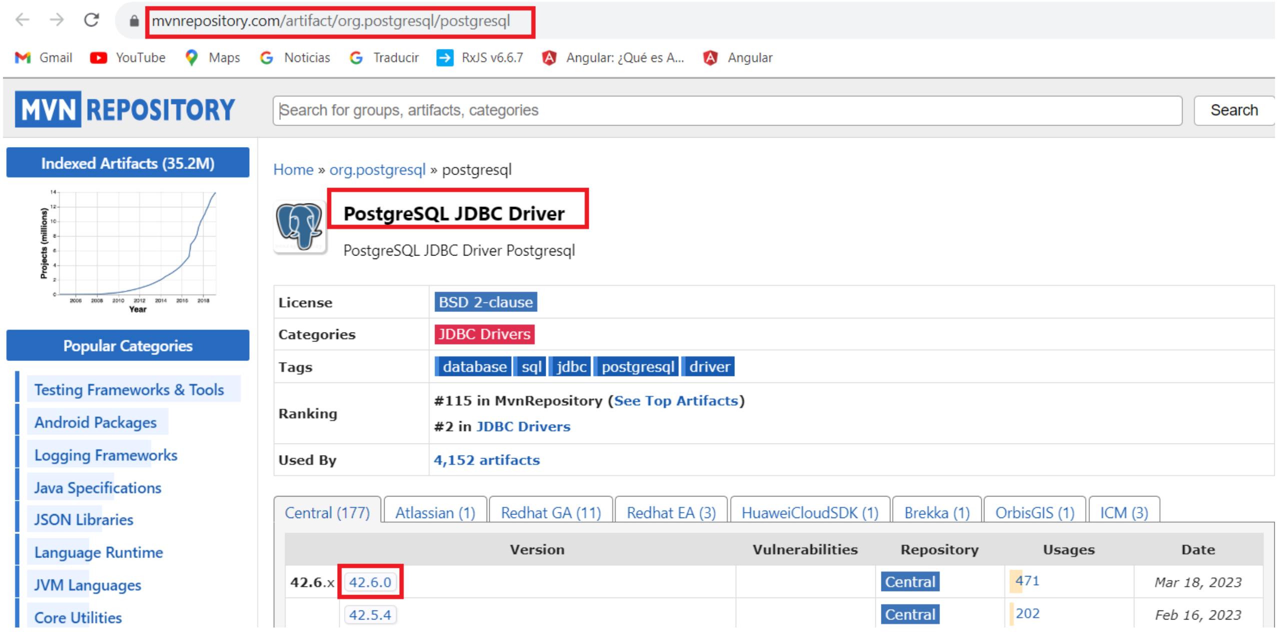


IMPORTANT NOTE: How to look for libraries dependencies in internet

In **Maven repository** we can find the dependencies in internet. For example if we are looking for the "org.postgresql"

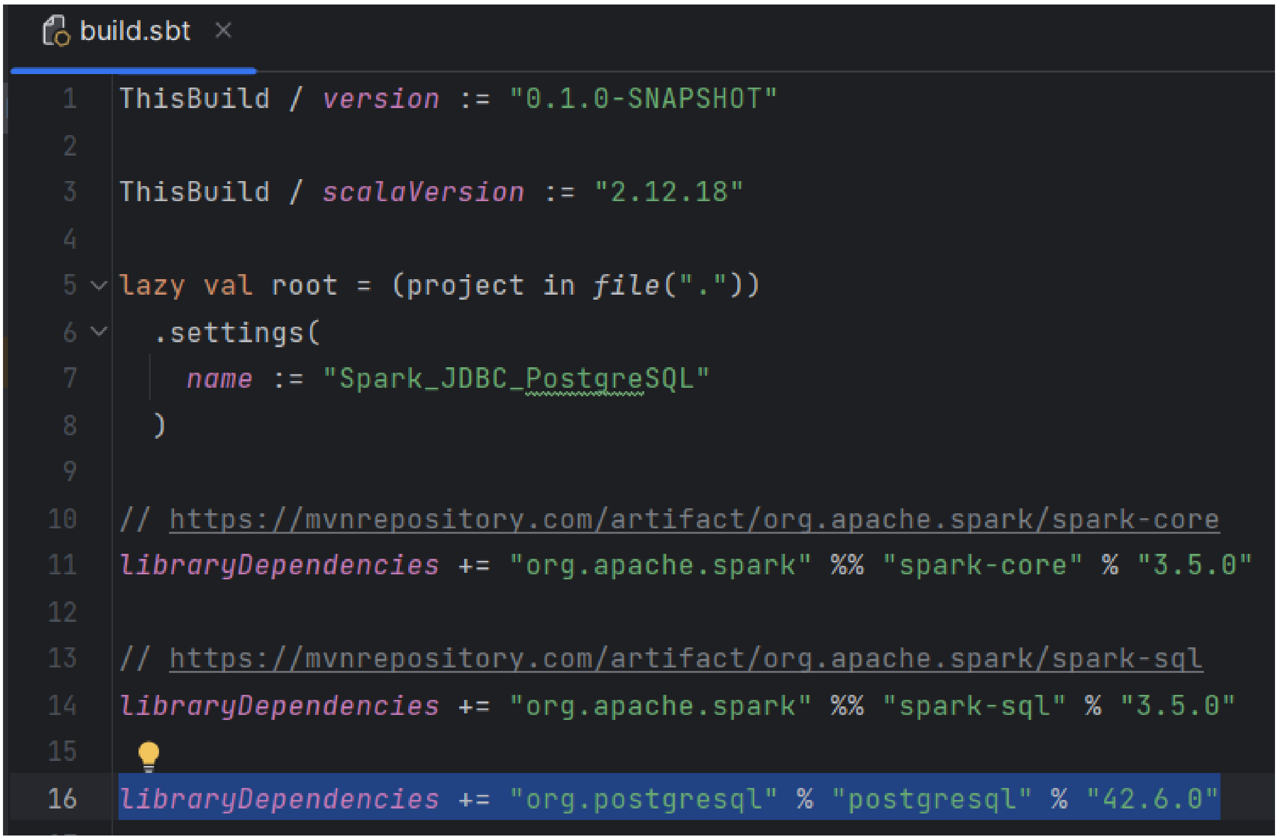


We press in the version link, in this case we press in the 42.6.0 link



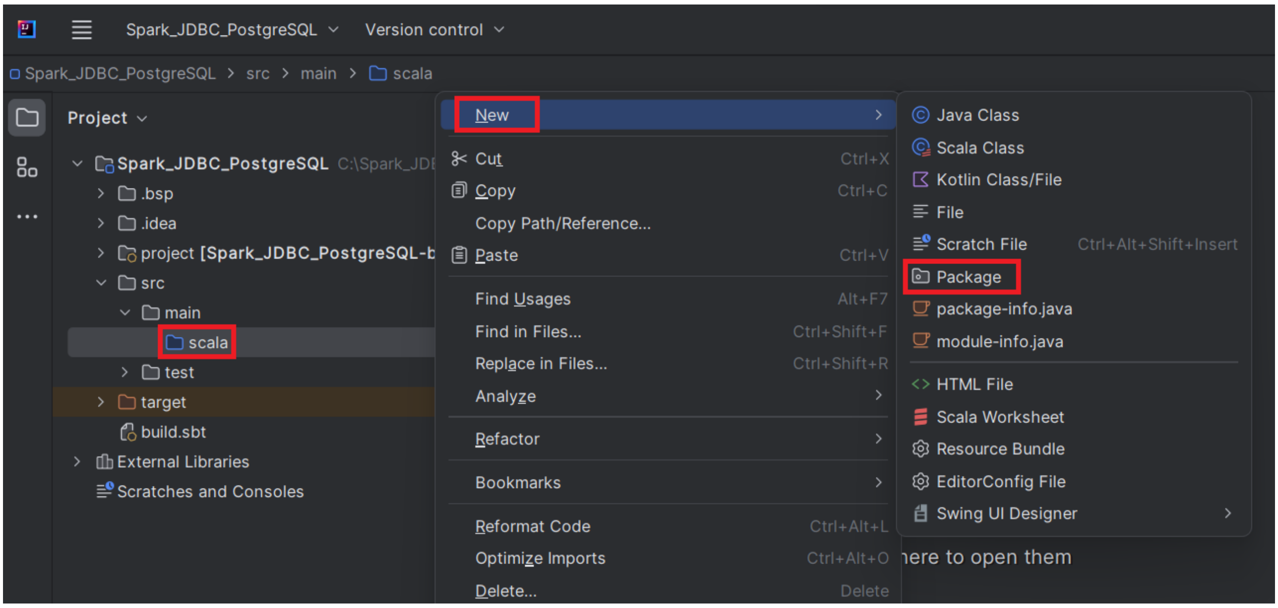
And then we select the SBT tab an copy the dependency reference in our build.sbt file

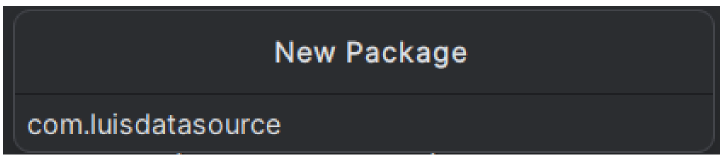
Then we go to the build.sbt file and we copy the library dependency code:

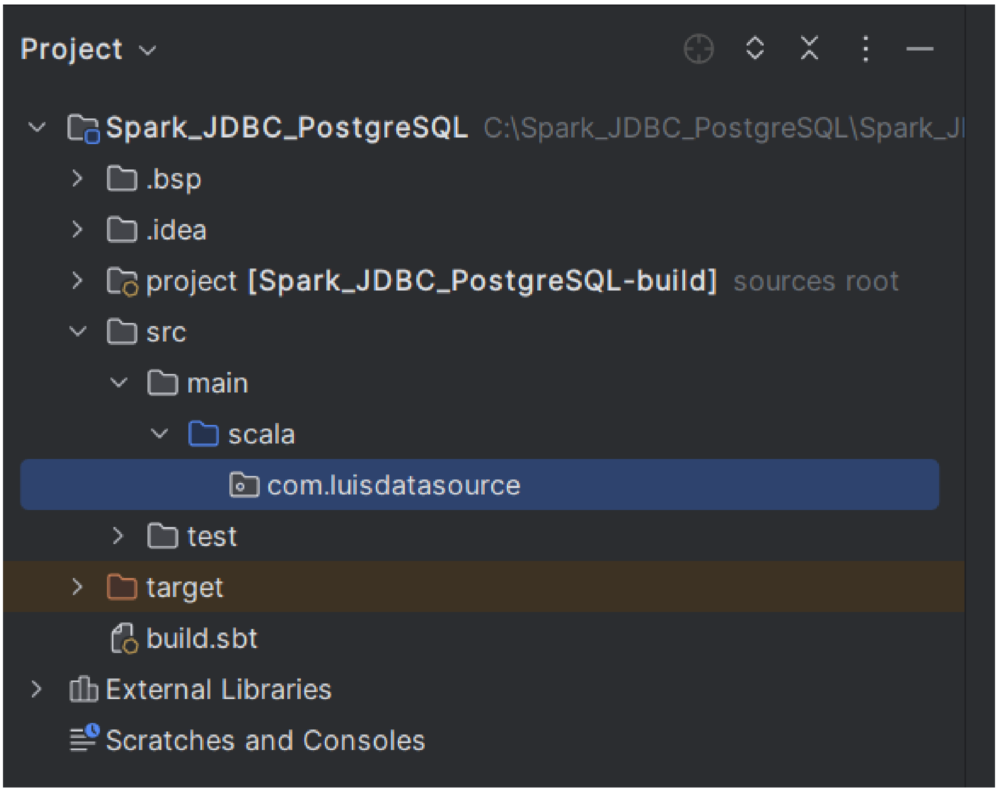


2.4. How to create a new package and new file inside the package

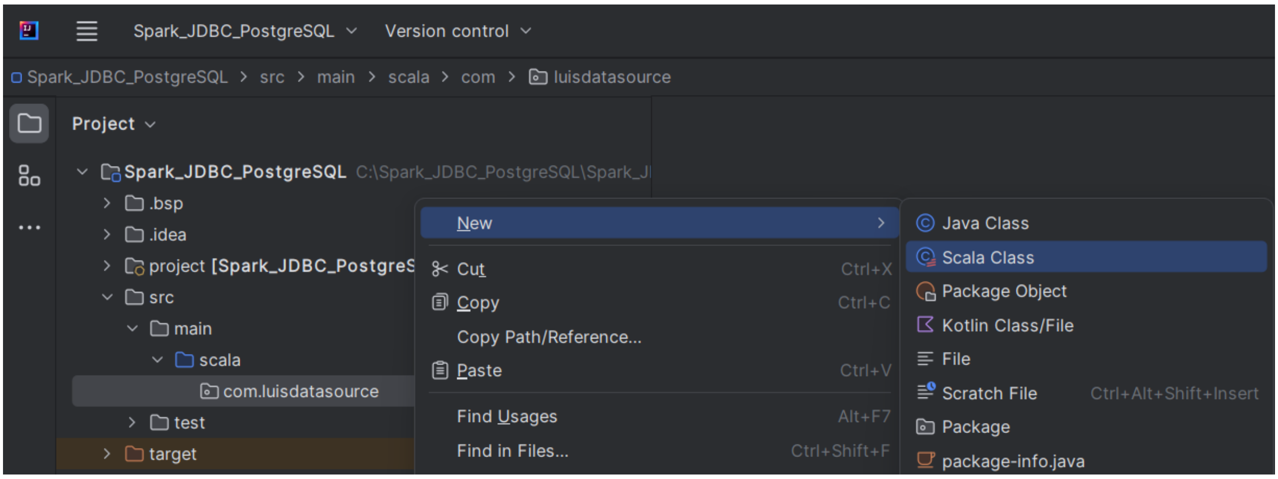
Firs we create the package. For that we right click on the scala folder and we select the menu options New->Package and we input the new package name



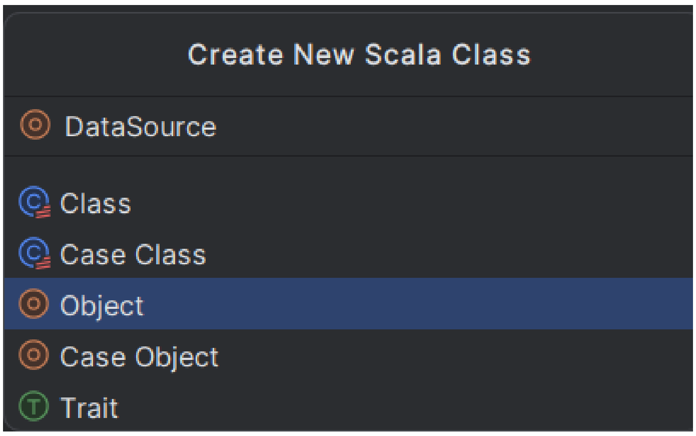




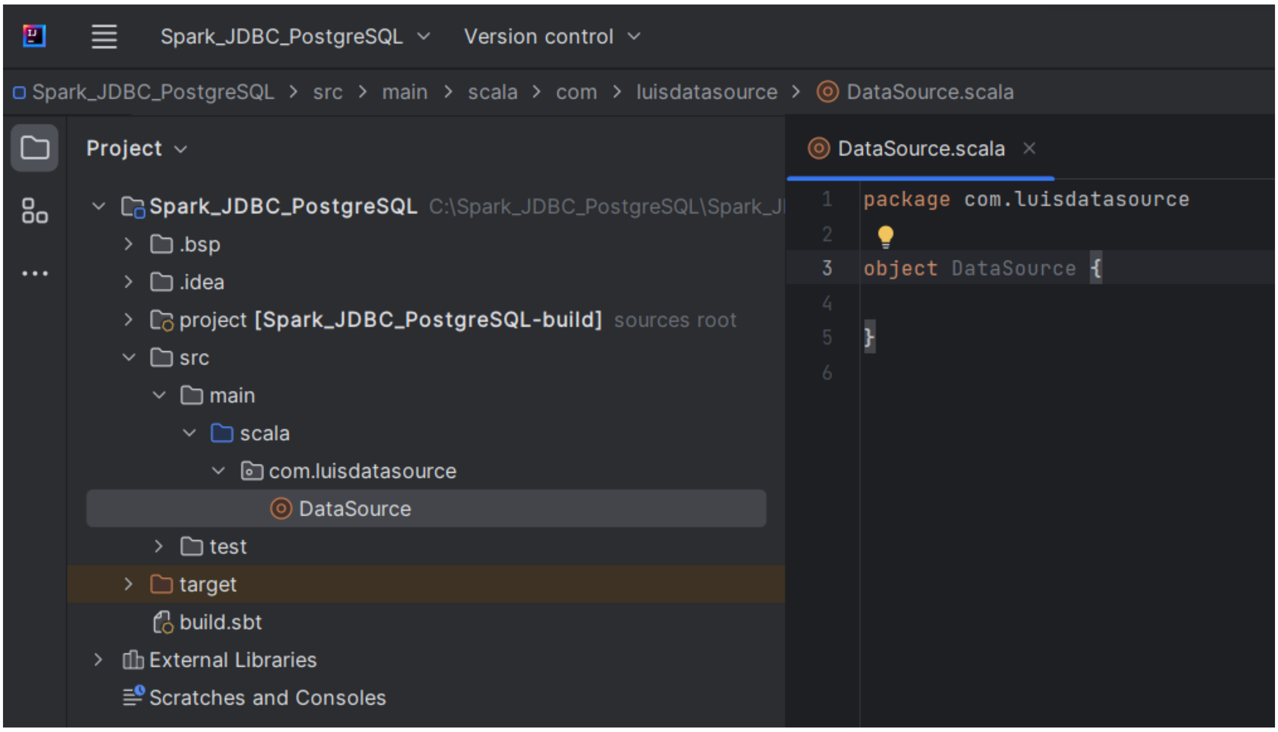
Now we create a new file inside the package. We select the menu options "New->Scala Class" and the "Object"



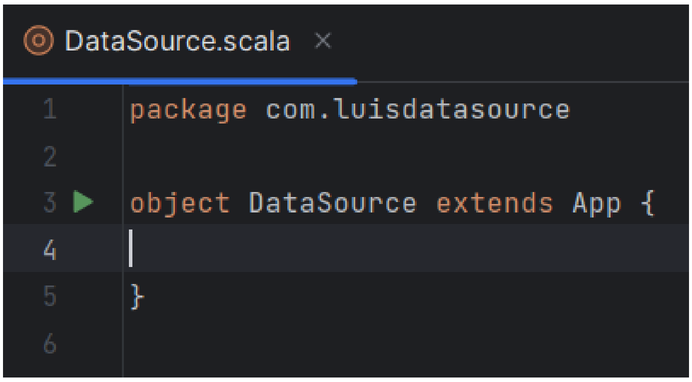
We input the new "Object" name and we set as "DataSource", an arbitrary name we invented



Now you can see the new package and inside the new file "DataSource.scala" with the new object "DataSource"



We "extends App" for the "DataSource" object. An we can see the execute green button appears in the left margin.



Now we can input the rest of the application source code.

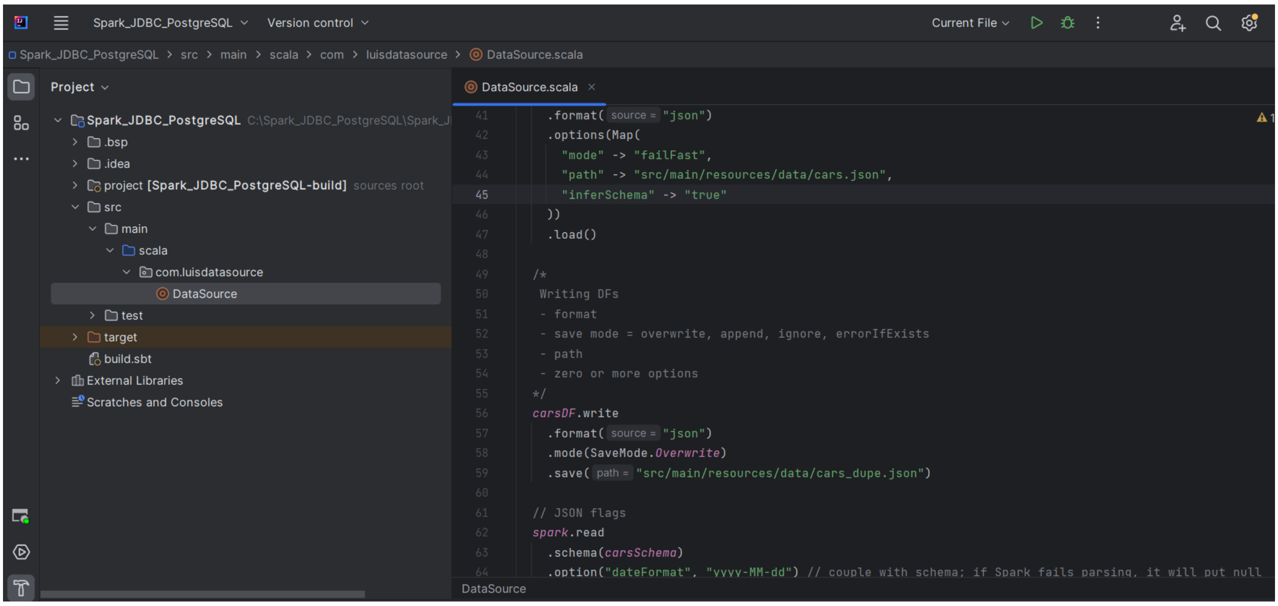
2.5. See the scala source code: scala\com.sparkExample1\DataSources.scala file

```
package com.luisdatasource

import org.apache.spark.sql.{SaveMode, SparkSession}
import org.apache.spark.sql.types._

object DataSource extends App {

  val spark = SparkSession.builder()
    .appName("Data Sources and Formats")
    .config("spark.master", "local")
    .getOrCreate()

  val carsSchema = StructType(Array(
    StructField("Name", StringType),
    StructField("Miles_per_Gallon", DoubleType),
    StructField("Cylinders", LongType),
```

```
    StructField("Displacement", DoubleType),
    StructField("Horsepower", LongType),
    StructField("Weight_in_lbs", LongType),
    StructField("Acceleration", DoubleType),
    StructField("Year", DateType),
    StructField("Origin", StringType)
  ))

  /*
    Reading a DF:
    - format
    - schema or inferSchema = true
    - path
    - zero or more options
   */
  val carsDF = spark.read
    .format("json")
    .schema(carsSchema) // enforce a schema
    .option("mode", "failFast") // dropMalformed, permissive (default)
    .option("path", "src/main/resources/data/cars.json")
    .load()

  // alternative reading with options map
  val carsDFWithOptionMap = spark.read
    .format("json")
    .options(Map(
      "mode" -> "failFast",
      "path" -> "src/main/resources/data/cars.json",
      "inferSchema" -> "true"
    ))
    .load()

  /*
   Writing DFs
   - format
   - save mode = overwrite, append, ignore, errorIfExists
   - path
   - zero or more options
  */
  carsDF.write
    .format("json")
    .mode(SaveMode.Overwrite)
    .save("src/main/resources/data/cars_dupe.json")

  // JSON flags
  spark.read
    .schema(carsSchema)
    .option("dateFormat", "yyyy-MM-dd") // couple with schema; if Spark fails parsing, it will put
    .option("allowSingleQuotes", "true")
    .option("compression", "uncompressed") // bzip2, gzip, lz4, snappy, deflate
    .json("src/main/resources/data/cars.json")

  // CSV flags
  val stocksSchema = StructType(Array(
    StructField("symbol", StringType),
    StructField("date", DateType),
    StructField("price", DoubleType)
  ))

  spark.read
    .schema(stocksSchema)
    .option("dateFormat", "MMM d yyyy")
```

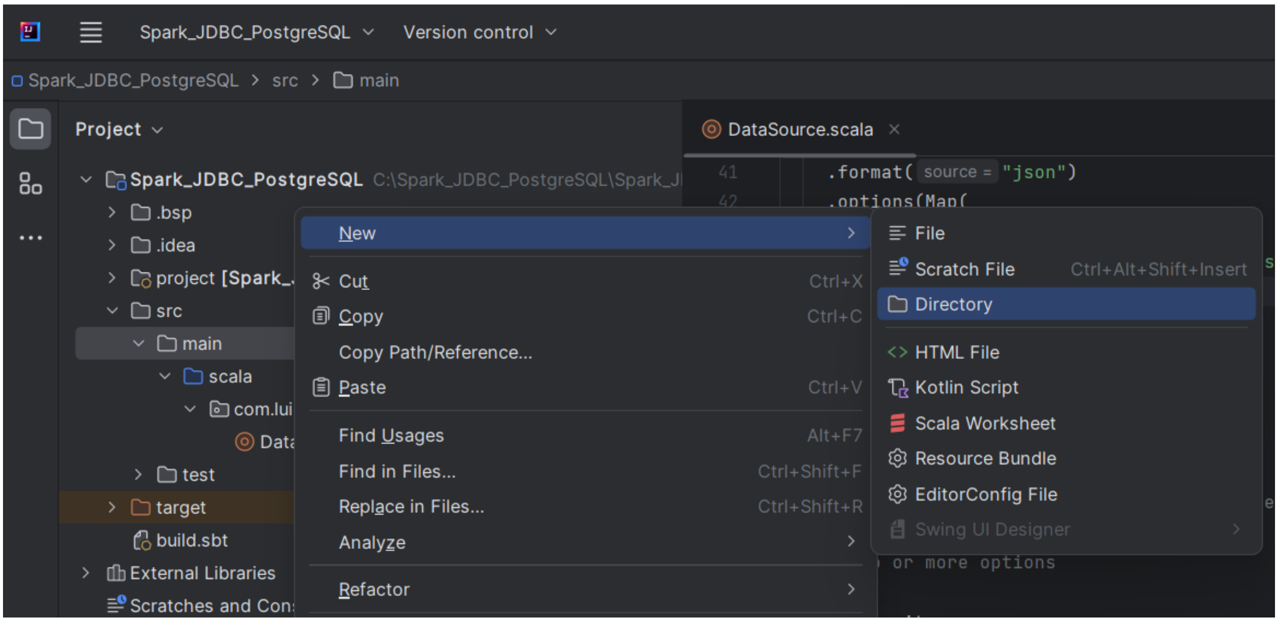
```
      .option("header", "true")
      .option("sep", ",")
      .option("nullValue", "")
      .csv("src/main/resources/data/stocks.csv")

    // Parquet
    carsDF.write
      .mode(SaveMode.Overwrite)
      .save("src/main/resources/data/cars.parquet")

    // Text files
    spark.read.text("src/main/resources/data/sampleTextFile.txt").show()

    // Reading from a remote DB
    val driver = "org.postgresql.Driver"
    val url = "jdbc:postgresql://localhost:5432/mydb"
    val user = "myuser"
    val password = "mypass"

    val employeesDF = spark.read
      .format("jdbc")
      .option("driver", driver)
      .option("url", url)
      .option("user", user)
      .option("password", password)
      .option("dbtable", "public.t1")
      .load()

    employeesDF.show()

    /**
      * Exercise: read the movies DF, then write it as
      * - tab-separated values file
      * - snappy Parquet
      * - table "public.movies" in the Postgres DB
      */

    val moviesDF = spark.read.json("src/main/resources/data/movies.json")

    // TSV
    moviesDF.write
      .format("csv")
      .option("header", "true")
      .option("sep", "\t")
      .save("src/main/resources/data/movies.csv")

    // Parquet
    moviesDF.write.save("src/main/resources/data/movies.parquet")

    // save to DF
  /*
  moviesDF.write
    .format("jdbc")
    .option("driver", driver)
    .option("url", url)
    .option("user", user)
    .option("password", password)
    .option("dbtable", "public.t1")
    .save()
```

```
    */
  }
```

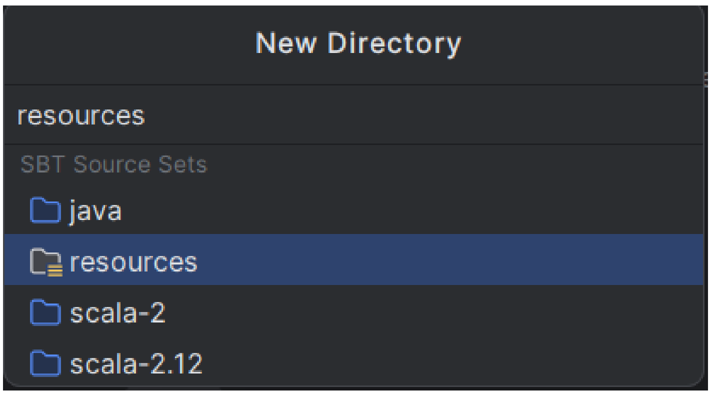


2.6. We create the resource folder to place the data

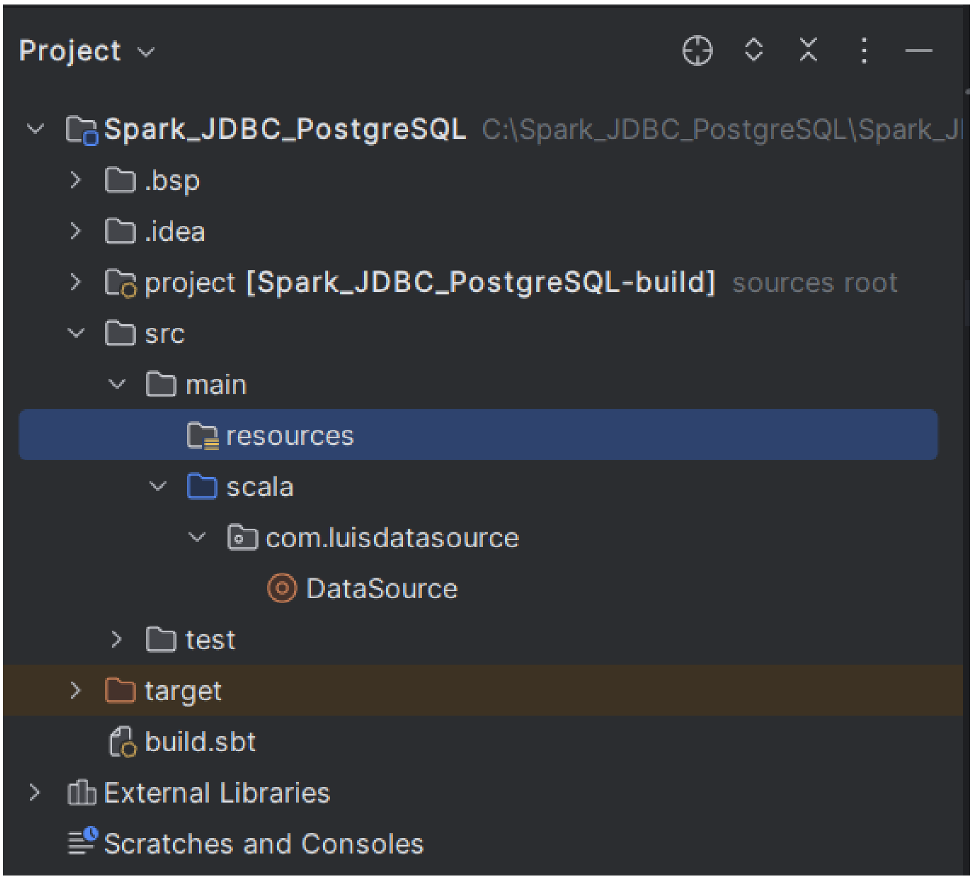
We right click on the "main" folder and we select the menu options "New->Directory"



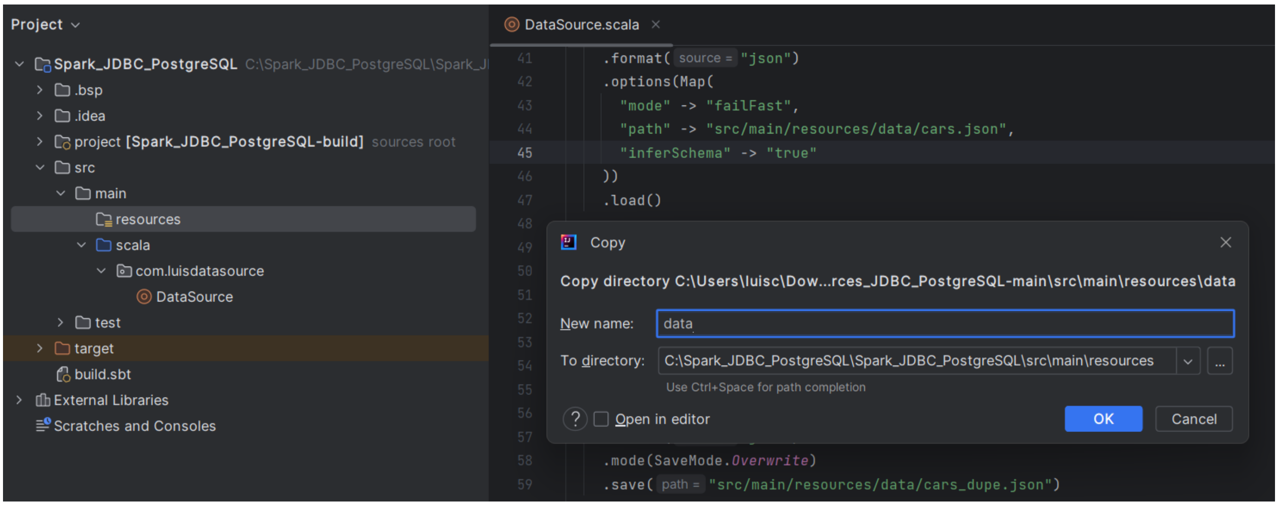
The we select "resources"



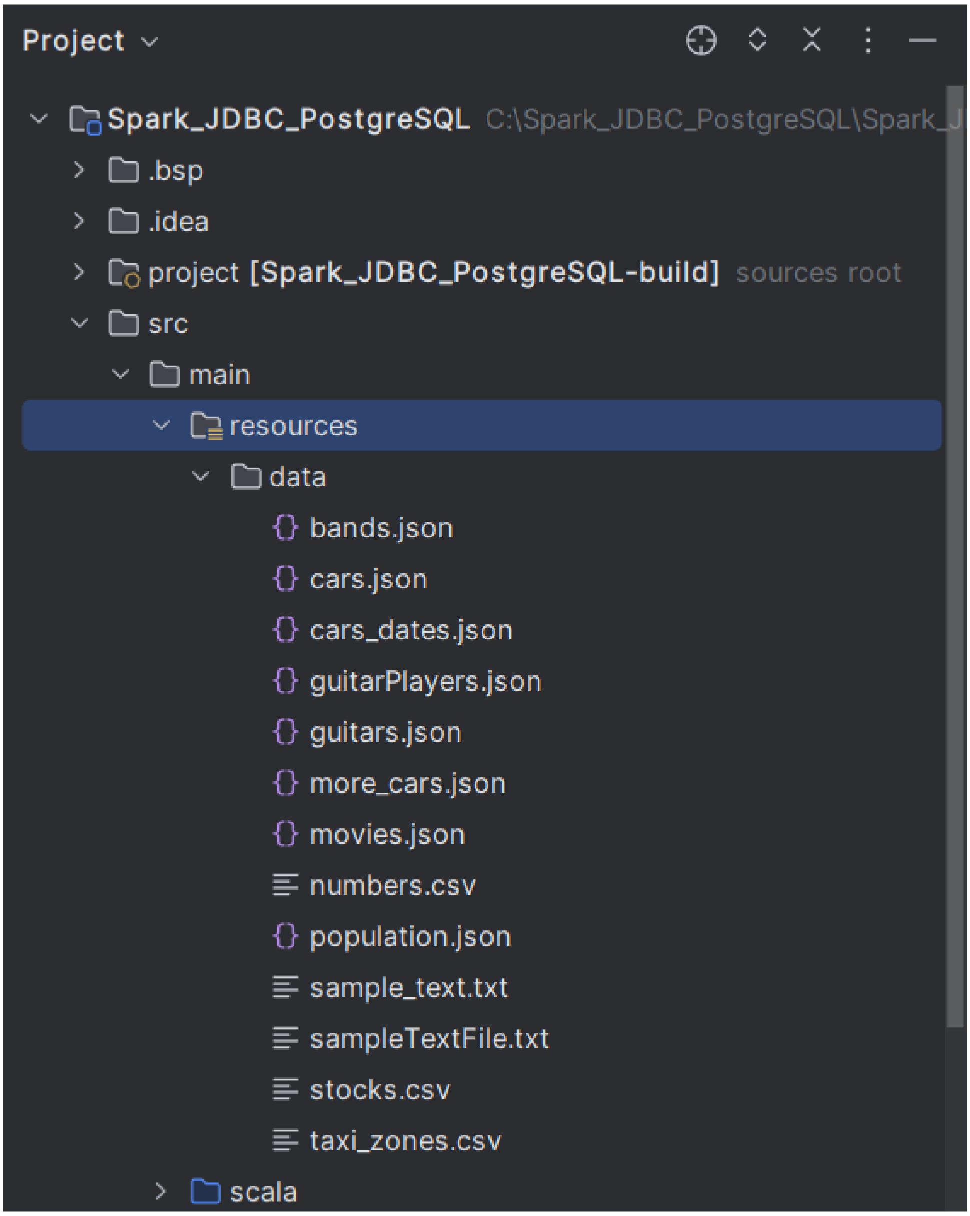
Now we can see the "resources" folder was created



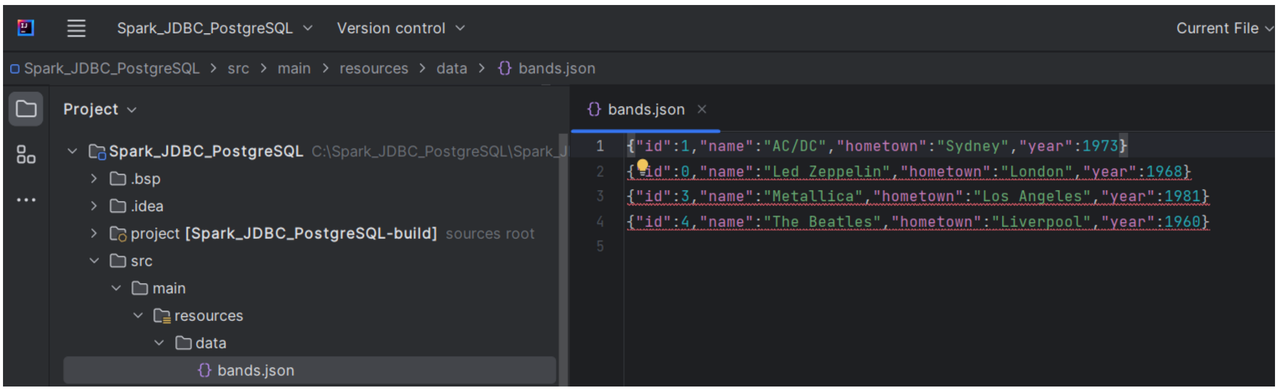
Now we right click on the "resources" folder and paste the "data" folder with all the data files inside.



You can see the "data" folder with all the data files inside

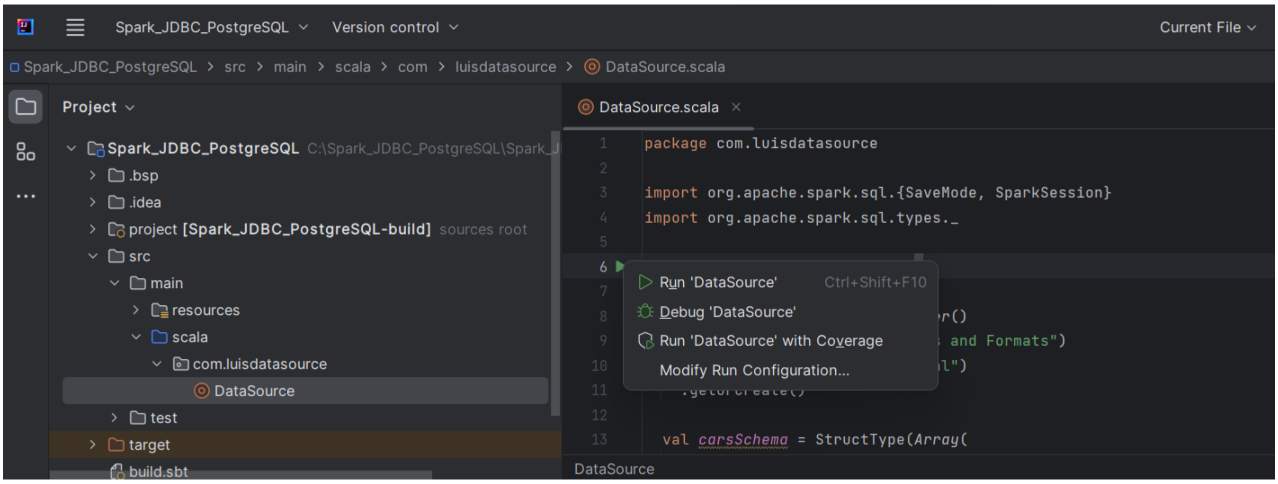


See as an example the bands.json file

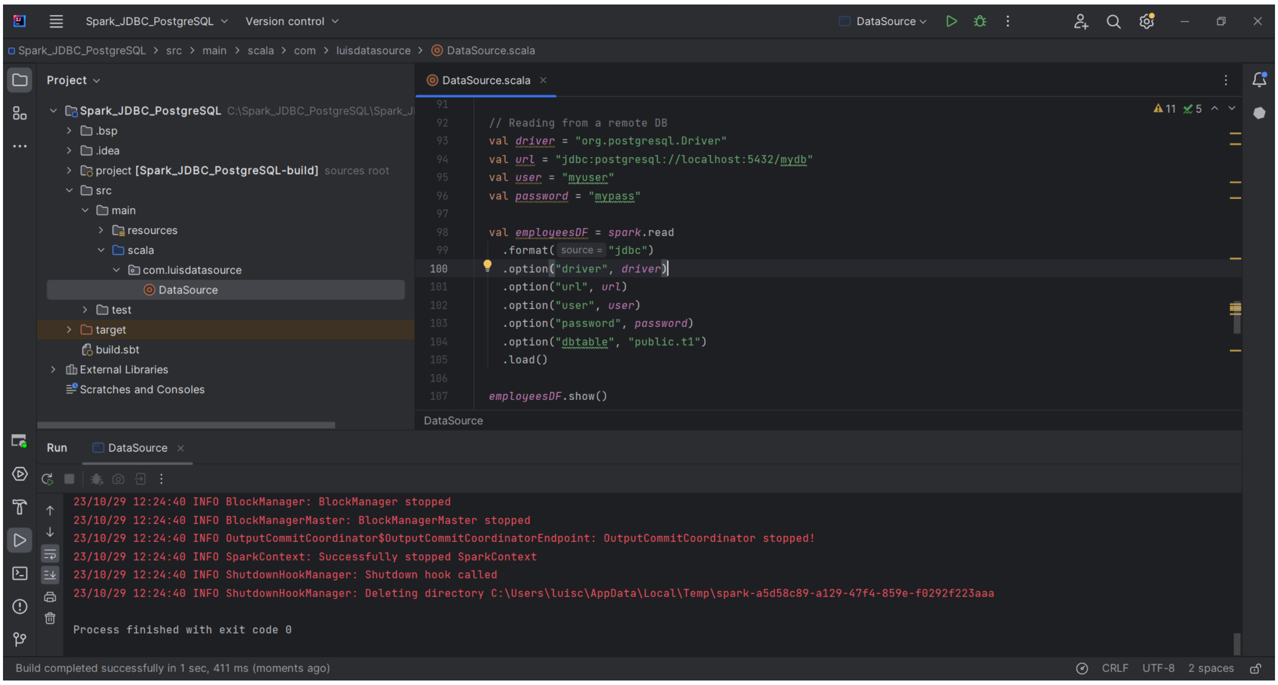


2.7. How to run the application

Press in the execution green buton and select the option "Run 'DataSource'"



You can see the "Build completed successfully" and the "Process finished with exit code 0"

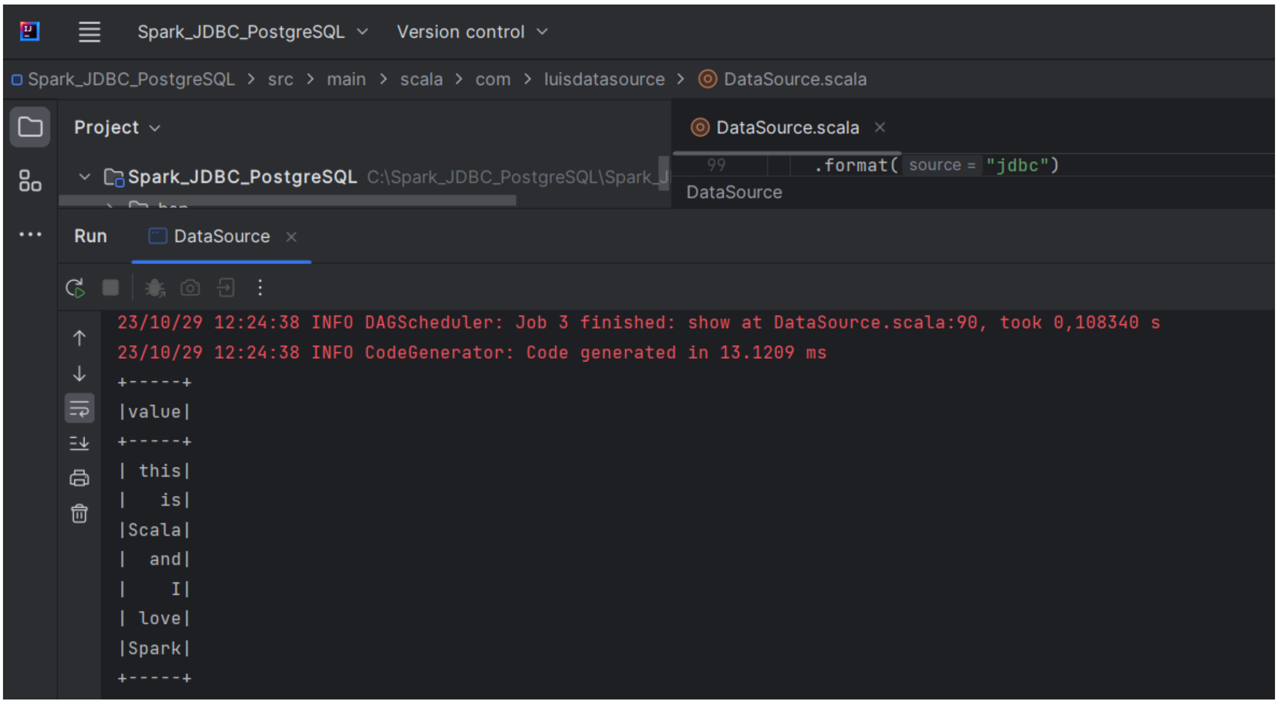


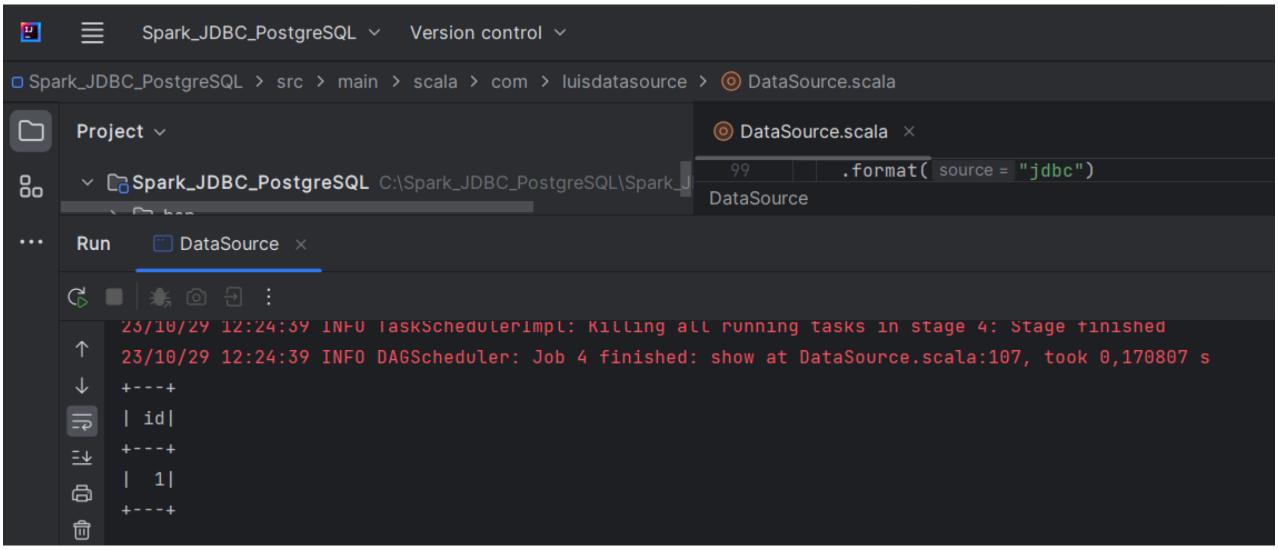
IMPORTANT NOTE: take care if you restart your computer, if this is the case then:

- Run Docker Desktop
- Run the postgreSQL container.
- Enter in the continer and follow all the steps defined above to create a new user and grant permission
- Be sure to start the server in your local machine also.

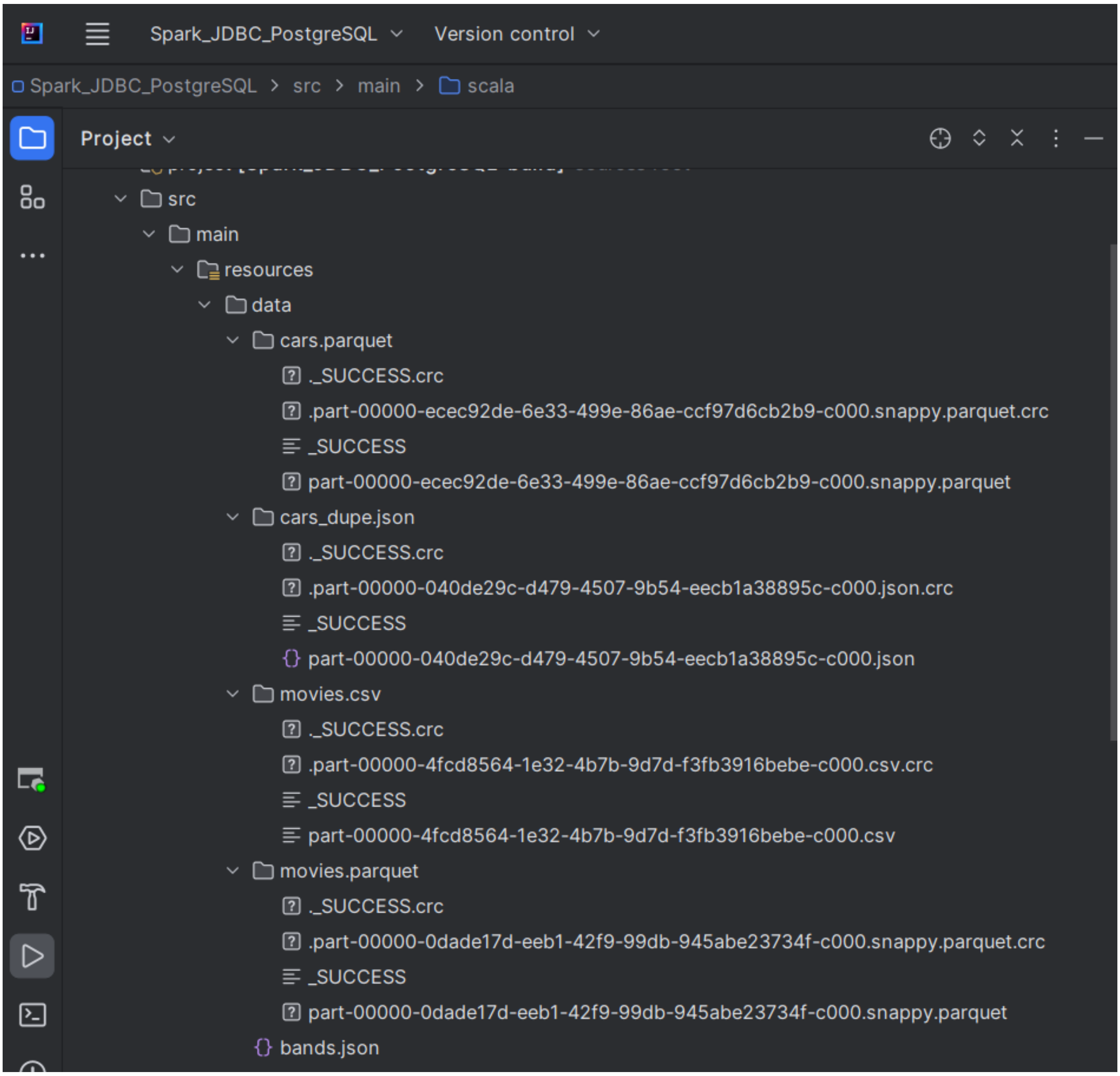
```
C:\Program Files\PostgreSQL\15\bin>pg_ctl start -D "C:\Program Files\PostgreSQL\15\data" -o
5433"
```

2.8. Application output

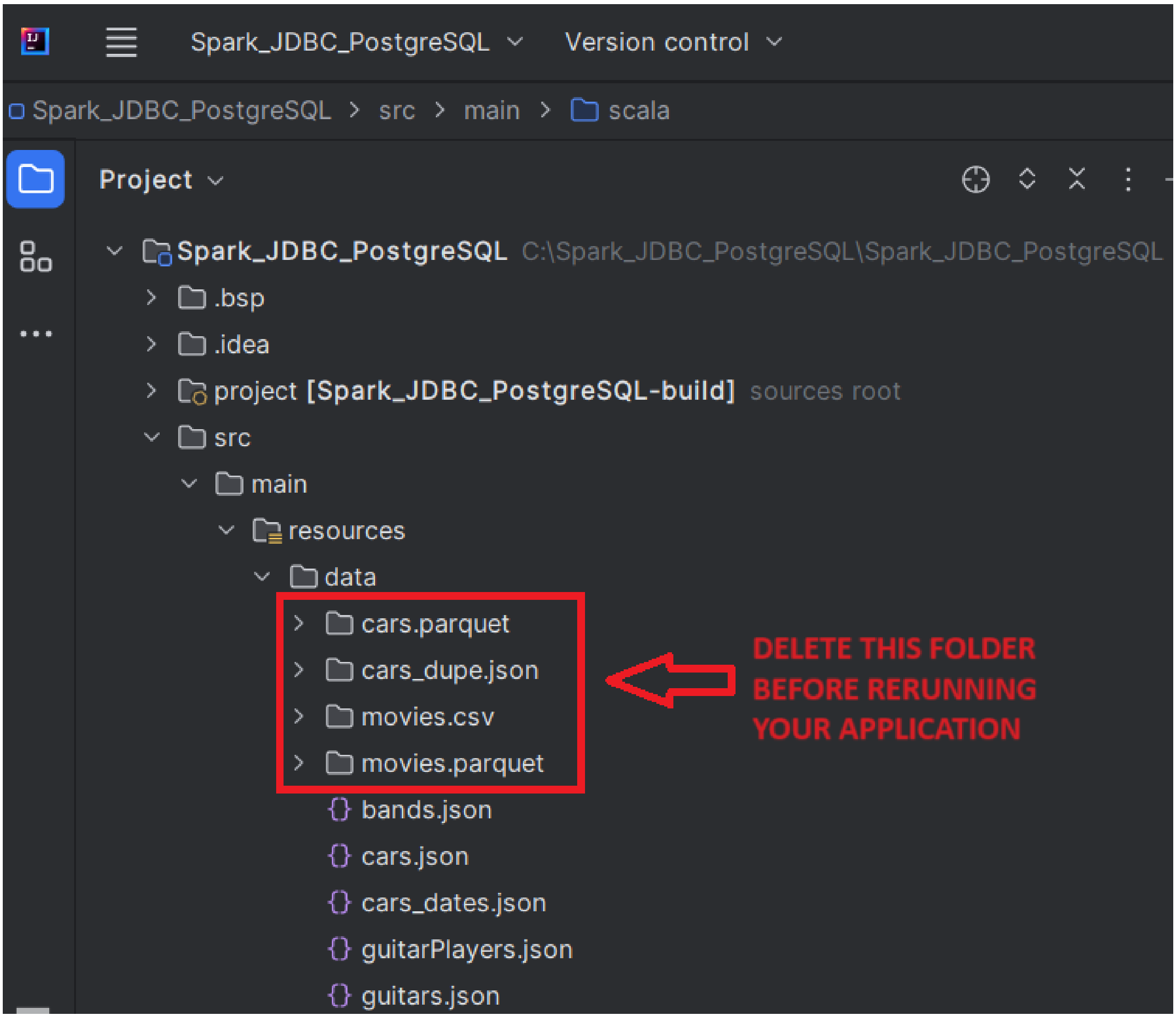




Also this new data files were created



IMPORTANT NOTE: if you would like to rerun the application you should delete the following folders before runing the application again



Releases

No releases published
Create a new release

Packages

No packages published
Publish your first package

Languages

- **Scala** 100.0%

Suggested Workflows

Based on your tech stack

Scala

Build and test a Scala project with SBT.

Configure

SLSA Generic generator

Configure

Generate SLSA3 provenance for your existing release workflows

More workflows

Dismiss suggestions