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SafeStreets

Implementation & Testing

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Contents

Table of Contents	3
1 Introduction and Scope	4
1.1 Purpose	4
1.2 Scope	4
1.2.1 Description of the given problem	4
1.3 Document Structure	4
2 Requirements and Functions	5
2.1 Requirements	5
3 Development Choices	7
3.1 Adopted Programming Languages	7
3.1.1 Back End	7
3.1.2 Front End: Web Application	7
3.1.3 Front End: Why no Mobile Application in the prototype?	7
3.2 Software used	7
3.2.1 Back End	7
3.2.2 Front End	8
3.3 Adopted API	8
3.3.1 Back End	8
3.3.2 FrontEnd	8
4 Structure of the source code	9
4.1 Back-end	9
4.1.1 Package diagram	9
4.1.2 Database Connection	10
4.1.3 Servlets	11
4.2 Front End	12
4.2.1 Web App	12
5 Testing	13
5.1 Back end Testing	13
5.2 Front End Testing	13
6 Installation Instructions	14
6.1 Install Java	14
6.2 Set Up Java	15
6.3 Download Tomcat	19
6.4 Download MySQL	20
6.5 Configure SafeStreets	27

1 Introduction and Scope

1.1 Purpose

The purpose of this document is describing the development of our prototype of SafeStreets, the choices we made in the development , the software we used for developing and for testing and at the end of the document we present how to install and run the developed software.

1.2 Scope

1.2.1 Description of the given problem

SafeStreets is a crowd-sourced application whose intention is to notify the authorities when traffic violations occur. Citizens, thanks to the system, will be able to send information about violations to the authorities who will take actions against them. In this way, the service provided by the authorities can be improved because they will receive notifications through the app. The sources of notifications are the Citizens who take photos of violations and send them to the authorities through the application. The information provided by users are integrated with other suitable information and are stored by the service. The system also runs an algorithm to read the license plate of the vehicle in the photos. All collected data can be seen by Citizens and authorities to find which streets are the safest. Users can have different levels of visibility: authorities must be able to know the license plates of vehicles in the photos, while normal users can only see data in the form of statistics. Moreover, data are sent to the municipal district so that important information can be extracted, and the system makes statistics and suggestion in order to make decisions to improve the safety of the area. Finally, the system will have to be easy to use, reliable and highly scalable to fit perfectly with the mutable context in which it will be used.

1.3 Document Structure

This chapter debates about contents and structure of Implementation and Testing Documnet, indeed this document is divided in different sections:

1. Introduction: This chapter rovides a general definition of the developed software;
2. Requirements and Functions: This chapter illustrates the requirements which the software meets and the functions developed to satisfy them;
3. Development Choices: This chapter shows the choices made during the developement, the used frameworks, programming languages and softwares are described here.
4. Structure of the source code:This chapter explains how the source codes are organized.
5. Testing: This chapter explains how the testing was carried on during the development.
6. Installation Instructions : This chapter shows how the software can be installed and run.

2 Requirements and Functions

2.1 Requirements

In this section we present the requirements debated in the RASD and DD and we analyze if they are present in the prototype developed.

- R1) Authorities' location must be known by the system when they are in service: This requirement is very important for the application, because if the authorities are trackable, they can receive their assignments in real time. The device measures their position every minute and sends it to the system.
- R2) When a Citizen makes a report the position is correctly added with the GPS when is available: When a citizen makes a report, the device measures his current position; this is important in order to know the place where the violation occurs.
- R3) The right authorities are notified about violations: in the implementation of the prototype, this requirement was not developed; however in the back-end there are some functionalities that implement this requirement.
- R4) Authority must be able to provide the system how the assignment finished, resolved and the type of violation, no intervention needed when arrived, false report: The system must know whether the assignment is taken, resolved or it was a false report. The system must be informed about the state of each assignment. If an assignment is correctly resolved (or there was no intervention needed), the system changes its state in unavailable. Moreover, the authority who resolved it, gives the system all the details about his work in order to create suggestions. Oppositely, if an assignment is refused, the system flags it as available, in order to let other authorities take it. Finally, in case of a false report the user who made it loses his trust and the assignment is marked as terminated. The Report manager handles the assignment and communicates with DatabaseAccessFacade to terminate correctly an assignment.
- R5) The system must make Statistics available when asked: This requirement is developed it constitutes an important part for behaviour analysis so it is available in the prototype in order to show how the system could analyse data. The functionality in the developed software must be improved for an actual release of the software. Now the size of the area in which the statistics are computed is fixed. In an actual release it should dinamically change or it could even be choosen by the client. More useful data may be added to statistics consulting data analysts to increase the value of this functionality.
- R6) Statistics are always updated when an event happens: This requirement is enforced in the developed software with the developing of Report manager and the functionality it provides to communicate with the DataAccessFacade to save reports and modify Assignments.
- R7) For registering a Municipality his/her data must be provided to a System manager who will add those data to the service to sign up him/her: the web application allows the Manager to register a Municipality only if he/she fills all the fields in a form he/she gains access when successfully logging in. When data is not correctly filled the web page doesn't allow the submission of the form. Even if the form is submitted disabling javascript from the browser the Server side controls the validity of the data and in case of invalid data it informs the client with an appropriate error message.
- R8) A visitor must be able to begin sign up process in the SafeStreets App filling a form with his data: the device first shows the user the statistics, then the visitor can access the sign-up page where he has to fill the form correctly in order to register. The system controls whether the data

inserted are valid and the User Manager, through the DatabaseAccessFacade, makes sure there is not another user with the same name.

- R9) When the creation of an account is successful the system must notify the Visitor sending an email to the address provided in the sign up process: The creation of an account is handled by the appropriate servlet depending on the creator of the account. After the creation of an account an email is sent to the email address of the user. The MailManager handles this part of the interaction. This function is important since it is necessary for users which must be added by other users like municipalities , authorities and managers whose passwords are randomly generated by the system. For showing an additional idea we added a link to delete the account if the creation wasn't done by the owner of the email. But for the lack of an actual server with an univoke name to which deploy our prototype the link is only symbolic.
- R10) When GPS is not available the user can input the position from a map: In some cases the device is not able to trace the position of the citizen; so the user can select his current position though the APIs provided by the map.
- R11)Users to use the full service must be able to login providing the right credentials: This functionality is provided by the access control done in all the servlets which does the controls of the user session. For the functionalities which are only for a given type of user an additional check on the user type in the session is made to avoid illegal access to the application. If a user accesses the application without permission (not logged in or access functionalities he/she can't access) than an error is returned with a message informing that the access to the functionalities is not allowed.
- R12) The camera of the mobile phone must be accessible to take photos of violations: this functionality is not implemented because the app runs on a device that has no camera. However, this is overcome because there is the possibility to upload photos that are stored in the device.
- R13) Suggestions must be available when municipalities request them: We included two parts of this functionality in the prototype. A static part which allows Citizens and authority to send suggestions to a municipality and a dynamic part which takes statistics around the municipality to build the suggestions. Comments are placed where the last part which uses data about accidents to build statistics could be placed in the StatisticsBuilder class.
- R14) R14) The User must be able to select the licence plate between the ones in output from the Licence Plate Recognition algorithm: if the algorithm makes a mistake in identifying a licence plate, the user has the possibility to input it in a text box.
- R15) Each Username is unique: This requirement is enforced by the structure of the Database used.

3 Development Choices

3.1 Adopted Programming Languages

3.1.1 Back End

For the developing of the back-end of the we used Java. We choose java for it being cross-platform, so the possibility of running the code on different machines. Even though the back-end prototype is developed in a single machine this choice allows with some modification to deploy different components on different machine and use functionality like Java Remote Method Invocation to communicate. The choice is also driven by the variety of functionality JEE has. JEE has components for database access but also for the creation of Http Servers. Another advantage of using Java is being Object Oriented and allowing Polymorphism and Inheritance allowing the user to create a structure for a general Object and expanding it in different forms. This allowed a really fast developing of the Response Objects which the server returns to the client. Other advantages in the development are the usage of annotations to enforce properties to functions (I.e.@Override) and last but not least automatic garbage collection. Garbage collection is an advantage for developing an application since it removes part of the controls the developer must perform it also adds a considerable drawback of slowing down the application if object are created and than discarded continuously. To remove part of this overhead the use of Object Pooling technique for the most resource consuming Objects is applied, in the project we used an Object Pool for Database Connections.

3.1.2 Front End: Web Application

To develop the front end we used javascript with jquery and leaflet. JQuery allows to write more readable code than javascript and simplifies the developement, also caching mechanism of browsers may allow users to load it from memory if it is already cached. A disadvantage is the difficulty to develop with different components and pages and in most cases the code written is only usable in one or few pages. Being the web applicaiton developed rather small it was possible to develop it without using complex frameworks. Leaflet is a lightweight javascript map library. It provides the functionalities required by the software with a quick loading time and an easy inclusion in the application.

3.1.3 Front End: Why no Mobile Application in the prototype?

We have chosen not to implement the mobile application because its only use was to communicate with the server and show data to the users. This functionalities can be found in the web interface; in fact, in order to test and develop the prototype, we have chosen only the web interface to uniform the front end structure. In this way, we can also reuse components employed in interactions through the users

3.2 Software used

3.2.1 Back End

The Back End developement was carried on using different softwares:

- Eclipse IDE for Java EE Developers : This IDE provides a rich environment to develop applications in Java. Eclipse has components for managing projects and the dependencies of the project . The IDE also supports JUnit Test Suite and allows to do Coverage testing. It also allows to work with git inside it to manage versioning of the project. We used it also for developing of the web App since it allows editing also of javascript ,html and css files.
- MySQL : MySQL is a relational DBMS easy to set-up, to export and import using MySQL workbench GUI. The GUI allows also simple table creation , table value modifications, stored procedure creation and trigger creation It is also easy to connect from the Java Code .

- Apache Tomcat : Tomcat is an open source implementation of the Java Servlet. This software is used to deploy the Back End. Using Eclipse IDE for the developement after downloading Tomcat the setup is really fast and easy.

3.2.2 Front End

The front end was developed using Eclipse IDE (described before).

3.3 Adopted API

3.3.1 Back End

In the developement of the Back End we used the API provided by Mysql server to connect to the database , the API of tomcat servlets to develop and deploy servlets and the Java Mail Api to send emails to the users.

3.3.2 FrontEnd

FIn the developement of the Front End we used the API provided by openStreetMaps in the web Appli-cation to get the map shown with leaflet and the geolocation API provided by the browser to get the user position. We also used APIs provided by OpenALPR in order to recognize licence plate thought Optical Character Recognition technology.

4 Structure of the source code

4.1 Back-end

4.1.1 Package diagram

The Java code has a Javadoc which can be accessed in [our github repository](#) Here we present the overall structure of the project at different levels. In this diagram a basic view of the code structure is seen.

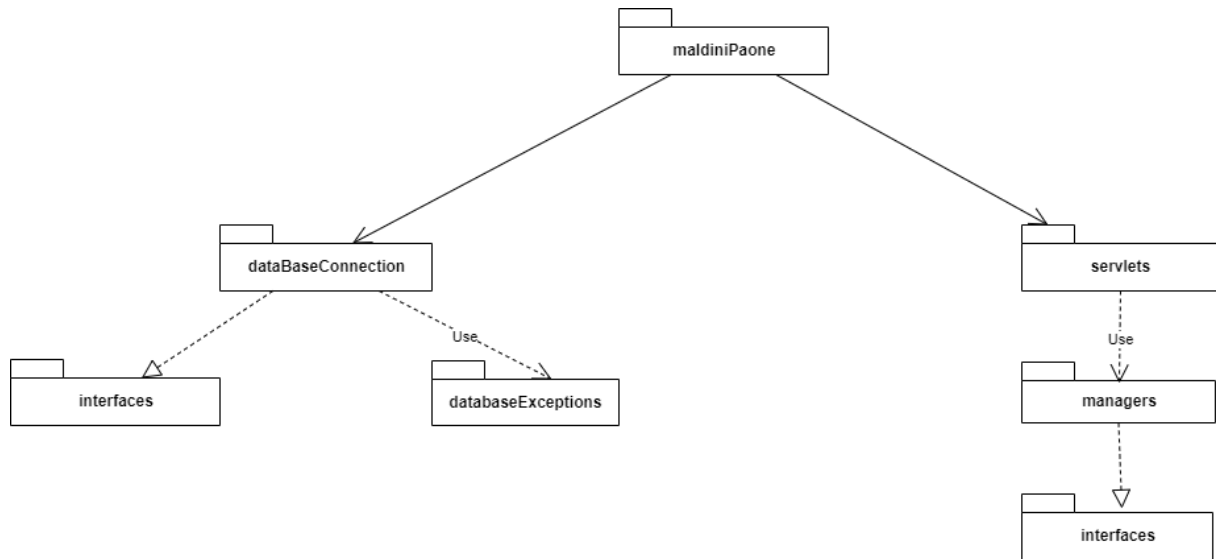


Figure 1: Package diagram of the main packages

The source can be divided in mainly two sub-parts. The first part concerning the connection to the database which is handled by the classes in the databaseConnection package and a second part which communicates with client devices which is handled by the Servlets implemented in the servlet package. The database Connection package has two sub packages one to define the interfaces it exposes to the other classes, the other with the Exception Classes which can be thrown by the classes in the package. The servlets package classes communicates with the managers in the managers package which provides interfaces to allow access to the needed functionalities. In this diagram the utilities package and its sub packages are not shown for the sake of clarity. This package contains useful objects, beans and constants which are used through the whole development.

4.1.2 Database Connection

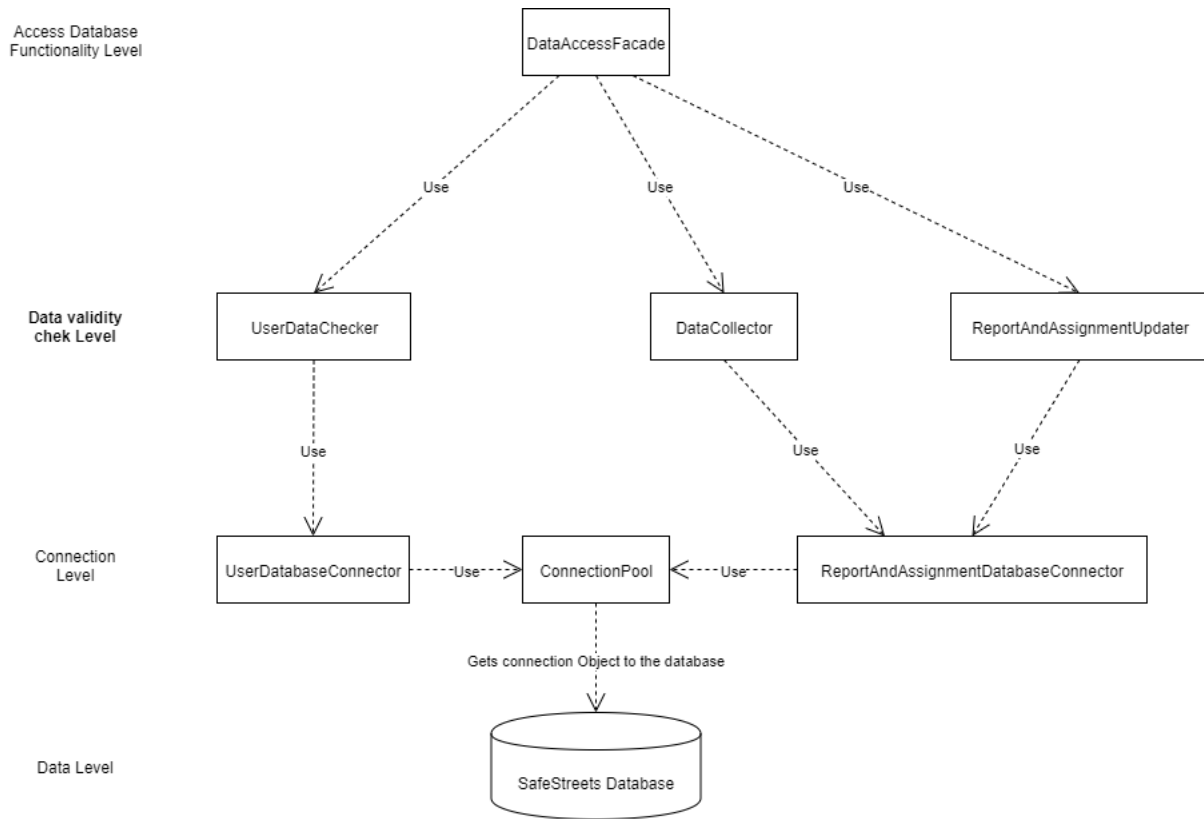
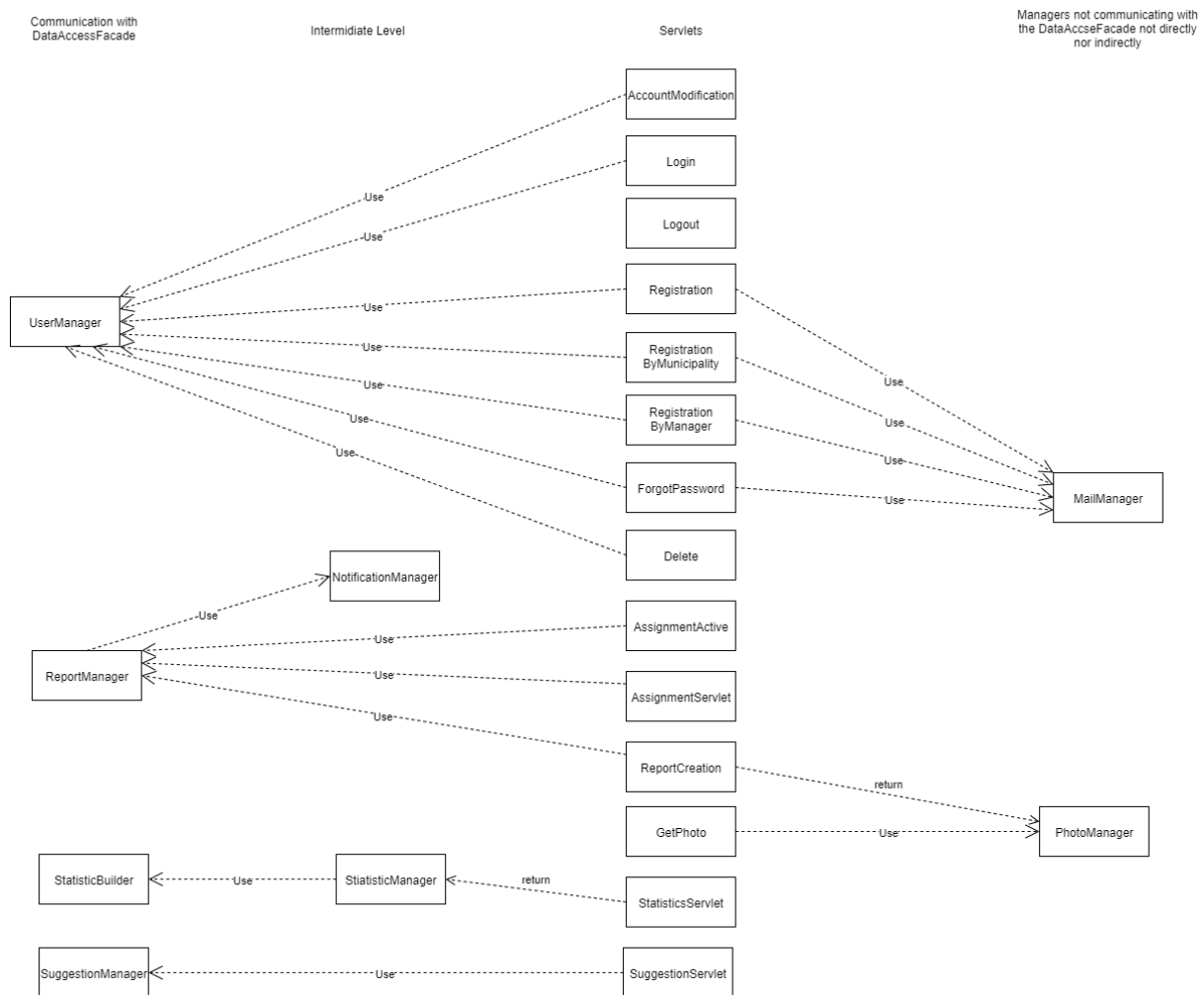


Figure 2: databaseConnection classes

This diagram shows the Classes in the databaseConnection package the database is also shown to present which component instantiates connection with it. A clear separation of concerns is shown between the different classes:

- **Connection Level :** classes in this level have 2 main functions the instantiation of connection which is done by the `ConnectionPool` and using the instantiated connections to get data ,save data, update data from the database. The latter function is implemented in two separated classes to divide the class managing information concerning the user accounts and the one managing information concerning reports and assignments. Implements the functionalities.
- **Data validity check Level:** classes in this level checks that input values for accessing the database are correct. This layer protects the possible accesses to the database with invalid values avoiding the instantiation of useless connection which may slow down the server. This level throws the appropriate exceptions if the database connection couldn't be instantiated on the lower level or if the parameters are invalid. Controls access to the functionalities.
- **Access Database Functionality Level :** this level contains a class `DataAccessFacade` as the name says it is a facade and so it presents to the other packages the functionalities that the database connection package provides. This layer contains almost only call to functions provided by the beneath level to allow a clear separation of the functionalities of the package. Allows access to the functionalities.

4.1.3 Servlets



The Servlet package's classes are shown in the above diagram. The functionalities provided by the servlets to the end users are provided to the servlets by managers in the package. The managers on the left part communicates with the DataAccess facade to retrieve, save or modify data on the database. The Intermediate level shown contains classes which communicate indirectly with the database because information used by it comes from communications with the database. The servlets provide functionalities of the service to the clients of the web application and of the mobile application. On the right part of the image 2 managers are shown. Those managers don't communicate directly with the database and allow the system to save photos and to send mails to the clients.

4.2 Front End

4.2.1 Web App

The web application is composed of an html file , a css file developed by us , css files of leaflet to present the map , external javascript imported libraries(jQuery, leaflet and openAlpr) and different javascript source files. The html file contains the single page application which allows municipalities and managers to access their functionalities. The javascript source files are basicFunctionalities.js and ourMap.js, the first source adds to the page the dinamic behaviour of buttons and avoids synchronous requests to the server using ajax get and post requests, the second source handles the creation of the map and the binding of events to update the map and defines the behaviour when the user clicks on markers on the map, the other javascript files are used to set up the functionalities of open alpr and use them to recognize license plates in a photo.

5 Testing

5.1 Back end Testing

For the Backend testing we created two jUnit test classes to test functionalities of user creation and creation and modification of reports and assignments. Here we first created some random Location objects and we checked that location with invalid coordinates can't be created using a coverage test to see if the test case actually tries to create them and the correct exception is cached. After this some users of every type are created. Every time a new user is created we try to create a second copy and check if that is not possible. After creating users the reports are created using a username of the citizens created. Later we make authorities accept the assignments created when adding the reports , then we make them terminate them. Every time we update the state of an assignment we try to re-do the action to test if invalid modifications are not possible and are correctly handled. For lack of time we didn't create actual test cases for functionalities outside the database connection package. For controlling functionalities we used console logging to try out functionalities and debug the system. We tried different inputs and invalid inputs checking if the outputs are correct and if the error messages are correctly shown to the user. For a final test we gathered a little group of people and we made them test the system on our computer giving them instructions to use the system. If we had more time we would have created a full test suite containing also tests for servlets package instead of using only log functions.

5.2 Front End Testing

For front end testing we covered the functionalities we wanted to offer to clients on the target devices to see if the interaction were correctly implemented. We controlled also that all the possible error messages were displayed to the user. We were also helped by the group of people we gathered who provided us useful feedbacks for improving the user experience for later release. With more time we would have done a rework on the user interface to improve the experience of using our system.


6 Installation Instructions

6.1 Install Java

If you already have the latest version of java sdk skip this step. Visit the [jdk installation page](#). Accept license agreement and install the version suitable for your operating system. If you downloaded the executable execute it if you downloaded the zip version unzip it in a new directory called JAVA which you should place in the programs folder of your pc.

Java SE Development Kit 13.0.1

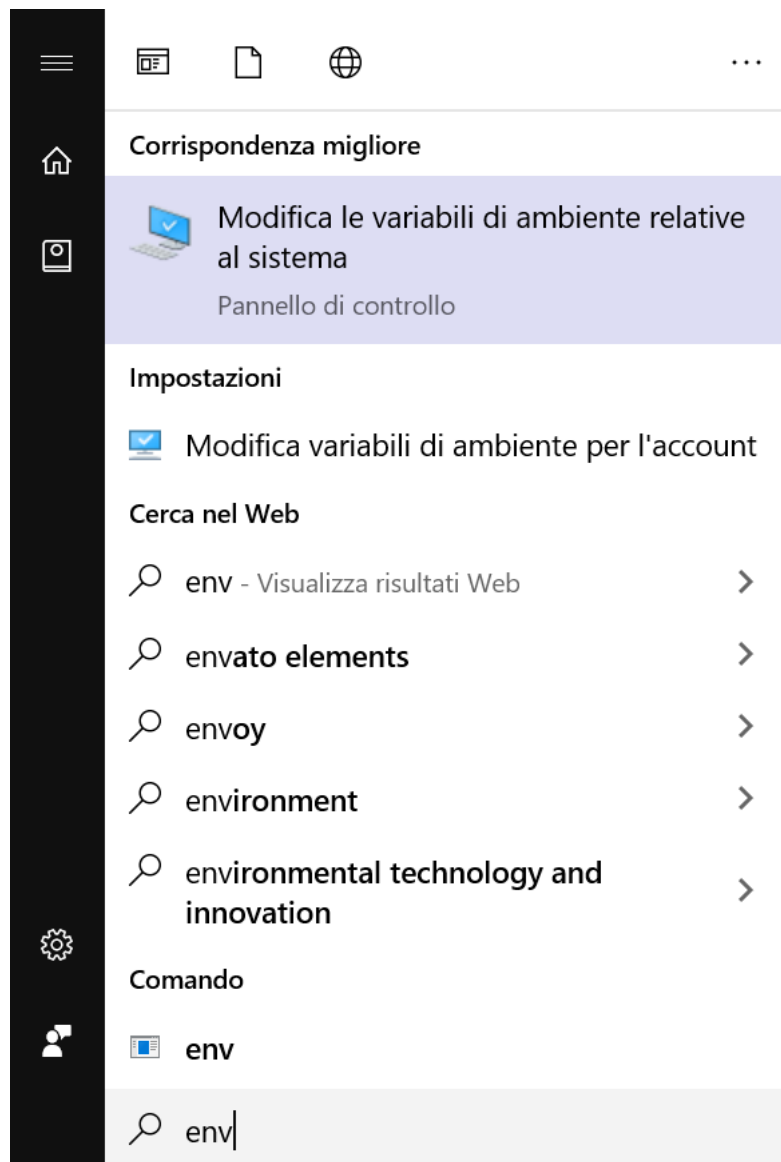
You must accept the [Oracle Technology Network License Agreement for Oracle Java SE](#) to download this software.

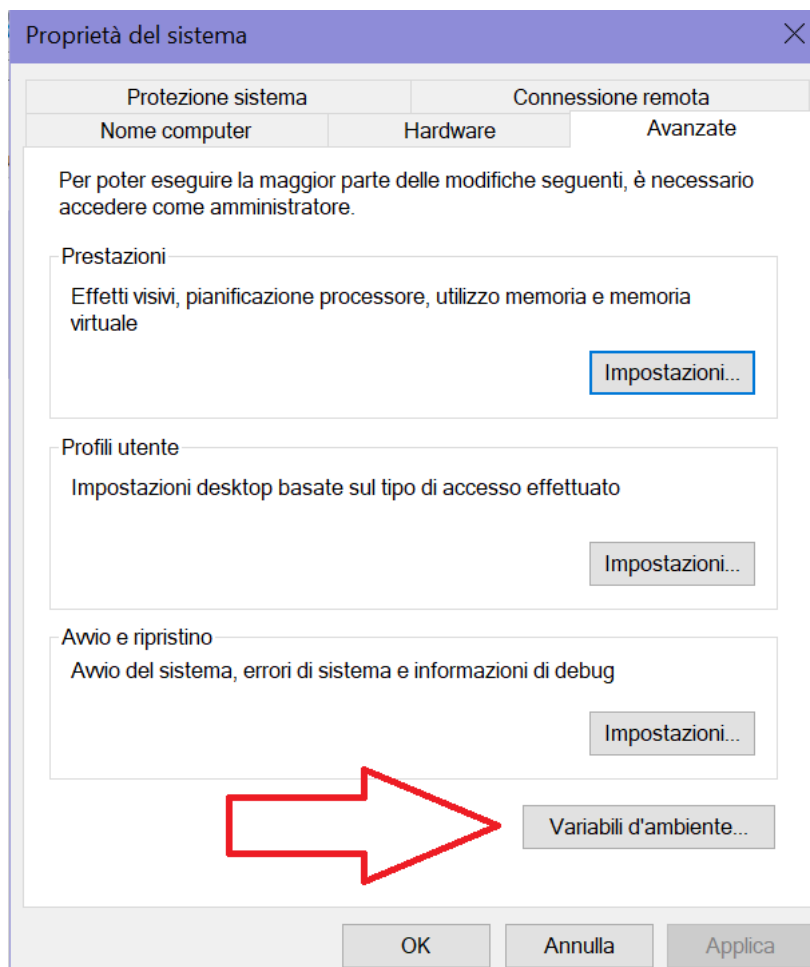

☐ **Accept License Agreement**
☒ **Decline License Agreement**

Product / File Description	File Size	Download
Linux	155.88 MB	jdk-13.0.1_linux-x64_bin.deb
Linux	163.17 MB	jdk-13.0.1_linux-x64_bin.rpm
Linux	180 MB	jdk-13.0.1_linux-x64_bin.tar.gz
macOS	172.78 MB	jdk-13.0.1_osx-x64_bin.dmg
macOS	173.11 MB	jdk-13.0.1_osx-x64_bin.tar.gz
Windows	159.84 MB	jdk-13.0.1_windows-x64_bin.exe
Windows	178.99 MB	jdk-13.0.1_windows-x64_bin.zip

6.2 Set Up Java

Set the environment variable `JAVA_HOME` to the directory where you installed the jdk. Normally the installation path will look like "`C:\Program-Files\Java\jdk-13.0.1`" where `jdk-13.0.1` could be different if you downloaded a more recent version. To set up environment variable in windows search in the search bar of the pc "`env`" a choice with "Edit the system environment variables" or in italian " modifica le variabili di ambiente relative al sistema " should appear click it than click environment variable at the bottom right of the menu which appears. A new window should appear, check if the variable `JAVA_HOME` is available in the list at the top, if it isn't press add otherwise choose it and press modify. In the opened window insert as variable name `JAVA_HOME` and as value the path of your jdk. After confirmation you can close all.





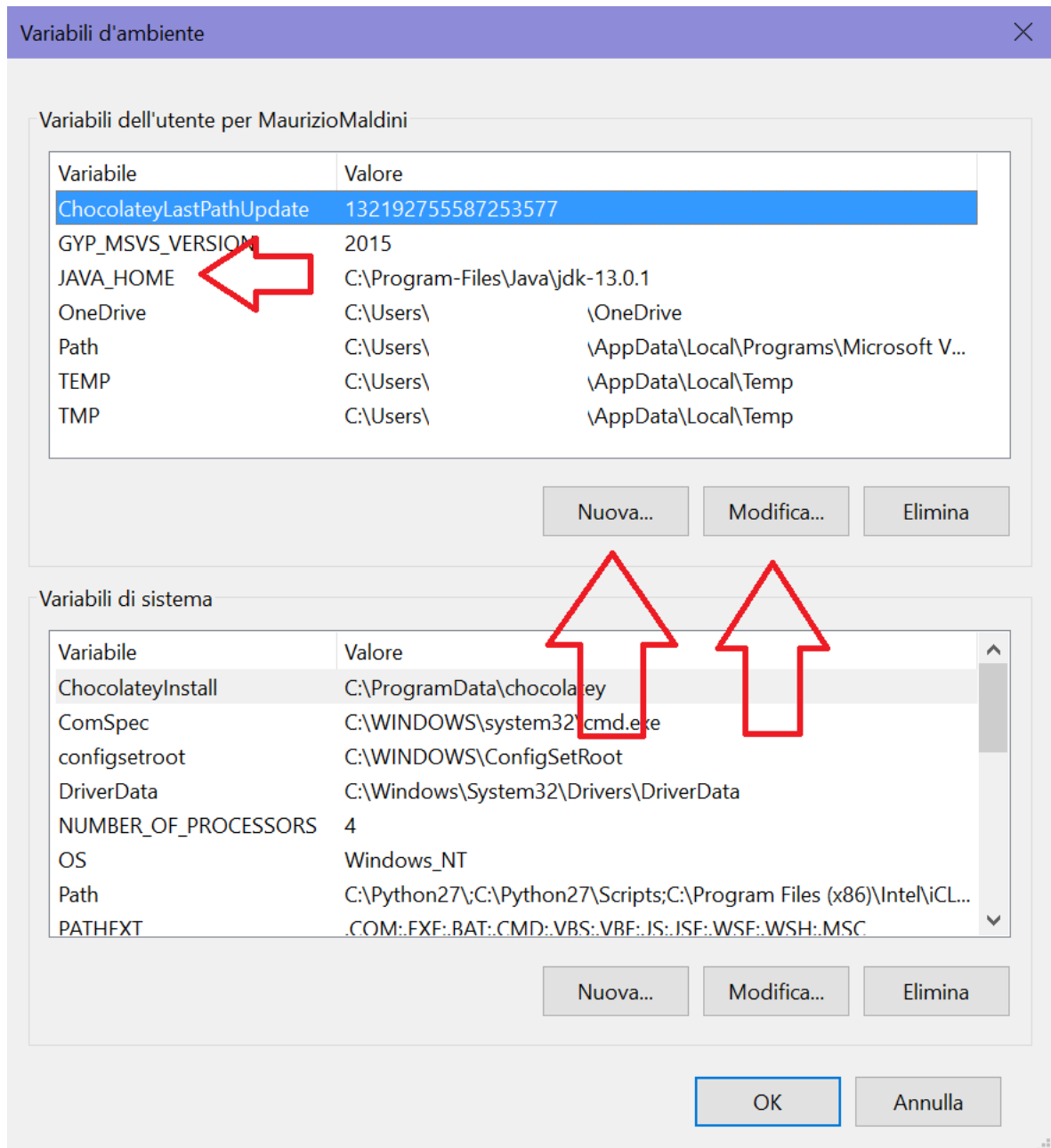
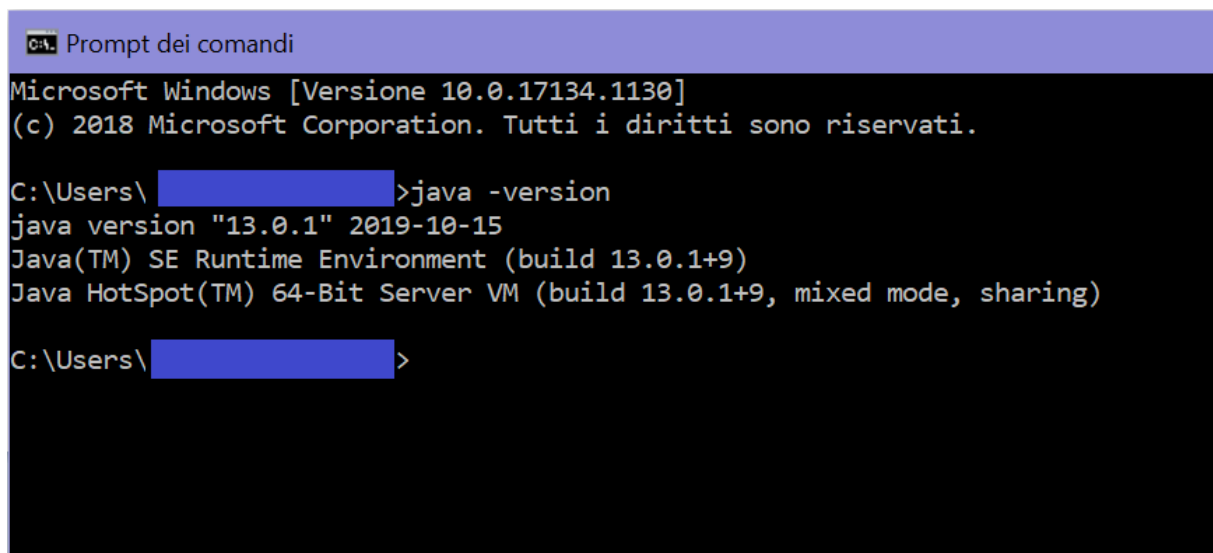


Figure 3: Here you can see where java home should be visible if not available add it or update if it is outdated



```
C:\> Prompt dei comandi
Microsoft Windows [Versione 10.0.17134.1130]
(c) 2018 Microsoft Corporation. Tutti i diritti sono riservati.

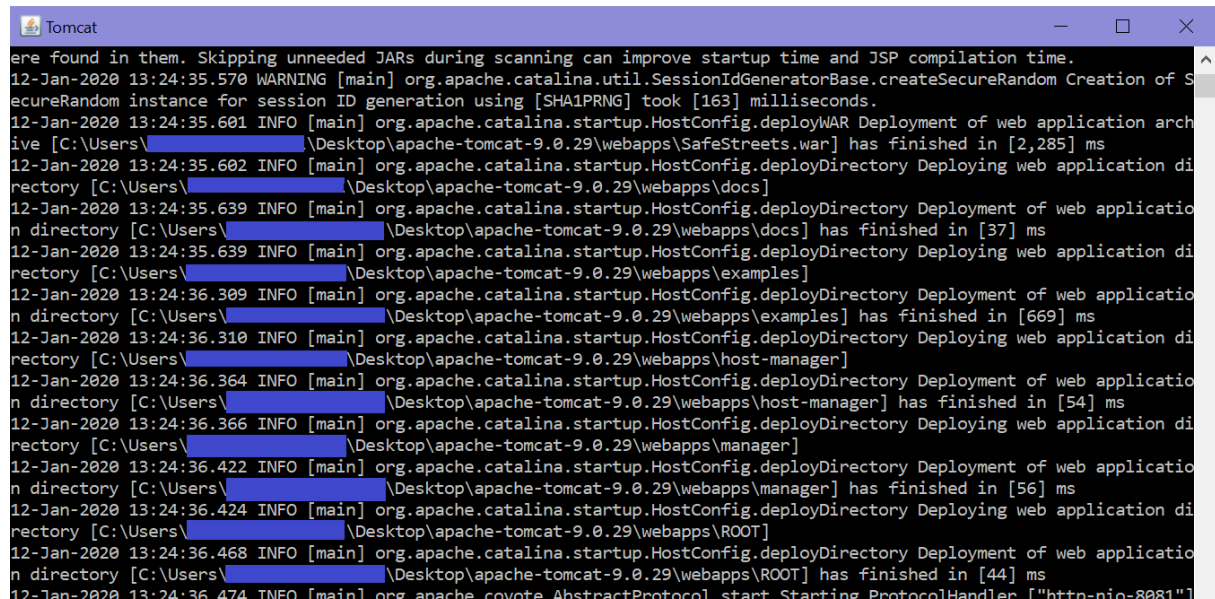
C:\Users\[redacted]>java -version
java version "13.0.1" 2019-10-15
Java(TM) SE Runtime Environment (build 13.0.1+9)
Java HotSpot(TM) 64-Bit Server VM (build 13.0.1+9, mixed mode, sharing)

C:\Users\[redacted]>
```

Figure 4: Now go to the console (for windows in the search bar search "cmd" and open command prompt) write the command `java -version` you should get an output similar to this image. If you don't get a similar message check if the variable `JAVA_HOME` is set correctly. If you get a different version from the one you installed check if you have other Oracle products installed and check if they are not interfering with the environment.

6.3 Download Tomcat

Visit the [tomcat download page](#). Download the correct version of the binary distribution for your os. For a lightweight deployment we suggest the zip version. Once downloaded unzip the folder. Open the folder and open the folder bin inside it, in this folder than execute the startup.bat for windows or startup.sh for linux. If java installation worked correctly and java home is set correctly you should get a screen like this one. if you got this screen run the shutdown.bat or shutdown.sh to stop the server. If a console flashes in and disappear immediately there is an error in the java home variable.



```

Tomcat
ere found in them. Skipping unneeded JARs during scanning can improve startup time and JSP compilation time.
12-Jan-2020 13:24:35.570 WARNING [main] org.apache.catalina.util.SessionIdGeneratorBase.createSecureRandom Creation of S
ecureRandom instance for session ID generation using [SHA1PRNG] took [163] milliseconds.
12-Jan-2020 13:24:35.601 INFO [main] org.apache.catalina.startup.HostConfig.deployWAR Deployment of web application arch
ive [C:\Users\...\Desktop\apache-tomcat-9.0.29\webapps\SafeStreets.war] has finished in [2,285] ms
12-Jan-2020 13:24:35.602 INFO [main] org.apache.catalina.startup.HostConfig.deployDirectory Deploying web application di
rectory [C:\Users\...\Desktop\apache-tomcat-9.0.29\webapps\docs]
12-Jan-2020 13:24:35.639 INFO [main] org.apache.catalina.startup.HostConfig.deployDirectory Deployment of web applicatio
n directory [C:\Users\...\Desktop\apache-tomcat-9.0.29\webapps\docs] has finished in [37] ms
12-Jan-2020 13:24:35.639 INFO [main] org.apache.catalina.startup.HostConfig.deployDirectory Deploying web application di
rectory [C:\Users\...\Desktop\apache-tomcat-9.0.29\webapps\examples]
12-Jan-2020 13:24:36.309 INFO [main] org.apache.catalina.startup.HostConfig.deployDirectory Deployment of web applicatio
n directory [C:\Users\...\Desktop\apache-tomcat-9.0.29\webapps\examples] has finished in [669] ms
12-Jan-2020 13:24:36.310 INFO [main] org.apache.catalina.startup.HostConfig.deployDirectory Deploying web application di
rectory [C:\Users\...\Desktop\apache-tomcat-9.0.29\webapps\host-manager]
12-Jan-2020 13:24:36.364 INFO [main] org.apache.catalina.startup.HostConfig.deployDirectory Deployment of web applicatio
n directory [C:\Users\...\Desktop\apache-tomcat-9.0.29\webapps\host-manager] has finished in [54] ms
12-Jan-2020 13:24:36.366 INFO [main] org.apache.catalina.startup.HostConfig.deployDirectory Deploying web application di
rectory [C:\Users\...\Desktop\apache-tomcat-9.0.29\webapps\manager]
12-Jan-2020 13:24:36.422 INFO [main] org.apache.catalina.startup.HostConfig.deployDirectory Deployment of web applicatio
n directory [C:\Users\...\Desktop\apache-tomcat-9.0.29\webapps\manager] has finished in [56] ms
12-Jan-2020 13:24:36.424 INFO [main] org.apache.catalina.startup.HostConfig.deployDirectory Deploying web application di
rectory [C:\Users\...\Desktop\apache-tomcat-9.0.29\webapps\ROOT]
12-Jan-2020 13:24:36.468 INFO [main] org.apache.catalina.startup.HostConfig.deployDirectory Deployment of web applicatio
n directory [C:\Users\...\Desktop\apache-tomcat-9.0.29\webapps\ROOT] has finished in [44] ms
12-Jan-2020 13:24:36.474 INFO [main] org.apache.coyote.AbstractProtocol.start Starting ProtocolHandler ["http-nio-8081"]

```

6.4 Download MySQL

If you have already a mysql server on your machine you may skip this part, keep in mind the server should be updated to a recent version. Visit the [MySQL insaller installation page](#). The page should show you the most appropriate installer for you operating system. Install it and run it. The installer should show you this window after loading.

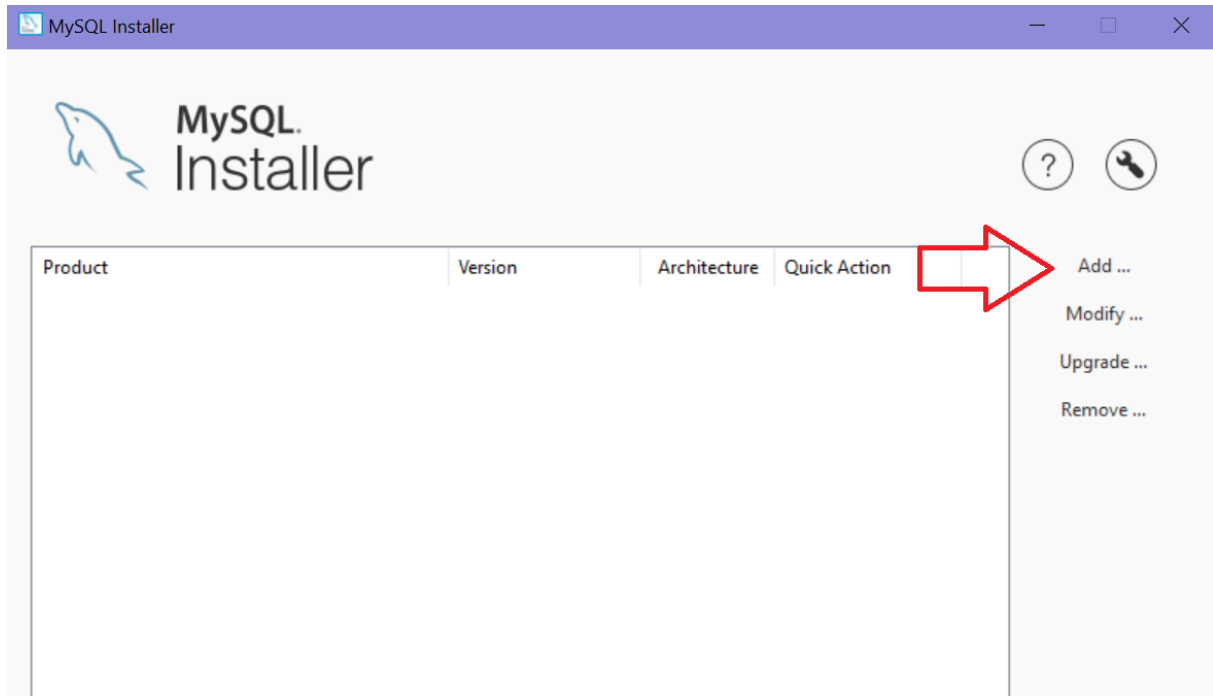


Figure 5: Click on the Add button

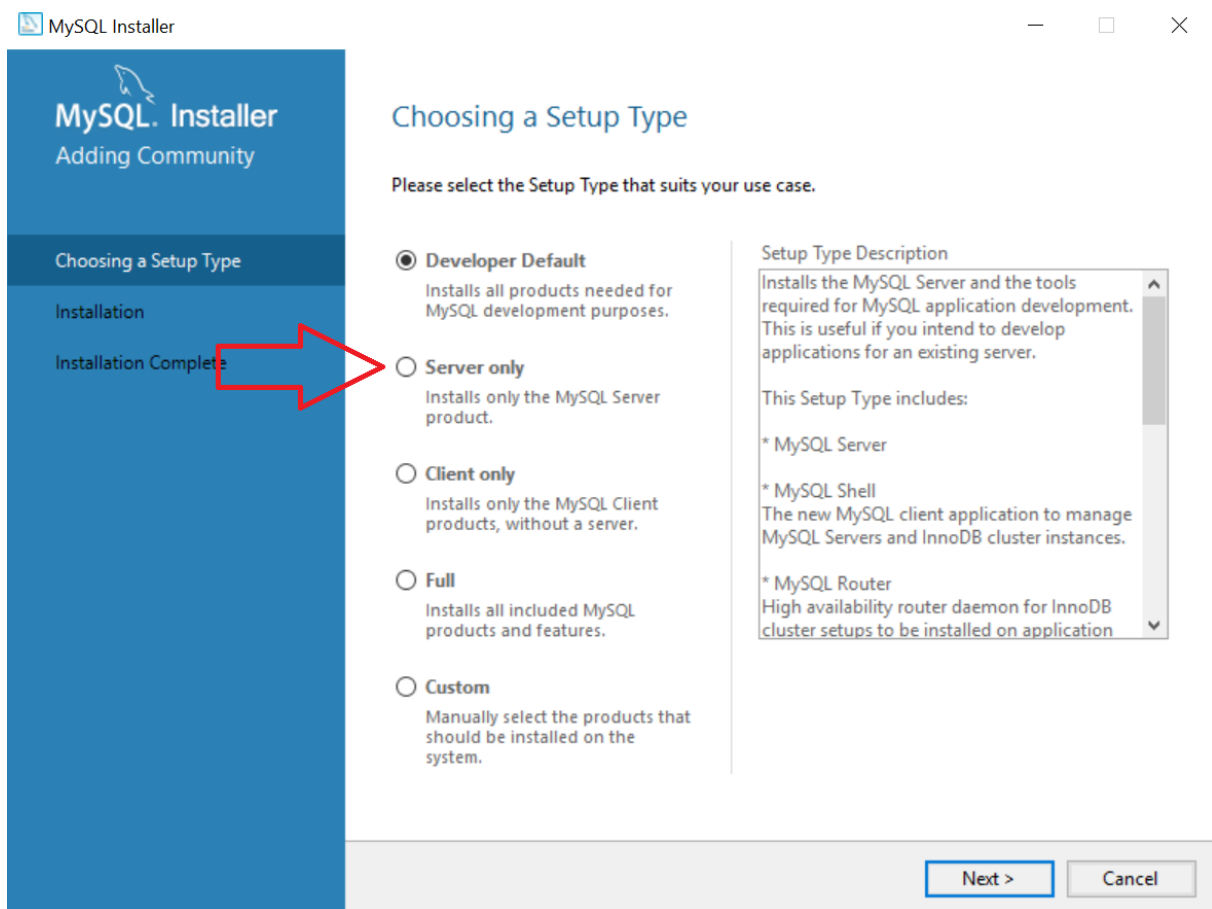


Figure 6: select Server only

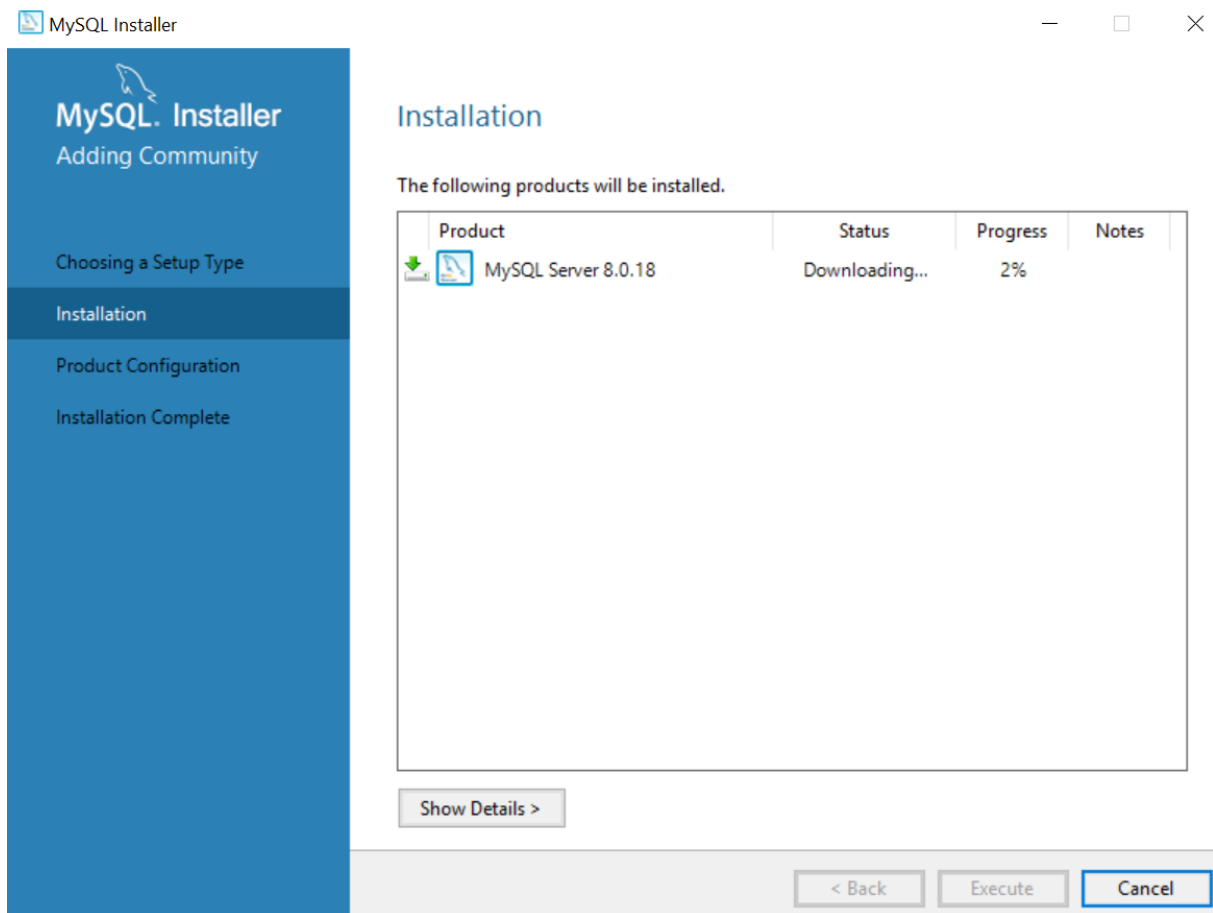


Figure 7: click execute. After the download is complete go to product configuration

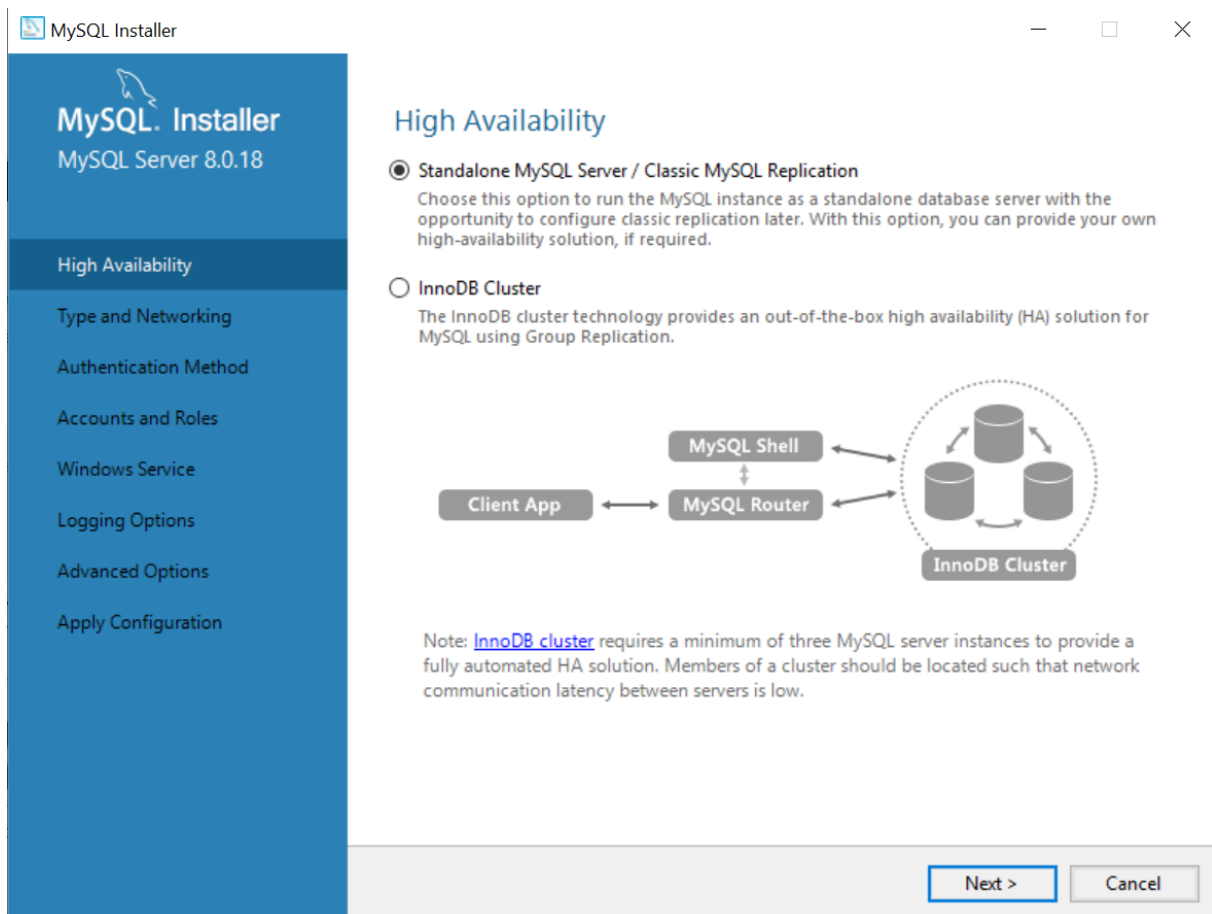


Figure 8: select Standalone MySQL Server and then click Next

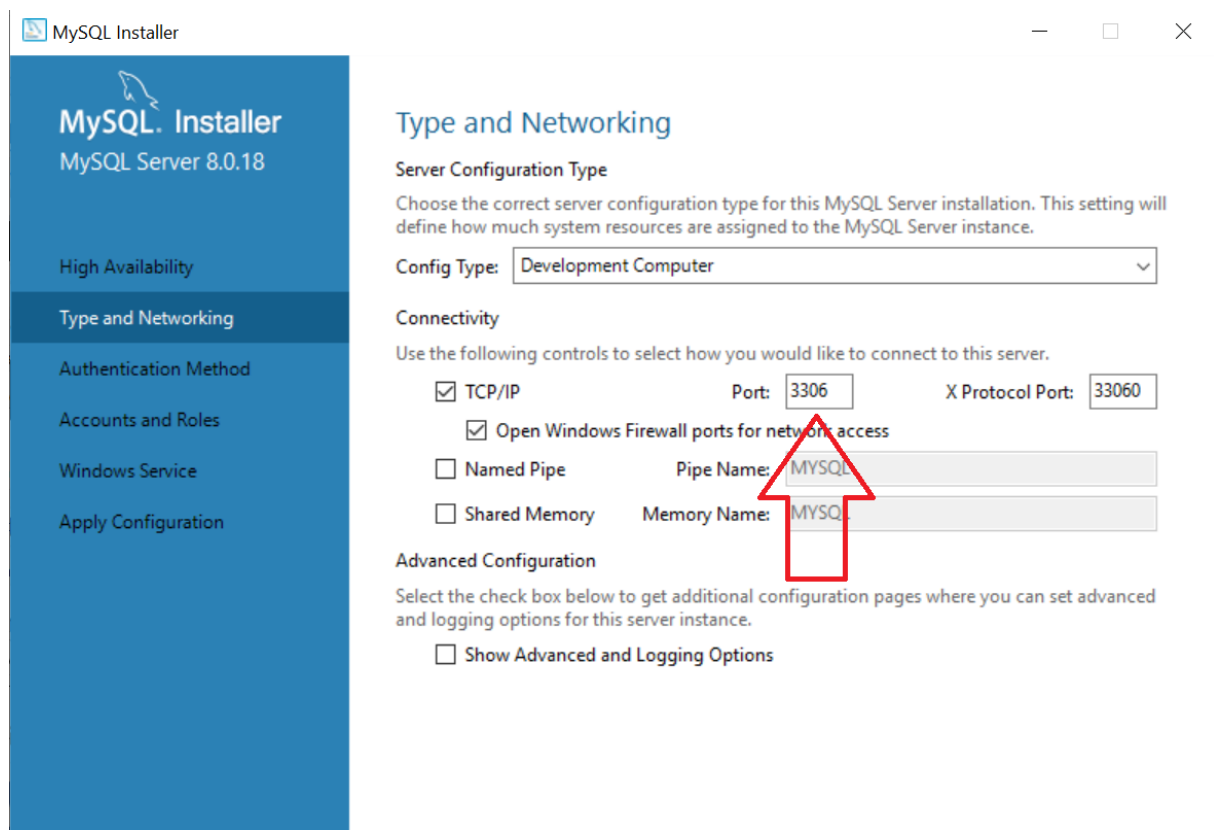


Figure 9: Check if the informations shown are the same. If you change port remember the number you insert to change later change our application setting. Click Next. Choose an authentication method. Click next.

Accounts and Roles

Root Account Password

Enter the password for the root account. Please remember to store this password in a secure place.

MySQL Root Password:	<input type="password"/>
Repeat Password:	<input type="password"/>

Figure 10: Set a password for the mysql server. Click next.

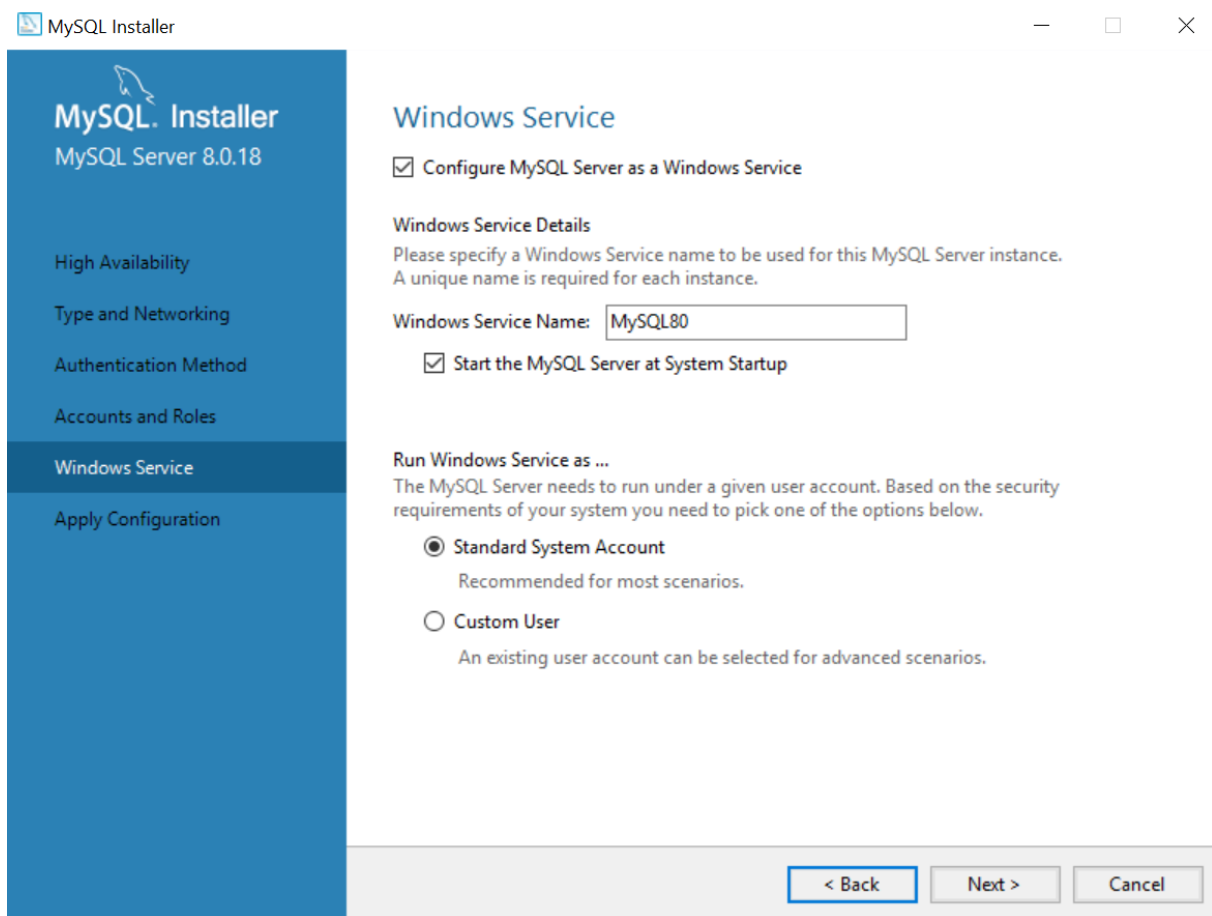


Figure 11: Click next

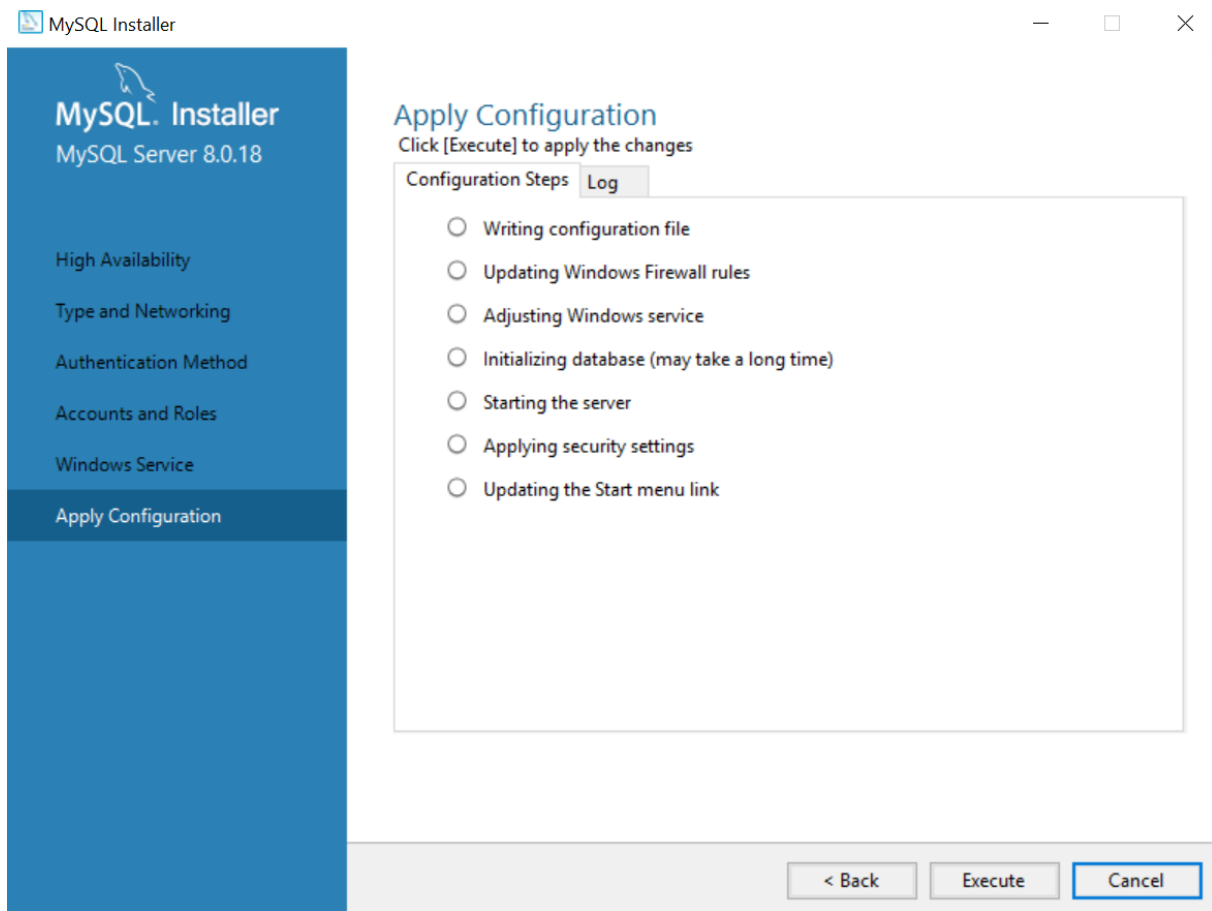


Figure 12: Click execute and after the configuration is complete click next. Your installation should be complete. Type in your search bar mysql you should get an entry called mysql 8.0 command line client open it and insert the password you have chosen for mysql. You should now be able to use my sql server on your pc.

6.5 Configure SafeStreets

From our directory get the DB.sql file and paste it inside the bin directory that you can find inside the mysql installation folder. You should find the folder inside your program folder. Now open mysql command line client. Once you log in type the commands

```
create schema safestreets;  
use safestreets;  
source DB.sql;
```

Don't forget the semicolon(;) at the end of the commands. This should install the database. Try the command

```
select * from authority;  
if a table is returned than the import is successful.
```

After this open the configuration.txt file in our directory. Don't delete the text on the left part and always keep at least a white space between left part and right part. Set the variables to the correct values. Set Db_username to the username you use to connect to mysql(if you didn't choose any write root) , db_password to the password you use to connect to the database. If you changed port for mysql server during the installation change the number 3306 with the chosen port in db_url mail_username and mail_password are used to send email to the account which registers to our service. you may put there your gmail account username and password (but only if you don't have a 2 factor authentication enabled, we suggest you to keep the account which is already there) Server Address should remain unchanged , if you modify tomcat configuration and change port please change it also here. Photo path represents the path where the photos are saved. If you want change it to desired folder (which must be accessible for both read and write operations). If you want to check what issues happens when running the code keep verbose true otherwise change true with false. Once you modified the configuration.txt put it in the tomcat folder. Now put the SafeStreets.war file from our directory in the webapps folder. Now executing the startup.bat or startup.sh from the bin folder of tomcat the server should be working. For a first check go to webapps folder and see if along with the SafeStreets app there is now a SafeStreets folder. After that open a browser search <http://localhost:8080/SafeStreets/> you should be seeing now our homepage. On tomcat console some setup messages are shown if any error occurs check out if there are errors printed there. Whenever you want to stop the server execute the shutdown.bat or shutdown.sh in the bin folder of tomcat and the server will go offline. To Start testing you can get some accounts credentials executing from mysql command line the commands.

```
use safestreets;  
select * from user;
```

You may register as a new Citizen from the login and registration page. Other users can be registered only by other users. Authorities only by municipality. Municipality only from municipalities and Managers . Managers only by managers.