AirWatcher – Design Document

This is the Design Document for the team composed of Maxence DRUTEL, Romain GALLÉ, Marie GUILLEVIC and Florian RASCOUSSIER.

Summary

[I. Application Architecture 3](#_Toc70953396)

[I.1. Architecture Design 3](#_Toc70953397)

[I.2. Class Diagram 4](#_Toc70953398)

[II. Example scenarios and sequence diagrams 5](#_Toc70953399)

[II.1. Scenario 1 – A private user needs to compare sensors 5](#_Toc70953400)

[II.2. Scenario 2 – Various users need to access the list of air cleaners 6](#_Toc70953401)

[II.3. Scenario 3 – A government user needs to mark a sensor unreliable 7](#_Toc70953402)

[III. Algorithms’ description 8](#_Toc70953403)

[III.1. FR8 – Determine the quality of air at a given time and location 8](#_Toc70953404)

[III.2. FR5 – Help determine if a sensor is reliable 11](#_Toc70953405)

[III.3. FR7 – Find the level of similarity between one specified sensor and all the others for a specific period 13](#_Toc70953406)

[IV. Test plan 16](#_Toc70953407)

[IV.1. Unitary Tests 16](#_Toc70953408)

[IV.1.a. UserController functions 16](#_Toc70953409)

[a- LoadCSV functions 16](#_Toc70953410)

[b- Authentication 17](#_Toc70953411)

[c- GetIndividualUsers 17](#_Toc70953412)

[d- GetProviders 17](#_Toc70953413)

[e- GetPrivilege 18](#_Toc70953414)

[IV.1.b. SensorController functions 19](#_Toc70953415)

[a- GetSensors 19](#_Toc70953416)

[b- GetSensor 19](#_Toc70953417)

[c- Malfunctionning analysis 20](#_Toc70953418)

[d- Mean Air Quality 21](#_Toc70953419)

[e- Compare Sensors 21](#_Toc70953420)

[f- Air Quality 22](#_Toc70953421)

[g- LoadCSV 24](#_Toc70953422)

[IV.1.c. CleanerController functions 25](#_Toc70953423)

[a- LoadCSV 25](#_Toc70953424)

[b- Compute Cleaner Statistics 25](#_Toc70953425)

[IV.2. Functional Tests 26](#_Toc70953426)

1. Application Architecture
   1. Architecture Design

We plan to design our application using the Model View Controller model (MVC). Storage classes (sensor data, user data…) will be stored in the Model package. A Controller class will oversee the execution our algorithms and our core commands. Finally, a Terminal class is responsible for recognizing user’s command and displaying the application’s outputs.

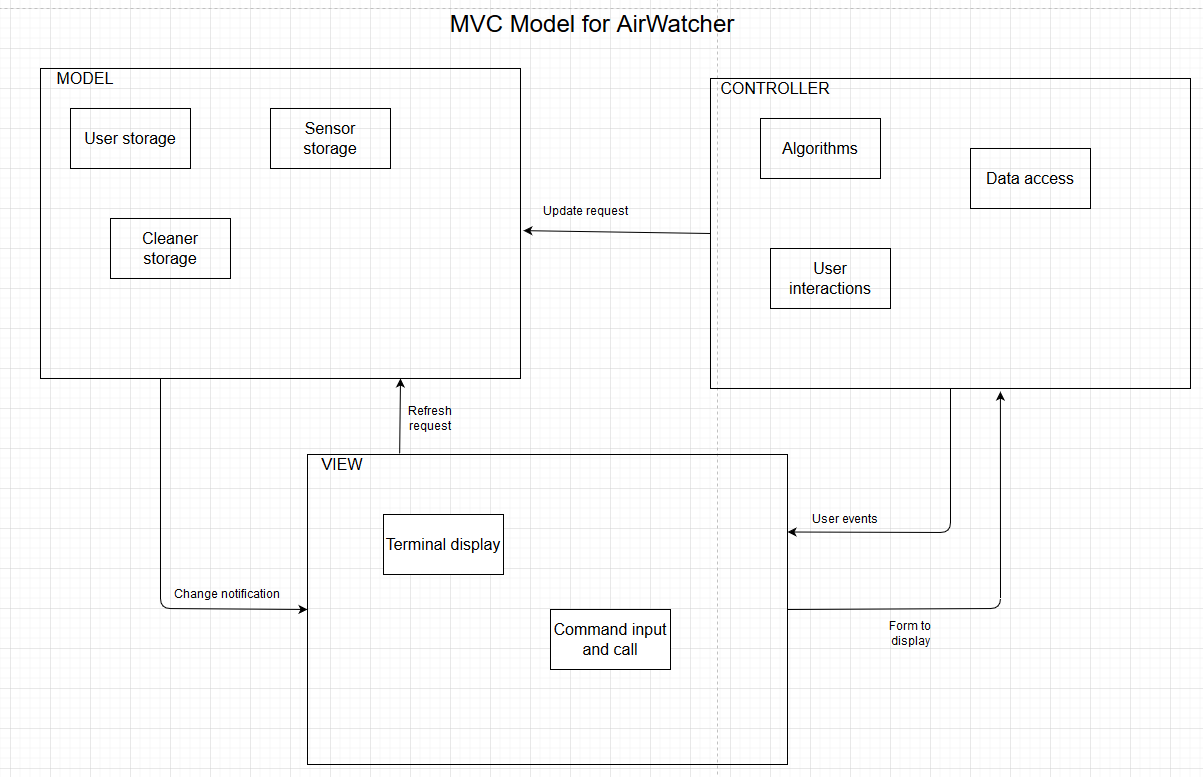


Figure 1 - MVC Architecture of AirWatcher

* 1. Class Diagram

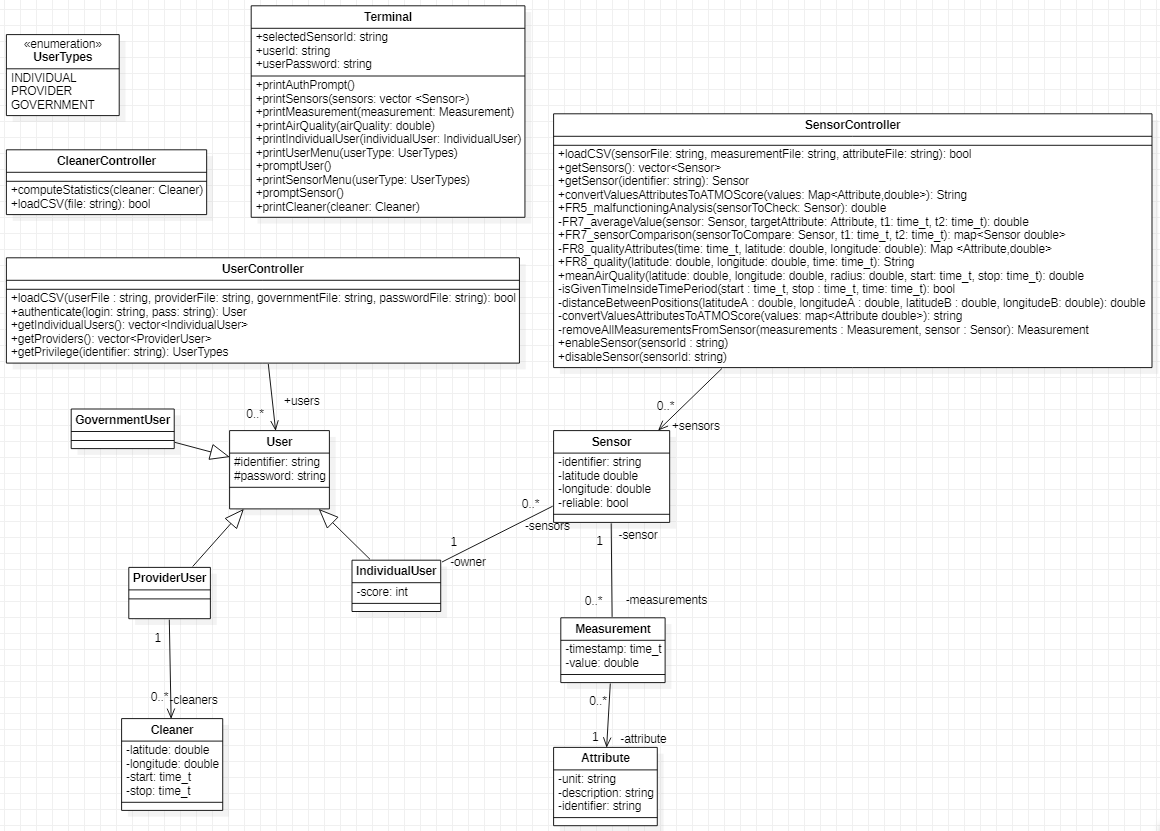


Figure 2 - Class Diagram of AirWatcher

1. Example scenarios and sequence diagrams
   1. Scenario 1 – A private user needs to compare sensors

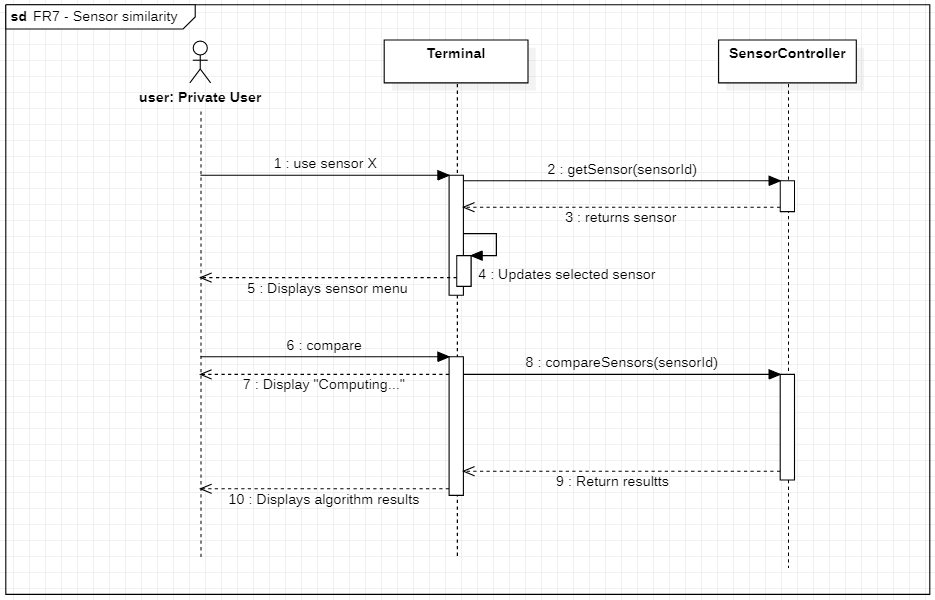


Figure 3 - A private user wants to compare sensors

* 1. Scenario 2 – Various users need to access the list of air cleaners

A user wants to get the list of air cleaners. According to his privileges, the user will be denied if he is private, access the list of owned cleaners if he is a provider, or access the list of all air cleaners if he is from government.

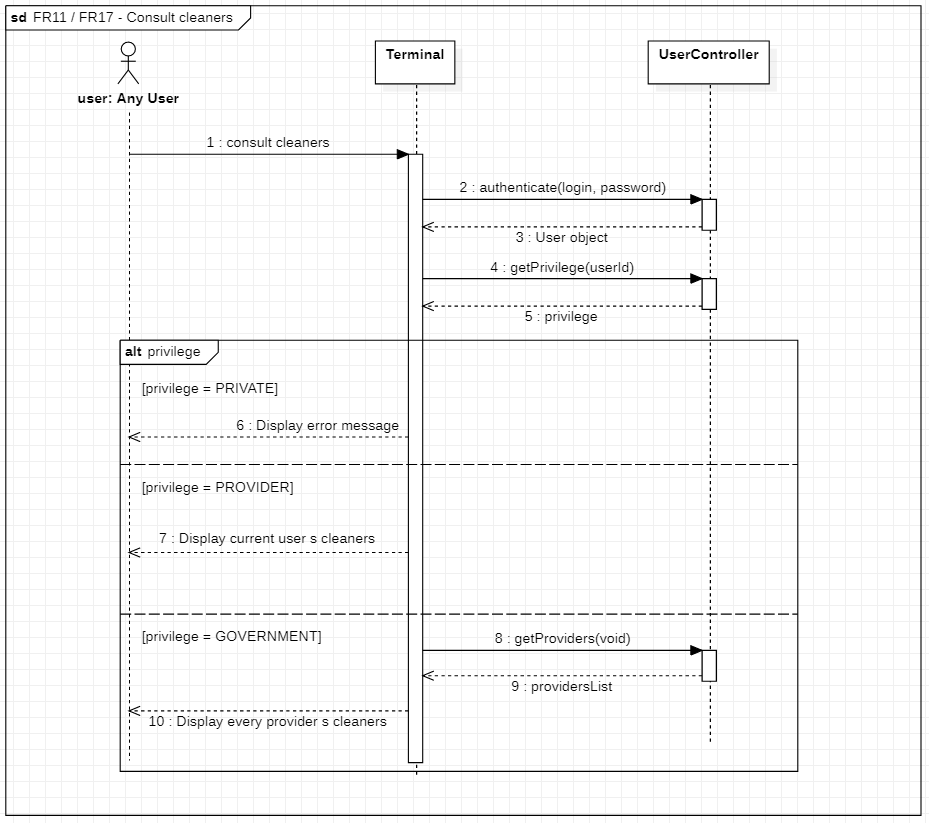


Figure 4 - Various users need to access air cleaners

* 1. Scenario 3 – A government user needs to mark a sensor unreliable

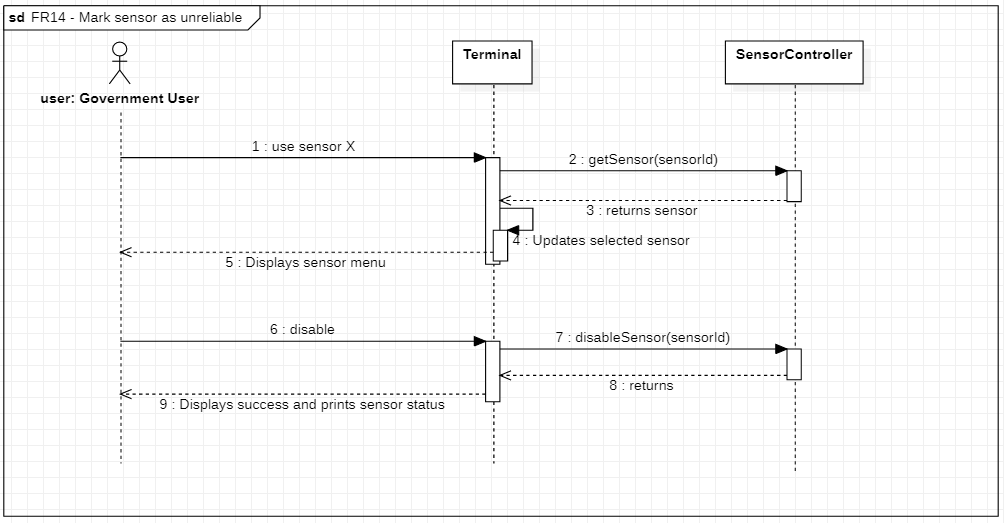


Figure 5 - A government user needs to mark a sensor unreliable

1. Algorithms’ description

Our code will work based on 3 core algorithms complying to the functional requirements of the specification document.

* 1. FR8 – Determine the quality of air at a given time and location

The goal is to determine the ATMO quality of air at a given time and location, based on the neighbouring’s sensors records. We will proceed by estimating the concentration of the 4 attributes (O3, SO2, NO2 and PM10) at the target location from all measurements made up to 24 hours before of after the target time.

We will then weight these measurements by their relative distance: the closer the sensor is, the more it will count. To proceed, we will take a random sensor and calculate its distance for the target location: it will be our referential and have a weight of 1. The weight of all other sensors will then be inversely proportionate to the distance from the target location: . If the referential is at 100m of the target location, a sensor located at 50m will have a weight of 2, and a sensor at 300m a weight of 1/3.

Finally, we determine the weighted average of measurements for each attribute from our determined weights. We can then apply the ATMO quality of air formula (<https://fr.wikipedia.org/wiki/Indice_de_qualit%C3%A9_de_l%27air>) to return the quality of air of the location at the specified time.

The worst-case complexity of this algorithm is **O(m)** where ‘m’ is the number of measurements.

algorithm FR8\_quality is

    inputs: Period timePeriod, Position askedPosition

    output: String predictedATMOScore

    call: FR8\_quality(Period timePeriod, Position askedPosition)

{

    // returns True if the timestamp is inside the period, False otherwise.

    function isGivenTimeInsideTimePeriod(Pediod period, Time timestamp) -> Boolean isInside

        if period.start <= timestamp and period.end >= timestamp

            return true

        else

            return false

    // returns the distance between 2 positions

    function distanceBetweenPositions(Position a, Position b) -> double distance

    // get a random Sensor, the fastest to get actually

    function getASensor() -> Sensor sensor

    // convert

    function convertValuesAttributesToATMOScore(Map<Attribute, double> values) -> String predictedATMOScore

    // get a list of all measurements

    function getAllMeasurements() -> Measurement[] allMeasurements

    // returns predicted values for ATMO attributes for a given position and a considered period of time for the data

    function FR8\_qualityAttributes(Period timePeriod, Position askedPosition) -> Map<Attribute, double> attributesPredictedValues

        var Attribute[] attributes := getAllAttributes() // an array of all data types (Attibutes)

        var Measurement[] allMeasurements := getAllMeasurements()

        var Map<Attribute, double> numeratorSums := {

            attributes.O3: 0.0,

            attributes.NO3: 0.0,

            attributes.SO2: 0.0,

            attributes.PM10: 0.0

        }

        var Map<Attribute, double> denominatorSums := {

            attributes.O3: 0.0,

            attributes.NO3: 0.0,

            attributes.SO2: 0.0,

            attributes.PM10: 0.0

        }

        var Sensor referentiel := getASensor()

        for each measurement in allMeasurements

            if measurement.getSensor().reliable and isGivenTimeInsideTimePeriod(timePeriod, measurement.timestamp)

                var double coefficient := distanceBetweenPositions(referentiel.position, measurement.getSensor().position)

                numeratorSums[measurement.attribute] := numeratorSums[measurement.attribute] + (coefficient \* measurement.value)

                denominatorSums[measurement.attribute] := denominatorSums[measurement.attribute] + coefficient

        var Map<Attribute, double> attributesPredictedValues := {

            attributes.O3: 0.0,

            attributes.NO3: 0.0,

            attributes.SO2: 0.0,

            attributes.PM10: 0.0

        }

        attributesPredictedValues := numeratorSum/denominatorSums

        return attributesPredictedValues

    // returns a ATMO coefficient for a given position and a considered period of time for the data

    function FR8\_quality(Period timePeriod, Position askedPosition) -> String predictedATMOScore

        var Map<Attribute, double> results := FR8\_qualityAttributes

        return convertValuesAttributesToATMOScore(results)

}

* 1. FR5 – Help determine if a sensor is reliable

The goal is to help determine if a private sensor is reliable or not. This algorithm will use our method designed for FR8 to predict values at a desired location and time based on neighbouring sensors’ data. We will thus create a list of all sensors excepting the one we want to analyse, and for each measurement of the analysed sensor, call the FR8 algorithm for the position of the sensor and the moment of each measurement.

We will then calculate the relative gap between the predicted value and the effective value measured by the sensor, which formula is:

Finally, we will sum these relative gaps for each measurement of the tested sensor and calculate an average relative gap and return it. This average relative gap represents the overall gap of the tested sensor’s measurements compared to the expected value from all other sensors. The government agency can then judge if the sensor will be marked at unreliable or not.

The worst-case complexity of this algorithm is **O(m²)**.

Algorithm FR5\_malfunctioningAnalysis is

    input: Sensor sensorToCheck

    output: Double averageRelativeGap

    call: FR5\_malfunctioningAnalysis(Sensor sensorToCheck)

{

    // get a list of all measurements

    function getAllMeasurements() -> Measurement[] allMeasurements

    // removes all the measurements from a measurement list of a given sensor

    function removeAllMeasurementsFromSensor(Measurement[] measurements, Sensor sensor) -> Measurement[] remainingMeasurements

    function FR5\_malfunctioningAnalysis(Sensor sensorToCheck) -> Boolean isReliable

        var Measurement[] measurements := getAllMeasurements()

        measurements := removeAllMeasurementsFromSensor(measurements, sensorToCheck)

        var Double relativeSum := 0.0

        var Integer nbOfMeasurementsForSensorToCheck := 0

        // for every measurement of the sensor, check if it is close to the expected one or not by adding to relative sum

        for each measurement in sensorToCheck.getMeasurements()

            var Map<Attribute, Double> expectedValues := FR8\_qualityAttributes(ALWAYS, measurement.getSensor().position)

            var Double expectedValue := expectedValues[measurement.attribute]

            var Double relativeDiff := abs(expectedValue - measurement.value) / expectedValue

            relativeSum := relativeSum + relativeDiff

            nbOfMeasurementsForSensorToCheck := nbOfMeasurementsForSensorToCheck + 1

        var Double averageRelativeGap := relativeSum / nbOfMeasurementsForSensorToCheck

        return averageRelativeGap

}

* 1. FR7 – Find the level of similarity between one specified sensor and all the others for a specific period

The goal is to estimate a level of similarity between one specified sensor and all the others for a specific period. A level of similarity of 1 means the two sensors found the same values for the period, while a similarity tending towards 0 means the two sensors had their measurements with a gap close to infinity.

To proceed, we will reuse our principle of relative gap used for the FR5 algorithm: for each Attribute, we will calculate their average value for all sensors and find the relative gap between the target sensor’s average and all other sensors using the previous formula. We will then finally average the relative gaps of all attributes to get a global relative gap between the specified sensor and the others.

Finally, we will have to determine a level of similarity, not a relative gap. It means finding a function for which (a relative gap of zero means the sensors are 100% identical) and . A fitting candidate would be an inverse function matching , thus:

We then store the level of similarity in a map along with its linked sensor and return it to the user.

The worst-case complexity of this algorithm is **O(max(s,m))** where ‘s’ is the number of sensors and ‘m’ the number of measurements.

Algorithm FR7\_sensorComparison is

    inputs: Sensor sensorToCompare, timestamp t1, timestamp t2

    output: Map<Sensor,double> proximity

    Pre-condition: sensorToCompare has measurements during the specified period

    call: FR7\_sensorComparison(Sensor sensorToCompare, timestamp t1, timestamp t2)

{

    function getAllSensors() -> Sensor[] allSensors

    // Calculates the average value of a targetted attribute of a sensor between t1 and t2

    function FR7\_averageValue(Sensor sensor, Attibute targetAttribute, timestamp t1, timestamp t2)

        var Double sum := 0

        var Integer checkedMeasurement :=0

        for each measurement in sensor.measurements

            if measurement.attribute.identifier = targetAttribute.identifier and measurement.timestamp > t1 and measurement.timestamp < t2

                sum += measurement.value

                checkedMeasurement+=1

        return sum/checedMeasurement

    //Calculates the proximity of all sensors compared to the targetted sensor: Calculates the relative gap between the average target value and the other sensors. Returns a map of all sensors with their target's proximity

    function FR7\_sensorComparison(Sensor sensorToCompare, timestamp t1, timestamp t2) {

        var Map<Sensor, double> proximity

        var Double refValues[4]; //Stores the average value of the target sensor

        var Integer i:=0

        for each attribute //NO2, O3, PM10...

            refValues[i] := FR7\_averageValue(sensorToCompare,attribute,t1,t2)

            i+=1

        for each sensor in getAllSensors()

            if sensor!=sensorToCompare

                var Double relative\_gap := 0

                var Integer i := 0

                for each attribute

                    var Double average := FR7\_averageValue(sensor,attribute,t1,t2)

                    relative\_gap += absolute(average-refValues[i])/refValues[i]

                    i+=1

                relative\_gap := relative\_gap/i

                proximity[sensor] = 1/(relative\_gap+1)

        return proximity

    }

1. Test plan

To execute the different tests, we created new csv files dedicated to the tests. We choose to take only 2 different sensors 0 and 1 and took one measurement for each of them. We also created a file for the passwords and for the government’s logins.

* 1. Unitary Tests
     1. LoadService functions

### LoadUsers

|  |  |  |
| --- | --- | --- |
| Tested Function | Test description / input | Expected result |
| loadService.loadUser(string userFile, string providerFile, string governmentFile, string passwordFile) | Paths to the following CSV files: users.csv providers.csv government.csv passwords.csv | true |
| Additional Test: Verification of the obtained user list after loading the different files | Size of userController.users should be equal to the sum of the entries in users.csv, providers.csv and government.csv | 6 |
| Additional Test: entry integrity check | Check that list entries are not empty. Check that first and last entries contains valid users, and all have password differing from null or string.empty() | N/A |

|  |  |  |
| --- | --- | --- |
| Tested Function | Test description / input | Expected result |
| loadService.loadUsers(string userFile , string providerFile, string governmentFile, string passwordFile) | Non-exisiting files and empty / not valid files | false |

### LoadSensors

|  |  |  |
| --- | --- | --- |
| Tested Function | Test description / input | Expected result |
| loadService.loadSensor(string sensorFile, string measurementFile, string attributeFile) | Path to the following CSV files: sensors\_test.csv, measurements\_test.csv, attributes.csv | true |
| Additional Test: Verification of the obtained sensors list after loading the different files | sensorController.sensors.size() | 2 |
| Additional Test: Verification of the obtained measurements list after loading the different files | Check the total number of measurements (sum of the number of measurements for each sensor) | 8 |

|  |  |  |
| --- | --- | --- |
| Tested Function | Test description / input | Expected result |
| loadService.loadSensor (string sensorFile, string measurementFile, string attributeFile) | Non-existing or invalid files | false |
| Additional Test: check sensors list integrity | Empty list before test. Check that sensorController.sensors list is empty | N/A |

### LoadCleaners

|  |  |  |
| --- | --- | --- |
| Tested Function | Test description / input | Expected result |
| loadCleaners.loadCleaners(string file) | Path to the cleaners.csv file | true |
| Additional Test: Verification of the obtained cleaners list after loading the different files | Check the total number of cleaners (sum of the number of cleaners for each provider) | 2 |

|  |  |  |
| --- | --- | --- |
| Tested Function | Test description / input | Expected result |
| loadCleaners.loadCleaners(string file) | Non-existing of invalid file | false |
| Additional Test: check cleaners list integrity | Empty lists before previous test. Check that all the providers have no cleaners registered. | N/A |

* + 1. UserService functions

### Authentication

|  |  |  |
| --- | --- | --- |
| Tested Function | Test description / input | Expected result |
| userController.authenticate(string login, string pass) | Provider0  provider0 | User object with identifier provider0 and cleaner object identifier Cleaner0 |

|  |  |  |
| --- | --- | --- |
| Tested Function | Test description / input | Expected result |
| userController.authenticate(string login, string pass) | Provider5  provider0 | Null |

### GetIndividualUsers

|  |  |  |
| --- | --- | --- |
| Tested Function | Test description / input | Expected result |
| userController.getIndividualUsers() | void | Vector of IndividualUsers objects with identifiers : User0 and User1 |

### GetProviders

|  |  |  |
| --- | --- | --- |
| Tested Function | Test description / input | Expected result |
| userController.getProviders() | void | Vector of Providers objects with identifiers : Provider0 and Provider1 |

### GetPrivilege

|  |  |  |
| --- | --- | --- |
| Tested Function | Test description / input | Expected result |
| userController.getPrivilege(string identifier) | User0 | INDIVIDUAL |

|  |  |  |
| --- | --- | --- |
| Tested Function | Test description / input | Expected result |
| userController.getPrivilege(string identifier) | Provider0 | PROVIDER |

|  |  |  |
| --- | --- | --- |
| Tested Function | Test description / input | Expected result |
| userController.getPrivilege(string identifier) | Government0 | GOVERNMENT |

|  |  |  |
| --- | --- | --- |
| Tested Function | Test description / input | Expected result |
| userController.getPrivilege(string identifier) | User8 | null |

* + 1. SensorController functions

### GetSensors

|  |  |  |
| --- | --- | --- |
| Tested Function | Test description / input | Expected result |
| sensorController.getSensors() | void | Vector of Sensor objects with identifiers: Sensor0 and Sensor1 |

### GetSensor

|  |  |  |
| --- | --- | --- |
| Tested Function | Test description / input | Expected result |
| sensorController.getSensors(string identifier) | Sensor0 | Sensor object with identifiers: Sensor0, latitude: 44 and longitude : -1 |

|  |  |  |
| --- | --- | --- |
| Tested Function | Test description / input | Expected result |
| sensorController.getSensors(string identifier) | Sensor101 | null |

### Malfunctionning analysis

This method uses several other functions to produce the wanted result:

1. removeAllMeasurementsFromSensor(Measurement[] measurements, Sensor sensor)

|  |  |  |
| --- | --- | --- |
| Tested Function | Test description / input | Expected result |
| sensorController. removeAllMeasurementsFromSensor(Measurement[] measurements, Sensor sensor) | getAllMeasurements() Sensor0 | Will give all the measurement except sensor0’s ones: Her we only have sensor1’s measurements |

|  |  |  |
| --- | --- | --- |
| Tested Function | Test description / input | Expected result |
| sensorController. removeAllMeasurementsFromSensor(Measurement[] measurements, Sensor sensor) | getAllMeasurements() sensor101 | null |

1. FR5\_malfunctioningAnalysis(in sensorToCheck:Sensor): double

|  |  |  |
| --- | --- | --- |
| Tested Function | Test description / input | Expected result |
| sensorController. FR5\_malfunctioningAnalysis(Sensor sensorToCheck) | sensor0 | 0.08 |

|  |  |  |
| --- | --- | --- |
| Tested Function | Test description / input | Expected result |
| sensorController. FR5\_malfunctioningAnalysis(Sensor sensorToCheck) | sensor101 | null |

### Mean Air Quality

|  |  |  |
| --- | --- | --- |
| Tested Function | Test description / input | Expected result |
| sensorController. meanAirQuality(double latitude, double longitude, double radius, time\_t start, time\_t stop) | 45  -2  5  01/01/2019 12:00:00 01/01/2019 12:00:00 | mediocre |

|  |  |  |
| --- | --- | --- |
| Tested Function | Test description / input | Expected result |
| sensorController. meanAirQuality(double latitude, double longitude, double radius, time\_t start, time\_t stop) | 45  -2  5  01/01/2019 12:00:00  15/15/2025 12:00:00 | null |

### Compare Sensors

This method uses several other functions to produce the wanted result:

1. FR7\_averageValue(Sensor sensor, Attibute targetAttribute, time\_t t1, time\_t t2)

Compute the average value of all its measurements for the given attribute

|  |  |  |
| --- | --- | --- |
| Tested Function | Test description / input | Expected result |
| sensorController. FR7\_averageValue(Sensor sensor, Attibute targetAttribute, time\_t t1, time\_t t2) | sensor0  03  01/01/2019 12:00:00  01/01/2019 12:00:00 | 50.25 |

|  |  |  |
| --- | --- | --- |
| Tested Function | Test description / input | Expected result |
| sensorController. FR7\_averageValue(Sensor sensor, Attibute targetAttribute, time\_t t1, time\_t t2) | sensor0  o2  01/01/2019 12:00:00  01/01/2019 12:00:00 | null |

2- FR7\_sensorComparison (Sensor sensorToCompare, timestamp t1, timestamp t2)

|  |  |  |
| --- | --- | --- |
| Tested Function | Test description / input | Expected result |
| sensorController. FR7\_sensorComparison (Sensor sensorToCompare, timestamp t1, timestamp t2) | Sensor0  01/01/2019 12:00:00  01/01/2019 12:00:00 | A map with Sensor object and a double value (similarity 0 to 1) :  Sensor1 and 0.846 |

|  |  |  |
| --- | --- | --- |
| Tested Function | Test description / input | Expected result |
| sensorController. FR7\_sensorComparison (Sensor sensorToCompare, timestamp t1, timestamp t2) | Sensor101  01/01/2019 12:00:00  01/01/2019 12:00:00 | null |

### Air Quality

This method uses several other functions to produce the wanted result:

1. isGivenTimeInsideTimePeriod(time\_t start, time\_t : stop, time\_t: time): bool

|  |  |  |
| --- | --- | --- |
| Tested Function | Test description / input | Expected result |
| sensorController. isGivenTimeInsideTimePeriod(time\_t start, time\_t : stop,time\_t: time): bool | 01/01/2019 12:00:00  01/01/2019 12:00:00  01/01/2019 12:00:00 | true |

|  |  |  |
| --- | --- | --- |
| Tested Function | Test description / input | Expected result |
| sensorController. isGivenTimeInsideTimePeriod(time\_t start, time\_t : stop, time\_t: time): bool | 01/01/2019 12:00:00  01/01/2020 12:00:00  01/01/2025 12:00:00 | null |

1. distanceBetweenPositions (double latitudeA, double longitude, double latitudeB, double longitudeB)

|  |  |  |
| --- | --- | --- |
| Tested Function | Test description / input | Expected result |
| sensorController. distanceBetweenPositions (double latitudeA, double longitude, double latitudeB, double longitudeB) | 44  -1  45  -2 | 1.41 |

1. FR8\_qualityAttributes (double latitude, double longitude, time\_t time)

|  |  |  |
| --- | --- | --- |
| Tested Function | Test description / input | Expected result |
| sensorController. FR8\_qualityAttributes (double latitude, double longitude, time\_t time) | 45  -2  01/01/2019 12:00:00 | Returns a Map<Attribute,double> with the Attribute object’s identifiers o3, No2, So2 and PM10 and their corresponding measurement:  O3 : 55.56  NO2 : 69.28  S02 : 38.56  PM10 : 47.39 |

|  |  |  |
| --- | --- | --- |
| Tested Function | Test description / input | Expected result |
| sensorController. FR8\_qualityAttributes (double latitude, double longitude, time\_t time) | 45  -2  15/15/2025 12:00:00 | null |

1. FR8\_quality (double latitude, double longitude, time\_t time)

|  |  |  |
| --- | --- | --- |
| Tested Function | Test description / input | Expected result |
| sensorController. FR8\_quality (double latitude, double longitude, time\_t time) | 45  -2  01/01/2019 12:00:00 | String equal to “Mediocre” |

|  |  |  |
| --- | --- | --- |
| Tested Function | Test description / input | Expected result |
| sensorController. FR8\_quality (double latitude, double longitude, time\_t time) | 45  -2  15/15/2025 12:00:00 | null |

* + 1. CleanerController functions

### Compute Cleaner Statistics

|  |  |  |
| --- | --- | --- |
| Tested Function | Test description / input | Expected result |
| cleanerController.computeStatistics(Cleaner cleaner) | Cleaner with identifier Cleaner0 | null |

* 1. Functional Tests

To test the different functionalities of our application we need to define what happens at each step of the scenario.  

**1 - Login fail**

|  |  |  |  |
| --- | --- | --- | --- |
| **Step** | **Description** | **Input** | **Results** |
| 1 | The user has to login | Id : User101  Password: banana | You don’t have access to the application. Please enter a good id or password. |

**2 - Access sensors list**

|  |  |  |  |
| --- | --- | --- | --- |
| **Step** | **Description** | **Actions** | **Results** |
| 1 | The user has to login | Id: Government0  Password: government0 | You are connected.  Menu  1- get\_sensors  2- use\_sensor <num>  3- airQ <latitude> <longitude> <start\_date><end\_date>  4- airQ <latitude> <longitude> <date>  5- consult cleaner <num>  6- get users  7- get providers  8- get\_cleaners  Which functionality do you want to use? |
| 2 | He then has to choose a functionality | get sensors | Name : Sensor0 Longitude: 44 Latitude: -1  Name : Sensor1 Longitude: 44 Latitude: -0.3  (The options are once again displayed) |

**3 - Retrieve sensor’s measurements**

|  |  |  |  |
| --- | --- | --- | --- |
| **Step** | **Description** | **Actions** | **Results** |
| 1 | The user has to login | Id : Government0  Password: government0 | You are connected.  Menu  1- get\_sensors  2- use sensor <num>  3- airQ <latitude> <longitude> <start\_date><end\_date>  4- airQ <latitude> <longitude> <date>  5- consult cleaner <num>  6- get users  7- get providers  8- get\_cleaners  Which functionality do you want to use? |
| 2 | He then has to choose a functionality | use sensor <0> | Name: Sensor0 Longitude: 44 Latitude: -1  Sensor Menu :  1- measurements  2- measurements<date>  3- evaluate  4- disable  5- enable  6- compare  7- menu  Which functionality do you want to use? |
| 3 | He then has to choose an option in the new menu | measurements | Date : 01/01/2019 12:00  O3 : 50.25  NO2: 74.5  SO2: 41.5  PM10: 44.75  (The options are once again displayed) |

**4 - Retrieve sensor’s measurements at a special date**

|  |  |  |  |
| --- | --- | --- | --- |
| **Step** | **Description** | **Actions** | **Results** |
| 1 | The user has to login | Id : Government0  Password: government0 | You are connected.  Menu  1- get\_sensors  2- use sensor <num>  3- airQ <latitude> <longitude> <start\_date><end\_date>  4- airQ <latitude> <longitude> <date>  5- consult cleaner <num>  6- get users  7- get providers  8- get\_cleaners  Which functionality do you want to use? |
| 2 | He then has to choose a functionality | use sensor <0> | Name: Sensor0 Longitude: 44 Latitude: -1  Sensor Menu :  1- measurements  2- measurements<date>  3- evaluate  4- disable  5- enable  6- compare  7- menu  Which functionality do you want to use? |
| 3 | He then has to choose an option in the new menu | Measurements<01/01/2019 12:00> | Date : 01/01/2019 12:00  O3 : 50.25  NO2: 74.5  SO2: 41.5  PM10: 44.75  (The options are once again displayed) |

**5 - Run malfunctioning sensor detection analysis**

|  |  |  |  |
| --- | --- | --- | --- |
| **Step** | **Description** | **Actions** | **Results** |
| 1 | The user has to login | Id : Government0  Password: government0 | You are connected.  Menu  1- get\_sensors  2- use sensor <num>  3- airQ <latitude> <longitude> <start\_date><end\_date>  4- airQ <latitude> <longitude> <date>  5- consult cleaner <num>  6- get users  7- get providers  8- get\_cleaners  Which functionality do you want to use? |
| 2 | He then has to choose a functionality | use sensor <0> | Name: Sensor0 Longitude: 44 Latitude: -1  Sensor Menu :  1- measurements  2- measurements<date>  3- evaluate  4- disable  5- enable  6- compare  7- menu  Which functionality do you want to use? |
| 3 | He then has to choose an option in the new menu | evaluate | 0.08  *(The options are once again displayed)* |

**6 - Mark specific sensor as unreliable *(Only for the government agency)***

|  |  |  |  |
| --- | --- | --- | --- |
| **Step** | **Description** | **Actions** | **Results** |
| 1 | A government agent has to login | Id : Government0  Password: government0 | You are connected.  Menu  1- get\_sensors  2- use sensor <num>  3- airQ <latitude> <longitude> <start\_date><end\_date>  4- airQ <latitude> <longitude> <date>  5- consult cleaner <num>  6- get users  7- get providers  8- get\_cleaners  Which functionality do you want to use? |
| 2 | He then has to choose a functionality | use sensor <0> | Name: Sensor0 Longitude: 44 Latitude: -1  Sensor Menu :  1- measurements  2- measurements<date>  3- evaluate  4- disable  5- enable  6- compare  7- menu  Which functionality do you want to use? |
| 3 | He then has to choose an option in the new menu | disable | Sensor0 has been disabled.  *(The options are once again displayed)* |

Similar test but for the functionality: Mark specific sensor as reliable. The command is now enabled, and the result should be displayed: Sensor0 has been enabled.

**7 - Compare the similarity between the other sensors**

|  |  |  |  |
| --- | --- | --- | --- |
| **Step** | **Description** | **Actions** | **Results** |
| 1 | The user has to login | Id : Government0  Password: government0 | You are connected.  Menu  1- get\_sensors  2- use sensor <num>  3- airQ <latitude> <longitude> <start\_date><end\_date>  4- airQ <latitude> <longitude> <date>  5- consult cleaner <num>  6- get users  7- get providers  8- get\_cleaners  Which functionality do you want to use? |
| 2 | He then has to choose a functionality | use sensor <0> | Name: Sensor0 Longitude: 44 Latitude: -1  Sensor Menu :  1- measurements  2- measurements<date>  3- evaluate  4- disable  5- enable  6- compare  7- menu  Which functionality do you want to use? |
| 3 | He then has to choose an option in the new menu | compare | Sensor1 : 85%  *(The options are once again displayed)* |

**8 - Consult a sensor: failed attempt**

|  |  |  |  |
| --- | --- | --- | --- |
| **Step** | **Description** | **Actions** | **Results** |
| 1 | The user has to login | Id : Government0  Password: government0 | You are connected.  Menu  1- get\_sensors  2- use sensor <num>  3- airQ <latitude> <longitude> <start\_date><end\_date>  4- airQ <latitude> <longitude> <date>  5- consult cleaner <num>  6- get users  7- get providers  8- get\_cleaners  Which functionality do you want to use? |
| 2 | He then has to choose a functionality | use sensor <102> | No sensor found  1- get\_sensors  2- use sensor <num>  3- airQ <latitude> <longitude> <start\_date><end\_date>  4- airQ <latitude> <longitude> <date>  5- consult cleaner <num>  6- get users  7- get providers  8- get\_cleaners  Which functionality do you want to use? |

**9 - Retrieve mean quality of air on a specified area**

|  |  |  |  |
| --- | --- | --- | --- |
| **Step** | **Description** | **Actions** | **Results** |
| 1 | The user has to login | Id : Government0  Password: government0 | You are connected.  Menu  1- get\_sensors  2- use sensor <num>  3- airQ <latitude> <longitude> <start\_date><end\_date>  4- airQ <latitude> <longitude> <date>  5- consult cleaner <num>  6- get users  7- get providers  8- get\_cleaners  Which functionality do you want to use? |
| 2 | He then has to choose a functionality | airQ <45> <-2> <01/01/2019 12:00><01/01/2019 12:00>” | Mean air quality : mediocre  (The options are once again displayed) |

Similar test but with an error in the dates, the latitude, or the longitude.   
Result: “Error in the input, please try again”

**10 - Retrieve quality of air at a given position and time**

|  |  |  |  |
| --- | --- | --- | --- |
| **Step** | **Description** | **Actions** | **Results** |
| 1 | The user has to login | Id : Government0  Password: government0 | You are connected.  Menu  1- get\_sensors  2- use sensor <num>  3- airQ <latitude> <longitude> <start\_date><end\_date>  4- airQ <latitude> <longitude> <date>  5- consult cleaner <num>  6- get users  7- get providers  8- get\_cleaners  Which functionality do you want to use? |
| 2 | He then has to choose a functionality | Enter the command “airQ <45> <-2> <01/01/2019 12:00>” | Air Quality : mediocre  (The options are once again displayed) |

Similar test but with an error in the date, the latitude, or the longitude.   
Result : “Error in the input, please try again”.

**11 – Access the list of owned air cleaners (Only for providers)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Step** | **Description** | **Actions** | **Results** |
| 1 | The Provider has to login | Id : Provider0  Password: provider0 | You are connected.  Menu  1- get\_sensors  2- use sensor <num>  3- airQ <latitude> <longitude> <start\_date><end\_date>  4- airQ <latitude> <longitude> <date>  5- consult cleaner <num>  6- get\_cleaners  Which functionality do you want to use? |
| 2 | He then has to choose a functionality | consult cleaner<0> | Name : Cleaner0  Latitude: 45.3333  Longitude: 1.33333  Installation date : 01/02/2019 12:00:00  (The options are once again displayed) |

**12 - Access individual users list *(Only for the government agency)***

|  |  |  |  |
| --- | --- | --- | --- |
| **Step** | **Description** | **Actions** | **Results** |
| 1 | The Government agent has to login | Id : Government0  Password: government0 | You are connected.  Menu  1- get\_sensors  2- use sensor <num>  3- airQ <latitude> <longitude> <start\_date><end\_date>  4- airQ <latitude> <longitude> <date>  5- consult cleaner <num>  6- get users  7- get providers  8- get\_cleaners  Which functionality do you want to use? |
| 2 | He then has to choose a functionality | get users | Name: User0  Sensor: Sensor70  Name: User1  Sensor: Sensor36  (The options are once again displayed) |

**13 - Access all air cleaners providers list (Only for the government agency)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Step** | **Description** | **Actions** | **Results** |
| 1 | The Government agent has to login | Id : Government0  Password: government0 | You are connected.  Menu  1- get\_sensors  2- use sensor <num>  3- airQ <latitude> <longitude> <start\_date><end\_date>  4- airQ <latitude> <longitude> <date>  5- consult cleaner <num>  6- get users  7- get providers  8- get\_cleaners  Which functionality do you want to use? |
| 2 | He then has to choose a functionality | get providers | Name: Provider0  Sensor: Cleaner0  Name: Provider1  Sensor: Cleaner1  (The options are once again displayed) |