App Manual

1DI, Group 40

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1. Introduction

Purpose and Scope

In this manual, we will describe the development process of the proposed application. We will address several topics, from the structure and main features of the application to its objective (**System Overview**). Next, it will also be discussed how the software installation procedure of the **Vaccine Hub** application developed by the Green Code team (**Software Installation**) works. It also contains a list of solutions for possible problems that may arise to help the user to solve these same problems (**Troubleshooting**). The contacts of the development team of this same application will also be provided to provide support to users of the **Vaccine Hub** application (**Contacts**). Finally, we will have a topic (**FAQs**) where you can find answers to the most frequently asked questions regarding the application.

It should be noted that this manual was prepared in the most succinct and objective way possible so that it is easy to understand for the target audience of this document.

System Overview

This project aims to develop an application aimed at health, with the objective of helping in the management of the entire vaccination process of a specific Health Unit, culminating with all the knowledge acquired by the development team during this semester in the curricular units taught (ESOFT, PPROG, MDISC, MATCP and LAPR2).

Vaccine Hub, an application developed by the Green Code development team, aims to manage the entire vaccination process, not only aimed at Covid-19 but also designed with the idea of being able to support the management of any type of future events that require a mass vaccination.

This application allows all users to schedule vaccines, to consult the list of users who are waiting and who are ready to be vaccinated in an organized and efficient way, to be able to register the vaccines administered, to evaluate the performance and statistics of each vaccination post, among other various features.

 The following figure shows the main modules:
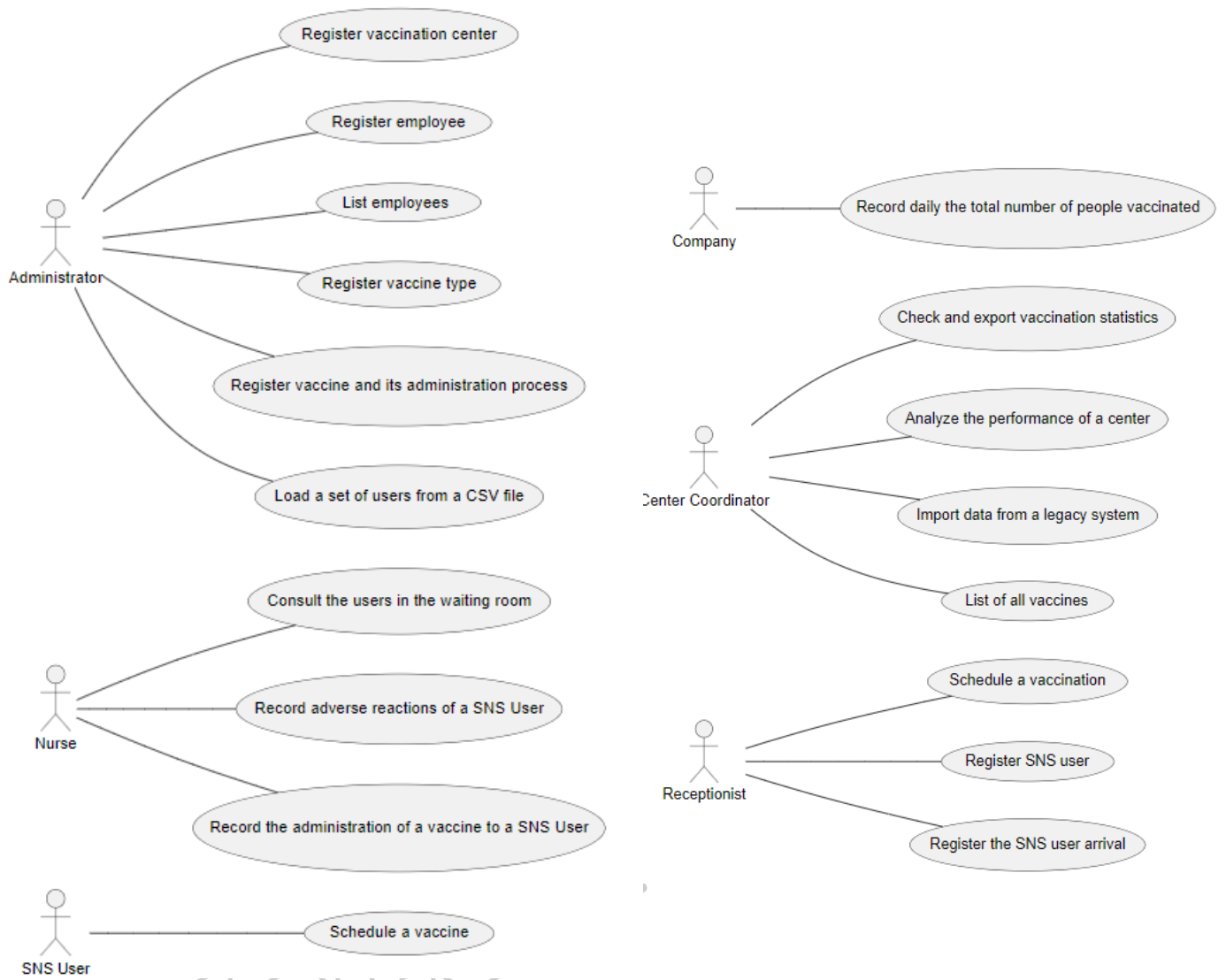
Figure 1- Main Modules

System Requirements

Vaccine Hub can run on any operating system without any problems, as it is a Maven Java project.

This was also designed with the intention that it can be performed on all devices present in the market.

We also recommend that the device has at least 2GB of RAM and at least 100MB of disk space.

Software Installation

For the proper functioning of the Vaccine Hub and for better use, you must carefully follow all the following steps:

Step 1) Java installation:

1. You must search for Java Download in your bowser;
2. You must select the official link to download;
3. You must click on the green button that says "Download";
4. Then you should receive the latest version of the Java download executable;
5. Later, you must save it on your computer and open;
6. Finally, you must follow the download steps that you will receive and complete the entire process and you will be ready to use!

Step 2) JavaFX installation:

1. You must search for JavaFX in your browser;
2. You must open the official JavaFX link;
3. Then scroll down until you find the "Download" button and click on it;
4. Next, you must also scroll down until you see the operating system downloads and select the one that corresponds to yours;
5. You will receive the JavaFX zip file;
6. After opening the file, click on the "Extract to" button;
7. Finally, you must then select the path that contains the previously downloaded Java and you are done!

Step 3) Running the Vaccine Hub:

1. After downloading the Vaccine Hub zip folder, you must extract it as in the JavaFX installation (Step 2 - 6);
2. Then you can open the extracted file;
3. There you can find the Vaccine Hub Jar executable;
4. That said, you can open and enjoy the application!

2. System Features

Main Menu

The application's main menu consists of 3 options:

- **Login -** Functionality for the administrator, receptionist and nurse to login to the application.
- **Schedule Vaccine -** Functionality for the SNS user to schedule his vaccine.
- **Know the Development Team –** Functionality to meet the application development team.

```
*** Main Menu ***
1. Do Login
2. Schedule Vaccine
3. Know the Development Team


0 - Cancel
Type your option:
```

Figure 2- Main Menu

If the choice is **1 – Login** provides the login where any user can login with 3 attempts to do.

```
Login UI:
Enter UserId/Email:
```

Figure 3- Login

If the choice is **2 – Schedule Vaccine** the SNS User will have to schedule vaccine where he will have to enter the following data:

- **SNS User Number**
- **Vaccine Center**
- **Date and Hour**
- **Vaccine type**

At the end of entering all data Lists the entered data to be confirmed by typing "y".

```
Insert SNS User Number:
987654321
Select Vaccination center
1. Name: VacinaBraco
Address: Rua alberto Porto
Phone Number: 987654321
Email: pica@mail.com
Fax Number: 987654321
Website: pica.pt
Opening Hours: 08:00 AM
Closing Hours: 08:00 PM
Slot Duration: 10
Slot Vaccine Limit: 10

0 - Cancel
Type your option:
1
Insert intended date (dd/mm/yyyy):
19/06/2022
Insert intended time:
Insert hours:
19
Insert minutes:
00
Select Vaccination type
1. Code: 00001 | Description: Spikevax description | Technology: Messenger RNA (mRNA) vaccines

0 - Cancel
Type your option:
1
```

```
Confirm the data:
SNS user number: 987654321
Date: Sunday, 19 of June of 2022
Time: 07:00 PM


Is the data correct? (Y/N)
y
Operation complete
```

Figure 4– Schedule Vaccine

If the choice is **3 – Know the Development Team** the list of members of group 40, Green Code, is displayed. After listing the members back to login.

```
Development Team:
        Gabriel Goncalves - 1191296@isep.ipp.pt
        Tiago Leite - 1191369@isep.ipp.pt
        João Durães - 1211314@isep.ipp.pt
        Francisco Bogalho - 1211304@isep.ipp.pt
        António Bernardo - 1210805@isep.ipp.pt
```

Figure 5 –Know the Development Team

Admin Menu

The application's admin menu consists of 6 options:

- **Register a vaccination center** – Functionality for the administrator to register a new vaccination center in the system.
- **Register an Employee** - Functionality for the administrator to register a new employee in the system and assign it a role.
- **List of employees** - Functionality for the administrator to list every employee registered in the system.
- **Specify a new vaccine type** - Functionality for the administrator to register a new vaccine type in the system.
- **Specify a new vaccine and its administration process** - Functionality for the administrator to register a new vaccine and its administration process in the system.
- **Load file with SNS Users data** - Functionality for the administrator to load, into the system, a file with the data of an SNS user account.

```
*** Admin Menu ***
1. Register a vaccination center
2. Register an employee
3. List of employees
4. Specify a new vaccine type
5. Specify a new vaccine and its administration process
6. Load file with SNS Users data

0 - Cancel
Type your option:
```

Figure 6– Admin Menu

Register a vaccination center

If the choice is **1 – Register a vaccination center** the admin will have to register a vaccine center where he will have to enter the following data:

- **Name**;
- **Address**;
- **Phone number** – the application validates if the number starts with 9 and has more than 9 digits;
- **Email –** the application validates if the email has "@" and the domain ex: ".pt";

- **Fax number**– the application validates if the number starts with 9 and has more than 9 digits;
- **Website**;
- **Opening hours and Closing hours**– the application validates if the admin enters incorrect dates ex: "31:68;
- **Slot duration and slot vaccine limit**;

At the end of entering all data Lists the entered data to be confirmed by typing "y".

```
*** Vaccination Center ***
Insert name:
RamaldeVacina
Insert address:
Rua de Ramalde, n99, 4350-100, Ramalde, Porto
Insert phone number:
987654321
Insert email:
ramaldevacina@saude.pt
Insert fax number:
987654321
Insert website:
ramaldevacina.pt
Insert Opening Hours:
Insert hours:
9
Insert minutes:
30
Insert Closing Hours:
Insert hours:
18
Insert minutes:
00
Insert slot duration:
5
Insert slot vaccine limit:
5
```

```
*** New Vaccination Center Data ***
Name: RamaldeVacina
Address: Rua de Ramalde, n99, 4350-100, Ramalde, Porto
Phone Number: 987654321
Email: ramaldevacina@saude.pt
Fax Number: 987654321
Website: ramaldevacina.pt
Opening Hours: 09:30 AM
Closing Hours: 06:00 PM
Slot Duration: 5
Slot Vaccine Limit: 5


Want to confirm the data? (y/n)
y
New vaccine center successfully ads!
```

Figure 7– Regist Vaccine Center

Register an Employee

If the choice is **2 – Register an Employee** the admin will have to register a employee where he will have to enter the following data:

- **Name**;

- **Address**;

- **Phone number** – the application validates if the number starts with 9 and has more than 9 digits;

- **Email –** the application validates if the email has "@" and the domain ex: ".pt";

- **Citizen card number**

- **Employee type**

At the end of entering all data Lists the entered data to be confirmed by typing "y".

```
Insert name:
Maria
Insert address:
Rua do Isep, Ipo, n 123, 4999-101, Porto
Insert phone number:
987654321
Insert email:
maria@mail.com
Insert citizen card number:
123456789
Employees types
Choose the type of employee you want to create:
1. ID: 1 | Description: NURSE
2. ID: 2 | Description: RECEPTIONIST
3. ID: 3 | Description: CENTER COORDINATOR

0 - Cancel
Type your option:
1
```

```
Confirm the data:
The name: Maria
The address: Rua do Isep, Ipo, n 123, 4999-101, Porto
The phoneNumber: 987654321
The email: maria@mail.com
The citizenCardNumber: 123456789
The Employee role: NURSE

Is the data correct? (Y/N)
y
Operation complete
```

Figure 8 – Regist Employee

List of Employee

If the choice is **3 – List of Employee** the admin will have to choose which type of employees he wants to list nurse, receptionist or center coordinator and after that choice the program lists the employees

```
List employees
Choose the type of employee you want to list:
1. ID: 1 | Description: NURSE
2. ID: 2 | Description: RECEPTIONIST
3. ID: 3 | Description: CENTER COORDINATOR

0 - Cancel
Type your option:
1
----- 1 -----
Name: Maria
Address: Rua do Isep, Ipo, n 123, 4999-101, Porto
Phone Number: 987654321
E-mail: maria@mail.com
Citizen Card Number: 123456789
Role: NURSE
```

Figure 9-List Employees

Specify a new vaccine type

If the choice is **4 – Specify a new vaccine type** the admin will have to specify a new vaccine type he will have to enter the following data:

- **Code –** if the code does not have more than 5 characters, it will not be accepted;
- **Description;**
- **Technology**

```
*** New Vaccine Type ***
Insert code:
AA123
Insert description:
Covid 19
Select technology:
1. Live-attenuated vaccines
2. Inactivated vaccines
3. Subunit vaccines
4. Toxoid vaccines
5. Viral vector vaccines
6. Messenger RNA (mRNA) vaccines

0 - Cancel
Type your option:
1
*** New Vaccine Type Data ***
Code: AA123 | Description: Covid 19 | Technology: Live-attenuated vaccines
```

Figure 10– Specify a new vaccine type

Specify a new vaccine and its administration process

If the choice is **5 – Specify a new vaccine and its administration process** the admin will have to specify a new vaccine and its administration process he will have to enter the following data:

- **Name**
- **Brand**
- **Vaccine type**
- **Age group data**
- **Dosage data**

At the end of entering all data Lists the entered data to be confirmed by typing "y".

```
*** New Vaccine ***
Insert name:
MataBicho
Insert brand:
tuga
Select vaccine type:
1. Code: 00001 | Description: Spikevax description | Technology: Messenger RNA (mRNA) vaccines

0 - Cancel
Type your option:
1
Insert number of age groups:
1

*** 1° Age group ***
Insert minimum age:
18
Insert maximum age:
80
Insert doses to administered:
1
*** 1° Dose ***
Insert dose number:
15
Insert dosage:
10
Insert time interval between last dose:
20
```

```
*** New Vaccine Data ***
Id: 5 | Name: MataBicho | Brand: tuga

Vaccine type
Code: 00001 | Description: Spikevax description | Technology: Messenger RNA (mRNA) vaccines

1° Age group
Minimum Age: 18 | Maximum Age: 80
1° Dose
Dose Number: 15 | Dosage: 10 | Time Interval Between Last Dose: 20

Want to confirm the data? (y/n)
y
New vaccine successfully adds!
```

Figure 11 - Specify a new vaccine and administration process

+

Load file with SNS Users data

If the choice is **6 – Load file with SNS Users data** the admin will have to load file with SNS user data he will have to enter the file path. Se o ficheiro importado tiver erros em algum dos campos ira reproduzir uma mensagem. At the end of entering the file path to be confirmed by typing "y".

```
Load a set of SNS Users from file
Insert the name of the file to be loaded:
src/files/teste.csv
----------------------------------------------------------------------------------------------------------------------------------
|         Name          |    Sex    |  BirthDate  |              Address             | PhoneNumber  |        Email        | SNSUSerNumber | CitizenCardNumber |
|-----------------------|-----------|-------------|----------------------------------|--------------|---------------------|---------------|-------------------|
| Vitor Hugo Cavalc...  | Masculino | 25/02/1952  | Rua São João do Porto|222|4...   | 953224331    | 953224331@gmail.c...| 161593120     | 10095830          |
|-----------------------|-----------|-------------|----------------------------------|--------------|---------------------|---------------|-------------------|
| Augusto Ramos         | Masculino | 24/05/1951  | Rua  Grupo 10 de Maio|210|4...   | 953224332    | 953224332@gmail.c...| 161593121     | 10095831          |
|-----------------------|-----------|-------------|----------------------------------|--------------|---------------------|---------------|-------------------|

Are you sure that you want to load the file in the entered path, with the registers shown above? (y/n)
y
The file was loaded with success!
```

```
Load a set of SNS Users from file
Insert the name of the file to be loaded:
src/files/SNSUserDataFromGaoFuNationalCenterDoPortoVaccinationCenter.csv
An error was found in line 1673 of the file! Date is incorrect! Please, correct it!
```

Figure 12– Load file with SNS User data
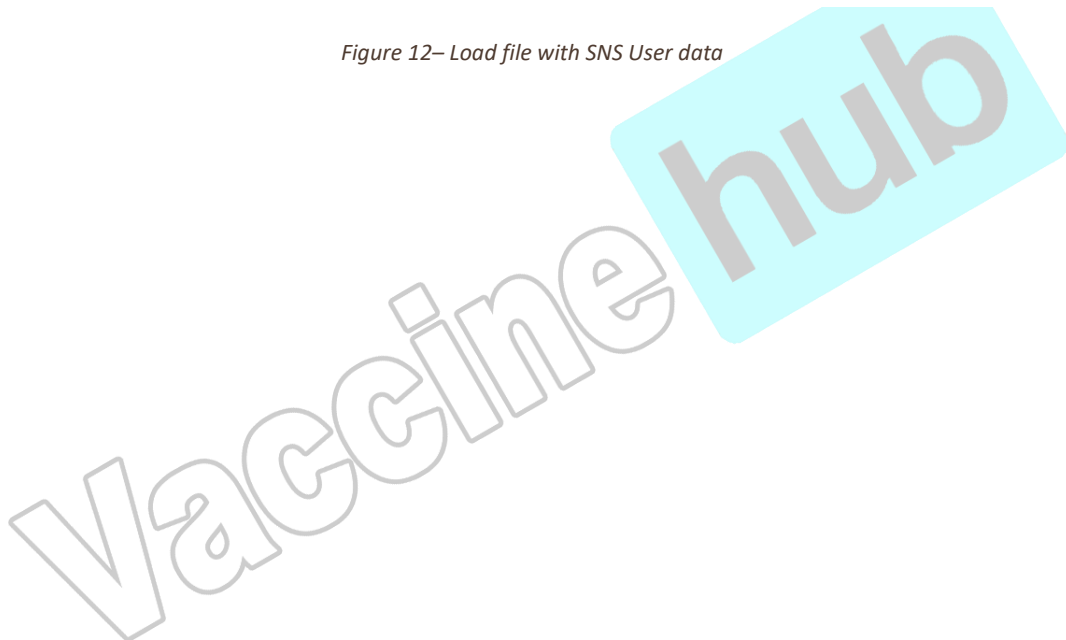
Receptionist Menu

Before the receptionist menu appears, he will have to choose which vaccination center he is working at. The application's receptionist menu consists of 3 options:

- **Register a SNS user** - Functionality for the receptionist to register a new SNS user in the system.
- **Register the arrival of a SNS user** - Functionality for the receptionist to register the arrival of an SNS user in the waiting list.
- **Schedule a vaccine** - Functionality for the receptionist to schedule the administration of the vaccine for one SNS user.

```
Select vaccination center:
1. Name: VacinaBraco
Phone Number: 987654321
Email: pica@mail.com



0 - Cancel
Type your option:
1

*** Receptionist Menu ***
1. Register a SNS user
2. Register the arrival of a SNS user
3. Schedule a vaccine
```

Figure 13- Recepcionist Menu

If the choice is **1 – Register a SNS user** the receptionist will have to specify a new vaccine and its administration process he will have to enter the following data:

- **Name;**
- **Address;**
- **Sex;**
- **Birth date –** the application is valid if the date entered is not greater than today;
- **Phone number** – the application validates if the number starts with 9 and has more than 9 digits;
- **Email;**
- **SNS user number -** the application validates if the number is between 7 and 9 numbers;
- **Citizen card number -** the application validates if the number is between 7 and 9 numbers;

At the end of entering all data Lists the entered data to be confirmed by typing "y".

```
*** New SNS User ***
Insert name:
Carlos
Insert address:
Rua padre Santos
Select sex:
1. Female
2. Male

0 - Cancel
Type your option:
2
Insert birth date:
01/08/2001
Insert phone number:
987654321
Insert email:
carlos@mail.pt
Insert SNS user number:
987654321
Insert citizen card number:
987654321
```

```
*** New SNS User Data ***
Name: Carlos
Address: Rua padre Santos
Sex: Male
Phone Number: 987654321
Email: carlos@mail.pt
Birth date: Wednesday, 1 of August of 2001
SNS user number: 987654321
Citizen card number: 987654321


Want to confirm the data? (y/n)
y
New SNS User successfully ads!
```

Figure 14- Recepcionist Menu

Register the arrival of a SNS user

If the choice is **2 – Register the arrival of a SNS user** the receptionist will have to register the arrival of a SNS user he will have to enter the:

- **Citizen card number Address;**

At the end of the citizen card insertion List the data entered to be confirmed twice by typing "y".

```
Insert SNS User Number:
987654321
Vaccination schedule list:
1. Date: Sunday, 19 of June of 2022
Time: 03:50 PM

Accept the arrival of the SNS user? (y/n)
y

*** SNS User Arrival Data ***
SNS User Number: 987654321
Arrival Date: Sunday, 19 of June of 2022
Arrival Time: 03:53 PM

Do you want to confirm the arrival of the sns user? (y/n)
y
Successfully registered the arrival of the SNS user.
```

Figure 15– Regist SNS User

Schedule a vaccine

If the choice is **3 – Schedule a vaccine** the receptionist will have to schedule a vaccine he will have to enter the following data:

- **Citizen card number Address;**
- **Date and hours**
- **Vaccine type**

At the end of entering all data Lists the entered data to be confirmed by typing "y".

```
Insert SNS User Number:
987654321
Select Vaccination center
1. Name: VacinaBraco
Address: Rua alberto Porto
Phone Number: 987654321
Email: pica@mail.com
Fax Number: 987654321
Website: pica.pt
Opening Hours: 08:00 AM
Closing Hours: 08:00 PM
Slot Duration: 10
Slot Vaccine Limit: 10

0 - Cancel
Type your option:
1
Insert intended date (dd/mm/yyyy):
19/06/2022
Insert intended time:
Insert hours:
15
Insert minutes:
50
Select Vaccination type
1. Code: 00001 | Description: Spikevax description | Technology: Messenger RNA (mRNA) vaccines

0 - Cancel
Type your option:

Confirm the data:
SNSUser: 987654321
Date: Sunday, 19 of June of 2022
Time: 03:50 PM
Vacine type: Code: 00001 | Description: Spikevax description | Technology: Messenger RNA (mRNA) vaccines

Is the data correct? (Y/N)
y
Operation complete
```

Figure 16-Shedule a vaccine

Nurse Menu

Before any functionality, the nurse must choose which vaccination center is working. Only after this choice does the nurse have access to the menu that offers 1 option:

- **Consult the users in the waiting room** - Functionality for the nurse to consult the list of users in the waiting room.

```
Login UI:
Enter UserId/Email:
nurse@lei.sem2.pt
Enter Password:
123456
Select vaccination center:
1. Name: RamaldeVacina

Email: ramaldevacina@saude.pt



0 - Cancel
Type your option:
1


*** Nurse Menu ***
1. Consult the users in the waiting room
```

Figure 17- Nurse Menu

.

Consult the users in the waiting room

If the choice is **1 – Consult the users in the waiting room** the nurse will have to consult the users in the waiting room.

```
|                              LIST OF USERS                             |
|------------------------------- User  0001 -----------------------------|
Name: Carlos
Sex: Male
Phone Number: 987654321
Birth date: Wednesday, 1 of August of 2001
Sns Number: 987654321
|_____|
```
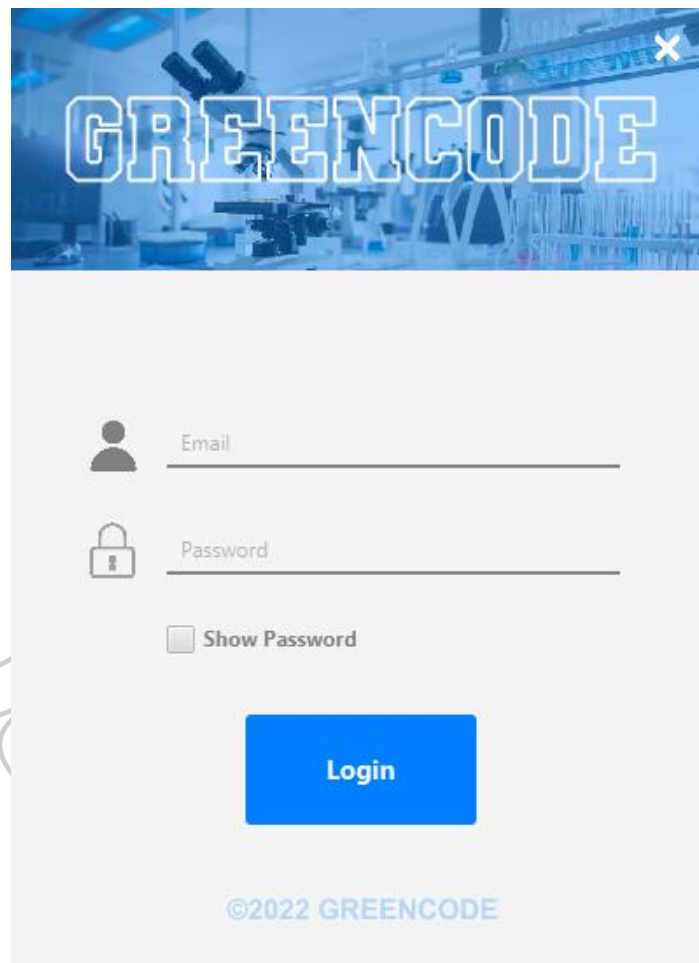
Figure 18 – Consult the user in the waiting room

Graphical user interface

Login

To login to the application in graphical mode, you must enter your email address and the corresponding password, by selecting the "Show Password" checkbox, you can view the entered password.

By clicking on the "Login" button, if the data are correct, the user, if he is a nurse, will be redirected to a new window in order to select the vaccination center in which he is working, if he is a coordinator of one hundred, this is taken to its respective menu.
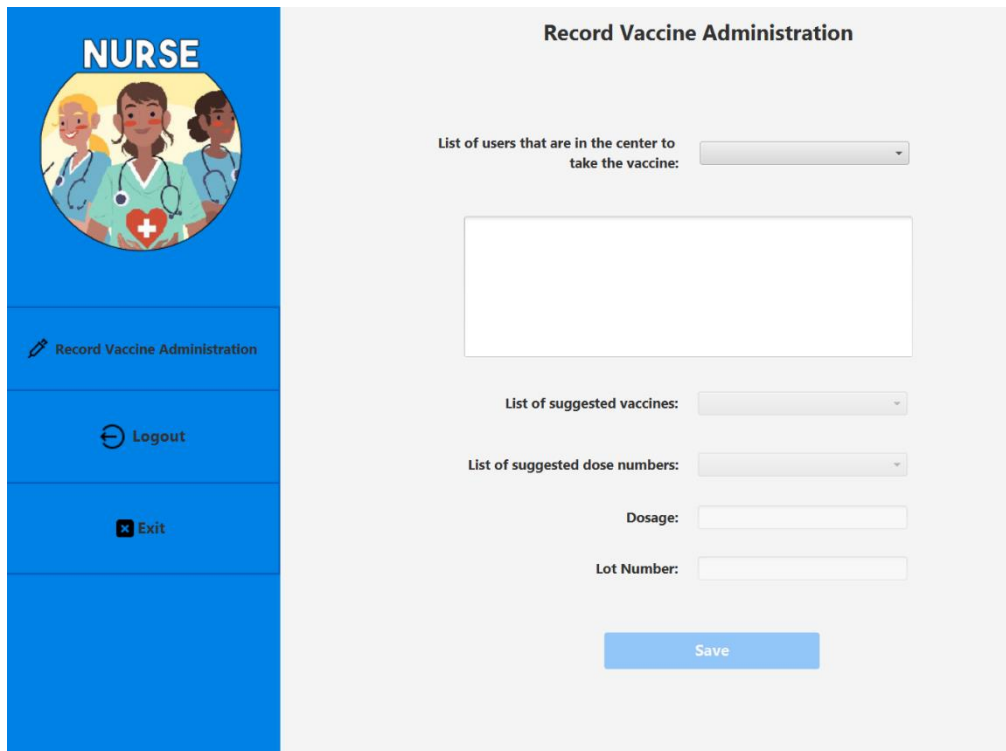

Figure 19 - Login window in graphical mode

Nurse Menu

The application's graphic nurse menu consists of 3 options:

- **Record Vaccine Administration** - Functionality for the nurse to record the administration of the vaccine to an SNS user.
- **Logout -** Functionality for the nurse to log out.
- **Exit -** Functionality for the nurse to close the application.

Figure 20 - Nurse menu in graphical mode

Record Vaccine Administration

To use the functionality of recording the administration of the vaccine, a set of sequential steps must be followed:

1. Select a SNS user from the waiting list;
2. View information about the SNS user such as their name, age and any adverse reactions;
3. Select the vaccine to be administered among those suggested;
4. Select the dose to be administered among those suggested;
5. View the dosage of the selected dose;
6. Enter the vaccine lot number;
7. Click on the "Save" button to save the vaccine administration.

Center Coordinator Menu

The application's graphic nurse menu consists of 5 options:

- **Import data** - Functionality for the vaccination center coordinator import data from a legacy system that was used in the past to manage centers.
- **Vaccination Statistics -** Functionality for the coordinator of the vaccination center check and export vaccination statistics.
- **Analyze the Performance -** Functionality for the vaccination center coordinator to analyze the performance of a center.
- **Logout -** Functionality for the center coordinator to log out.
- **Exit -** Functionality for the center coordinator to close the application.

Figure 21 - Center coordinator in graphical mode

Import Data

In the functionality of importing data, it is necessary to indicate the path of the file to be imported, after the system performs the necessary validations, the file data is shown in the table.

Before importing data, a sorting criterion "Date and time of arrival at the center" or "Leaving date and time from the center" must be selected. It is also possible to sort the data in ascending or descending order.

To import the data just click on "Import Data".

Figure 22 - Data import functionality

Vaccinations Statistics

In the functionality of vaccination statistics, it is necessary to indicate the name of the file where you want to save the data and the desired time interval.

After these data are entered, it is necessary to click on the "Confirm" button, which will look for the total number of vaccinated between the two entered dates and will present the data in graphic format.
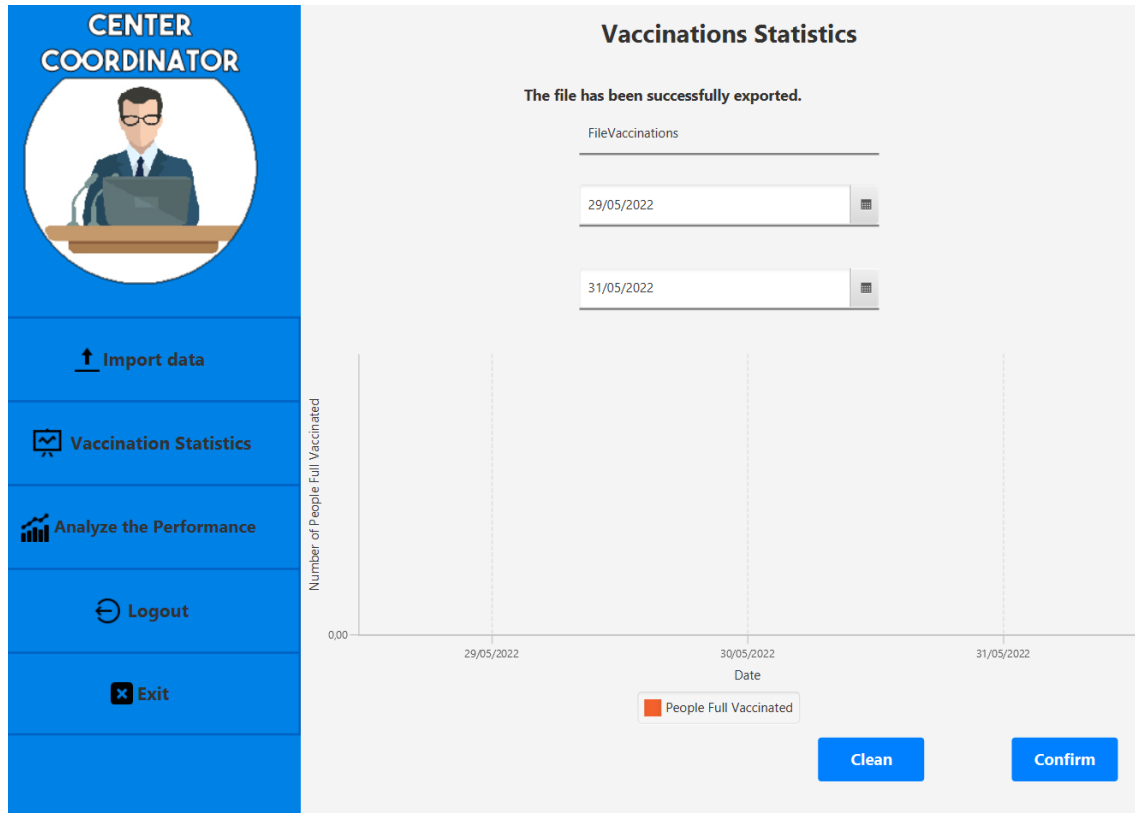
Figure 23 - Vaccinations statistics functionality

Analyze the performance

In the functionality of analyzing the performance of a vaccination center, the intended day for the analysis must be entered, as well as the desired time interval in minutes.

After entering this data, press the "Calculate" button, then, if the interval entered is correct, the contiguous sublist of maximum sum is displayed in graphic form, in addition to the sum and time interval of the sublist.

The "Clear" button allows you to clear all text boxes and the graphic.
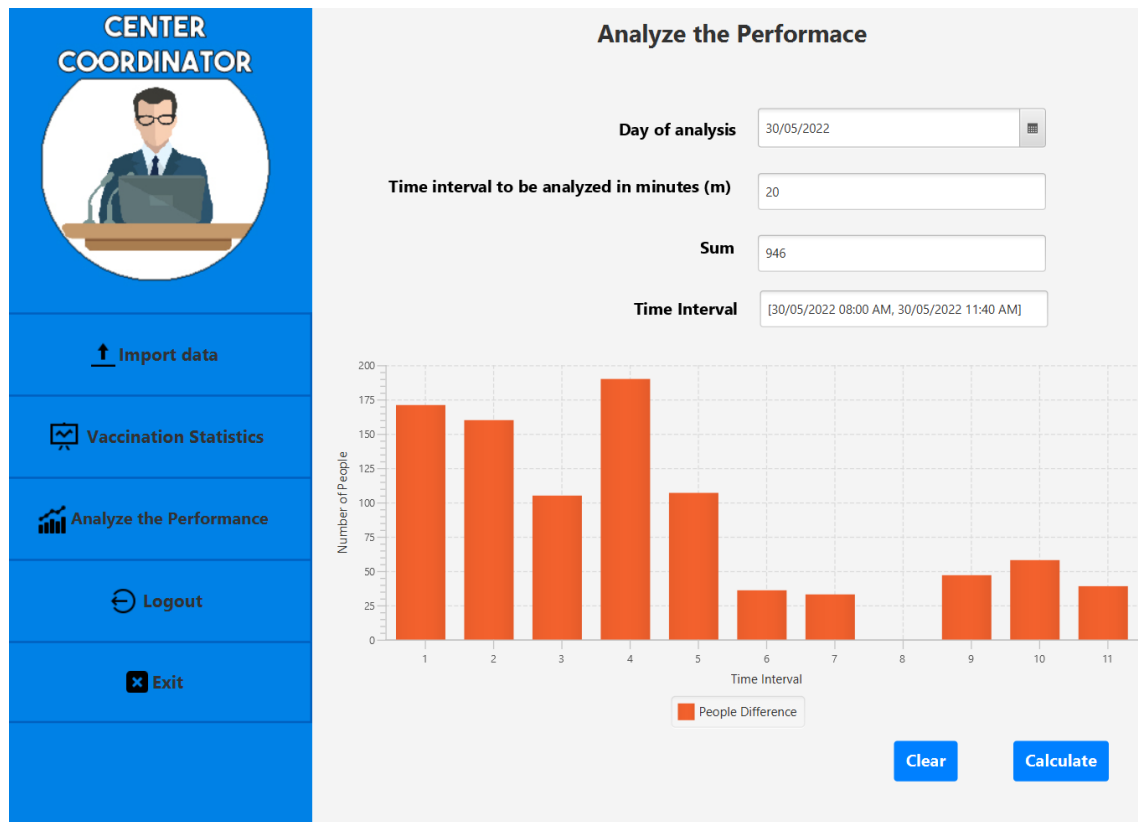
Figure 24 - Analyse performance functionality

3. Troubleshooting

In case you encounter any difficulties/problems while using the Vaccine Hub, try to follow some of the following steps:

Unable to register an employee

Problem	Solution
Invalid Email Address	When entering the email, be sure to use '@' and '.' (example: example@vaccinehub.com)
Invalid Phone Number	When entering the phone number, make sure it follows the Portuguese format and contains 9 digits.
Invalid Citizen Card Number	When entering the Citizen Card Number, make sure it is in Portuguese format. (Please check here 🇵🇹)

Unable to register vaccine type

Problem	Solution
Invalid Vaccine Code	When entering the vaccine code to create a vaccine type, make sure it has 5 alphanumeric digits

Unable to Specify a new Vaccine

Problem	Solution
Missing Vaccine Types	If there is no vaccine type, it is not possible to proceed, please register a new vaccine type
Invalid Age Group	If the minimum age of the group is bigger than the maximum age of the group, you will need to restart the creation process and making sure to introduce a valid age group.
Invalid Time Interval and/or Dosage	Dosage and interval time must be positive integer values

Unable to register a vaccine administration

Problem	Solution
Empty Waiting Room	To register the administration of the vaccine to an SNS user, it is necessary to previously register their entry into the vaccination center
Missing Vaccine	If the suggested vaccine list is empty it means that, the chosen user age does not fit into any of the available vaccine.

Invalid Lot Number	If 'Lot number is not valid' error pops up, you inserted an invalid lot number. A valid lot number has five alphanumeric characters an Hyphen and two numerical characters (example: 21C16-05).

Unable to register a vaccination center

Problem	Solution
Invalid Email Address	When entering the email, be sure to use '@' and '.' (example: example@vaccinehub.com)
Invalid Phone Number	When entering the phone number, make sure it follows the Portuguese format and contains 9 digits.
Invalid Website	As you insert the website, make sure to use a valid prefix and domain (example vaccinehub.pt)
Invalid Opening/Closing hour	When entering the opening and closing times of the vaccination post, be sure to choose a value between 0 and 24 which are the limits of hours in a day and a value between 0 and 60 for the minutes
Invalid Slot Duration and/or Limit	When entering a slot duration and/or slot limit, this must be a positive integer

Problem	Solution
Missing Vaccination Centers	To register the administration of the vaccine to an SNS user, it is necessary to previously register their entry into the vaccination center
Missing Vaccine Type	If the suggested vaccine list is empty it means that, the chosen user age does not fit into any of the available vaccine.
Unavailable Dates	If 'Lot number is not valid' error pops up, you inserted an invalid lot number. A valid lot number has five alphanumeric characters an Hyphen and two numerical characters (example: 21C16-05).

Unable to import Data from Legacy System

Contacts

Our development team, Green Code, is available for any kind of support needed. Therefore, below are the contacts where you can talk to members:

- Gabriel Goncalves - 1191296@isep.ipp.pt
- Tiago Leite - 1191369@isep.ipp.pt
- João Durães - 1211314@isep.ipp.pt
- Francisco Bogalho - 1211304@isep.ipp.pt
- António Bernardo - 1210805@isep.ipp.pt

4. FAQs

Question – What is Vaccine Hub?

Answer – It is a software developed by the Green Code team for the Directorate-General for Health in order to manage the Covid-19 vaccination process or any other pandemic that may arise in the future.

Question – Can I request a Vaccination Certificate?

Answer – This feature is not available.

Question – After scheduling the vaccination, can I ask to receive a message with the appointment schedule?

Answer – Yes, if you want!

Question – When the recovery period ends, can I be alerted by a message?

Answer – Yes, after your time is up, you will get a message saying that your recovery time is up.

Question – Can Vaccine Hub adapt to future pandemics?

Answer – Yes, whenever a new pandemic appears, Vaccine Hub will adapt.

Question - What types of vaccines are available?

Answer - The type of vaccines depends on each Vaccination Center and on the ongoing outbreak.

Question - Is it possible for me to take different doses of the vaccine at different Vaccination Centers?

Answer - Yes, it is possible, each dose can be administered at different vaccination centers.

Question - Can I access my vaccination record?

Answer - No, Vaccine Hub does not make your vaccination history visible.

Question - How many Center Coordinators can be associated with a vaccination center?

Answer - There can only be one Center Coordinator associated with a vaccination center.

Question - How can I access the dosage for a certain vaccine dose?

Answer - Dosage for respective dose is presented during Vaccine Administration.

5. Annexes
Annex A

Simple Linear Regression
Overview of Simple Linear Regression

Simple linear regression is a methodology developed from statistics and econometrics. This method uses a single explanatory variable in order to describe and estimate the relationship between two quantitative variables, that is, one dependent on the other (Y depends on X). Through this relationship we were able to have a graph, with great precision, predicting the values of the dependent variable with the values of the independent variable.

To create this graph, most of the time it is necessary to use a method called ordinary least squares, the objective of which is to minimize the sum of these squares of deviations, as much as possible.

With this graph we can calculate the correlation coefficient, this coefficient allows us to see how much data is needed. As a rule, we look for a correlation coefficient greater than 0,90.

Here, we can see the regression line equation:

$$Yi = \hat{a} + \hat{b}x + \varepsilon i$$

Simple Linear Regression Model

In this project, an .xlsx file was used with all the necessary data, such as new cases, new deaths, reproduction rate, ICU patients, hospital patients, new exams, positive rate and fully vaccinated people). Since we have new cases and new deaths as dependents, keep in mind that all the others are independent.

The objective was to make a daily and weekly analysis and to study all possible relationships.

Regarding the Simple Linear Regression Model, there are 12 different relationships, so for the purposes of this user manual, we will only show the most relevant ones.

Model significance

This model is divided into a daily and weekly analysis and there are 12 different relationships, which means that there are 24 different Anova tables of correlation coefficients, confidence intervals and hypothesis tests.

After doing the necessary math, we were able to conclude that of these 24 values only a few are significant. That is, if in fact the largest of them present correlation coefficients.

After analyzing the Anova table, we draw a conclusion with the value 713,730 (F0). Therefore, we conclude that we can admit that a given regression is linear if the value of Fo is greater than $f_{\alpha;1;n-2}$ (6,85).

Regarding the most significant models were the Y_1-X_5 relationship, new cases with a positive rate, and Y_2-X_5, new deaths with a positive rate, however, there is an overview of the entire study with regard to Simple Linear Regression.

Daily		
Relationship	Regression line	Correlation coefficient
new_cases-> reproduction_rate	-2824,5x + 3422,7	0,1603
new_deaths-> reproduction_rate	-174,82x + 183,39	0,3347
new_cases-> icu_patients	4,3399x - 147,45	0,5986
new_deaths-> icu_patients	0,2199x - 23,914	0,8377
new_cases-> hosp_patients	0,6896x + 15,108	0,7326
new_deaths-> hosp_patients	0,0336x - 13,628	0,9484
new_cases-> new_tests	0,0049x + 885,97	0,0033
new_deaths-> new_tests	-0,0002x + 44,629	0,0024
new_cases-> positive_rate	30986x - 37,059	0,8581
new_deaths-> positive_rate	1421,9x - 13,01	0,9847
new_cases-> people_fully_vaccina	-0,0014x + 2031,5	0,1999
new_death-> people_fully_vaccina	-0,00007x + 89,262	0,3122

Weekly		
Relationship	Regression line	Correlation coefficient
new_cases-> reproduction_rate	-2945,1x + 24642	0,1853
new_deaths-> reproduction_rate	-181,55x + 1321,5	0,3568
new_cases-> icu_patients	4,377x - 1126,7	0,6643
new_deaths-> icu_patients	0,2204x - 169,25	0,8535
new_cases-> hosp_patients	4,377x - 1126,7	0,6643
new_deaths-> hosp_patients	0,0337x - 96,414v	0,9601
new_cases-> new_tests	0,0049x + 885,97	0,0033
new_deaths-> new_tests	-0,0002x + 44,629	0,0024
new_cases-> positive_rate	31262x - 335,96	0,9392
new_deaths-> positive_rate	1430,4x - 93,144	0,996
new_cases-> people_fully_vaccina	-0,0015x + 14503	0,2277
new_death-> people_fully_vaccina	-0,00007x + 638,01	0,327

Daily

new_cases->positive_rate

Fonte variação	GL	Soma de quadratica	Média quadratica	F0
Regressão	1	245236314,792	245236314,8	713,7307351
Erro (residual)	118	40544541,133	343597,8062	
Total	119	1,23691E-10		

R^2	0,8581
R	0,9264

As the correlation coefficient table indicates, 0,858, is the closest to 1 and higher than 0,80, so that means it's a significative model and 85,81 % of the variation is explained by it.

new_deaths->positive_rate

Fonte variação	GL	Soma de quadratica	Média quadratica	F0
Regressão	1	516388,510	516388,5104	7573,108225
Erro (residual)	118	8046,081	68,18712938	
Total	119	9,37916E-12		

R^2	0,9847
R	0,9923

As the correlation coefficient table indicates, 0,984, is the closest to 1 and higher than 0,80, so that means it's a significative model and 98,47% of the variation is explained by it.

Weekly

new_cases->positive_rate

Fonte variação	GL	Soma de quadratica	Média quadratica	F0
Regressão	1	1699764595,411	1699764595	231,6242
Erro (residual)	15	110076873,648	7338458,243	
Total	16	2,91038E-11		

R^2	0,9392
R	0,9691

As the correlation coefficient table indicates, 0,939, is the closest to 1 and higher than 0,80, so that means it's a significative model and 93,92% of the variation is explained by it.

new_deaths->positive_rate

Fonte variação	GL	Soma de quadratica	Média quadratica	F0
Regressão	1	3558472,692	3558472,692	3711,1049
Erro (residual)	15	14383,072	958,8714917	
Total	16	1,25056E-12		

R^2	0,9960
R	0,9980

As the correlation coefficient table indicates, 0,996, is the closest to 1 and higher than 0,80, so that means it's a significative model and 99,60% of the variation is explained by it.

Hypothesis tests for model coefficients

The purpose of the Hypothesis Test is to analyze the relationship and decide on its results. We also test whether we can consider the parameter values equal to zero.

Here's what a hypothesis test looks like:

$$H0: \hat{a} = 0 \ v.s. \ H1: \hat{a} \neq 0 \qquad or \qquad H0: \hat{b} = 0 \ v.s. \ H1: \hat{b} \neq 0$$

Confidence intervals for prediction values

Depending on the confidence level, the purpose of these intervals is to calculate an interval to which we are sure the parameter value belongs.

To calculate a confidence interval, we need to specify a confidence interval, as requested - 90% and 95%, and determine the value of tc. Next, we calculate the standard deviation, which depends only on the number of samples and the values of the dependent variable. Finally, apply the formula and finally add and subtract everything with the corresponding parameter.

$$a \pm tcs\sqrt{\frac{1}{n} + \frac{\bar{x}^2}{Sxx}} \qquad\qquad b \pm tcs\sqrt{\frac{1}{Sxx}}$$

From this we can get the range - an upper and lower bound.

Daily					
-------------------------------	90%			95%	
-------------------------------	alpha	beta		alpha	beta
new_cases-> reproduction_rate	[2573,6; 4271,7]	[-3810,9; -1838,1]		[2408.5, 4436,8]	[-4002.8, -1646,2]
new_deaths-> reproduction_rate	[151,0; 215,8]	[-212,4; -137,2]		[144.7, 222.1]	[-219.8,-129.9]
new_cases-> icu_patients	[-29,7; -18,1]	[0,21; 0,23]		[-30.9,-17.0]	[0.03,0.04]
new_deaths-> icu_patients	[-140,8; 171,0]	[0,63; 0.75]		[-171.2,201,4]	[0.61,0.77]
new_cases-> hosp_patients	[-16,6; 10,7]	[0,03; 0,03]		[-17.1,-10.1]	[0.03, 0.04]

new_deaths-> hosp_patients	[341,6; 1430,3]	[-0,008; 0,018]		[235.8,1536.2]	[-0.012, 0.021	
new_cases-> new_tests	[21,3; 67,9]	[-0,0007; 0,0004]		[16.8, 72.5]	[-0.0009,0.0005]	
new_deaths-> new_tests	[-149,3; 75,2]	[29063,4; 32909,2]		[-171.1, 97,03]	[28689.5, 33283.1]	
new_cases-> positive_rate	[-14,6; -11,4]	[1394,8; 1448,9]		[-14.9, -11.1]	[1389.5,1454.2]	
new_deaths-> positive_rate	[1370,5; 2392,5]	[-0,002; -0,001]		[1600.3, 2462.7]	[-0.002,-0.0009]	
new_cases-> people_fully_vaccina	[74,9; 103,6]	[-0,0001; -0,0001]		[72.13,106.4]	[-0.0001,-0.0001]	
new_death-> people_fully_vaccina	[-360,7; 65,8]	[3,80; 4,88]		[-402.19, 107.3]	[3.69, 4.99]	

Weekly					
------------------------------	90%		95%		
------------------------------	alpha	beta	alpha	beta	
new_cases-> reproduction_rate	[7871,5; 41411,7]	[-5739,9; -150,2]	[4251,6; 45031,5]	[-6343,2; 453,1]	
new_deaths-> reproduction_rate	[659,4; 1983,6]	[-291,9; -71,2]	[516,5; 2126,5]	[-315,7; -47,4]	
new_cases-> icu_patients	[-5012,1; 2758,8]	[2,9; 5,8]	[-5850,8; 3597,5]	[2,6; 6,1]	
new_deaths-> icu_patients	[-283,2988; -55,1929]	[0,1791; 0,2618]	[-307,9173; -30,5744]	[0,1702; 0,2707]	
new_cases-> hosp_patients	[-2585,8386; 2588,8102]	[0,5473; 0,8488]	[-3144,3174; 3147,2890]	[0.51,0.88]	
new_deaths-> hosp_patients	[-149,7420; -43,0860]	[0,0306; 0,0368]	[-161,3; -31.6]	[0,03; 0,04]	
new_cases-> new_tests	[341,6114; 1430,3289]	[-0,0081; 0,0180]	[-10703; 25396,1]	[-0,06; 0,06]	
new_deaths-> new_tests	[21,2988; 67,9586]	[-0,0007; 0,0004]	[-373,4; 1220,2]	[-0,004; 0,002]	
new_cases-> positive_rate	[-1801,9699; 1130,0403]	[27660,846; 34862,6797]	[-2118,4; 1446.5]	[26883,5; 35639,9]	
new_deaths-> positive_rate	[-109,9016;-76,3863]	[1389,2156; 1471,5390]	[-113,5; 72,8]	[1380,3; 1480,4]	

new_cases->\npeople_fully_vaccina	[7392,7282; 21614,2330]	[-0,0027;- 0,0002]	[5857,9; 23149,1]	[-0,003; 0]
new_deaths->\npeople_fully_vaccina	[343,0838; 932,9396]	[-0,0001; 0,0000]	[279,4; 996,6]	[-0,0001; -0,0001]

Multiple Linear Regression

Overview of Multiple Linear Regression

As its name implies, Multiple Linear Regression is also a linear regression model, although it uses multiple explanatory variables, as opposed to Simple Linear Regression.

The purpose of these regressions is to study the relationship between these variables - one depends on many other independent ones.

Bearing in mind that the MLR works with more than two variables, there is no such thing as a regression line like the SLR. Then, we calculate the correlation coefficients for each variable.

The regression model looks like this:

$$y_i = \beta0 + \beta1x1 + \beta2x2 + \beta3x3 + \cdots + \beta kxk + \varepsilon_i$$

To calculate these coefficients, we first need to calculate some matrices:

- **The X matrix** – where the first column is formed by 1's and the others columns are composed by the values of the independent variables.
- The X matrix **transposed**
- X matrix transposed **times** the X matrix
- The **inverse** of the matrix above.
- Finally, the X matrix transposed **times** the dependent variable values.

Then, by determining these matrices, we just have to multiple the inverse matrix with the last one mentioned. By calculating these, we will have a different correlation coefficients.

After calculating the coefficients, we can estimate the values of the dependent variables with the values of the independent variables.

Like the SLR, in the MLR, to better explore the relationship between these variables, these coefficients were also estimated with hypothesis tests and V.

Finally, the Anova table is also used to take decisions about the results.

Multiple Linear Regression Model

Similar to the SLR analysis, this one is also divided into daily and weekly analysis, however, unlike the SLR, instead of having twelve different relationships, here we have only two, which are the new cases and new deaths will be all the others.

As there are two dependent and six independent variables, then there are seven correlation coefficients in each relationship.

For each coefficient, there are confidence intervals and hypothesis tests.

In addition, there is an Anova table, which helps in decision making.

Due to the user manual, we will only show and discuss the results achieved.

Model significance

By looking at the Anova table, we can decide based on the value of Fo. We can conclude that it is acceptable to admit that a given regression is linear if the value of Fo is greater than fα;k;n-(k+1).

After the calculations, we came to the conclusion that the 2 relationships, both in the daily and weekly analysis, present high coefficients of determination, which means that they explain the variance of the data well.

The results obtained can be found on the next page (Table Anova and Coefficient of Determination).

Hypothesis tests for model coefficients

As mentioned earlier in Simple Linear Regression, hypothesis tests serve to conclude whether we can consider the parameters equal to zero. In this case, in Multiple Linear Regression the objective is the same, instead of the parameters, we test all the coefficients.

Here's what a hypothesis test looks like

$$H_0: \beta_j = 0 \ \ v.s \ \ H_1: \beta_j \neq 0$$

In order to make a decision we have to check whether or not To is higher than tc

$$t_o = \frac{\beta}{\sqrt{\delta^2 C_{jj}}}$$

So, if To is higher than tc, we reject Ho.

Here we have an overview of the entire study on Multiple Linear Regression

Confidence intervals for prediction values

The purpose of Confidence Intervals is to calculate an interval depending on a given confidence level.

At intervals of 100, the value of certain coefficients is within 90 or 95 of these intervals.

To calculate and confidence interval first we need to select the coefficient. Then, we need to calculate the standard deviation and use the corresponding value of the C_{jj} value.

$$\beta_j \pm \sqrt{\delta^2 C_{jj}}$$

Sorting clients by arrival time, or by leaving time

Introduction

In the sprint D of the Integrative project, the MDISC course entered in two User Stories (US) to be developed by our team. The US 16 wanted us to develop a brute-force algorithm to find the maximum subsequence in a given array.

The US 17 required to our team to develop two sorting algorithms. Our team chose the quick sort and the bubble sort algorithms. The first one is theoretically the faster and is recursive algorithm, the second one is theoretically slower.

We will analyze bought of them with runtime tests for different input sizes, and then the worst-case time complexity.

What is Bubble Sort?

Bubble Sort Algorithm is one of the simpler but isn't very efficient. It sorts elements in ascending order by simply comparing adjacent values two to two and placing them in ascending order (in case they aren't in that order).

What is Quick Sort?

Quick Sort is a sorting algorithm belonging to the divide-and-conquer group of algorithms. This type of algorithms recursively breaks down a problem into two or more subproblems of same type, making them simpler to solve.

This algorithm has the best results when working with large arrays of data.

Runtime tests for inputs of varying sizes

In this section, we will test the two algorithms with runtime tests for inputs of varying sizes.

Bubble Sort

For 7049 inputs	
Test number	Time elapsed (seconds)
1	375.56
2	370.18
3	372.06

Average: 372.6s

For 3524 inputs	
Test number	Time elapsed (seconds)
1	94.14
2	96.03
3	93.46

Average: 94.543s

For 1762 inputs

Test number	Time elapsed (seconds)
1	23.44
2	23.35
3	23.92

Average: 23.57s

For 881 inputs	
Test number	Time elapsed (seconds)
1	5.92
2	5.86
3	5.91

Average: 5.897s

For 440 inputs	
Test number	Time elapsed (seconds)
1	1.47
2	1.47
3	1.49

Average: 1.477s

For 220 inputs	
Test number	Time elapsed (seconds)
1	0.39
2	0.39
3	0.38

Average: 0.387s

Quick Sort

For 7049 inputs	
Test number	Time elapsed (seconds)
1	3.84
2	3.75
3	3.84

Average: 3.81s

For 3524 inputs	
Test number	Time elapsed (seconds)
1	1.16
2	1.18
3	1.15

Average: 1.163s

For 1762 inputs	
Test number	Time elapsed (seconds)
1	0.44
2	0.45
3	0.47

Average: 0.453s

For 881 inputs	
Test number	Time elapsed (seconds)
1	0.19
2	0.17
3	0.20

Average: 0.187s

For 440 inputs	
Test number	Time elapsed (seconds)
1	0.12
2	0.07
3	0.11

Average: 0.10s

For 220 inputs	
Test number	Time elapsed (seconds)
1	0.07
2	0.04
3	0.08

Average: 0.063s

With this varied-length time intervals, we can build the following graphical representation:
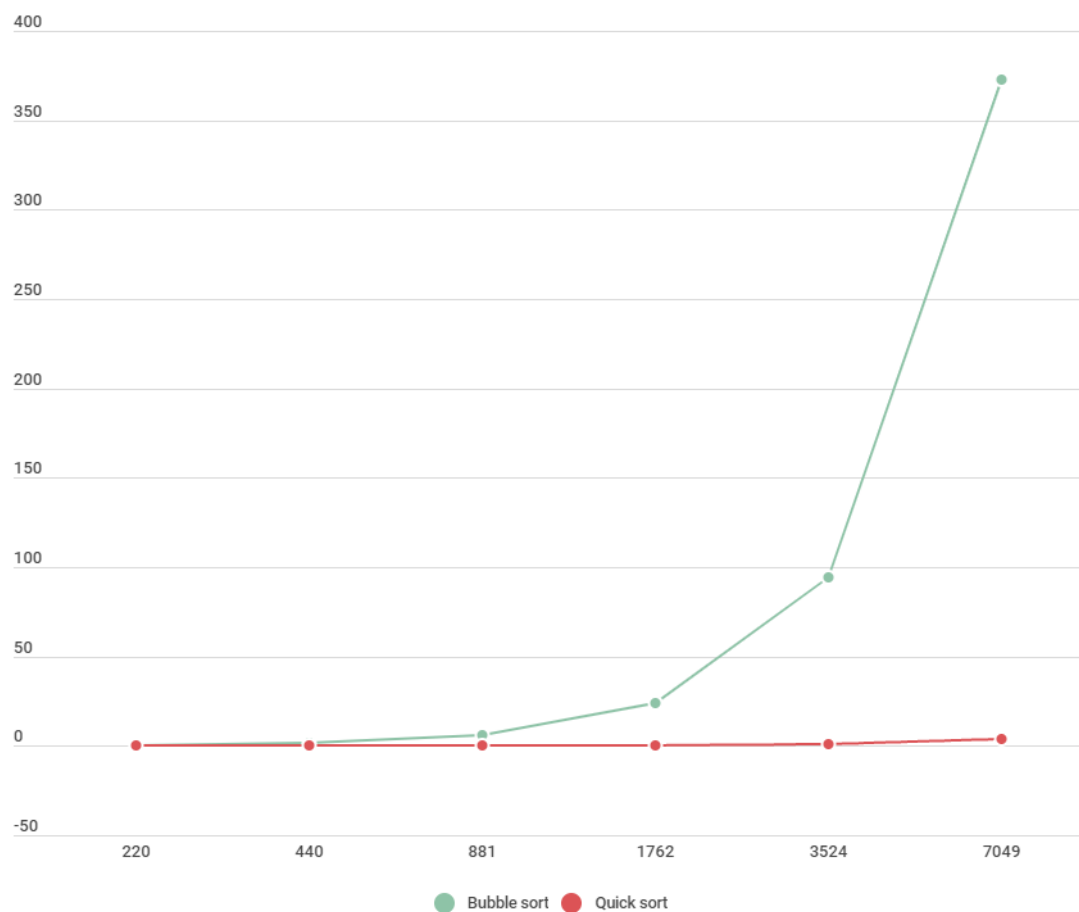
We can see that the Quick Sort algorithm is considerably faster than the Bubble Sort one. The time elapsed in both algorithms increase when the input length increase, but we can observe that the Bubble Sort increases exponentially when the input grow. Otherwise, the Quick Sort, increase when the input length increase, but it's much less than the other.

From this test, we can see that the Quick Sort is a better algorithm to sort data, specially when the input length tends to be high.

Worst-case time complexity analysis

Bubble Sort

Line	Code
1	`procedure bubbleSort(a[1], a[2], …, a[n]:real)`
2	`for i:= 1 to n-1`
3	`for j:= 1 to n - i`
4	`if a[j] > a[j+1] then`
5	`swap a[j] and a[j+1]`

Analyzing line by line the worst time complexity of the Bubble Sort algorithm, we can see the following.

Line	Number of operations made
1	(Method header)
2	n-1
3	$(n-1) + (n-2) + (n-3) + \cdots + \left(n - (n-1)\right) = (n-1) + (n-2) + \cdots + 1 = \frac{n-1}{2} * n$
4	$\frac{n-1}{2} * n$
5	Not a primitive operation

So, making this analyze, we can conclude that the worst-time complexity is $O(n) + O(n^2) + O(n^2) = O(n^2)$. This algorithm has polynomial complexity.

Quick sort

Line	Code
1	`procedure quickSort(a[1], a[2], …, a[n]:real, low:int, high:int)`
2	`if low < high then`
3	`int p = partition(a[1], a[2], …, a[n], low, high)`
4	`quickSort(a[1], a[2], …, a[n], low, p-1)`
5	`quickSort(a[1], a[2], …, a[n], p+1, high)`

Line	Code
1	`procedure partition(a[1], a[2], …, a[n]:real, low:int, high:int)`
2	`int p = low, j`
3	`for j := low + 1 to high`
4	`if arr[j] < arr[low] then`
5	`swap a[p+1] to a[j]`
	`swap a[low] to a[p]`

	Number of operations
1 | 2 | 3 | 4 | 5 | … | n	n
2 | 3 | 4 | 5 | … | n	n − 1
3 | 4 | 5 | … | n	n − 2
4 | 5 | … | n	n − 3
5 | … | n	n − 4
… | n	…
n − 1 | n	1

Quick Sort can have, theoretically, the worst-case of $O(n^2)$.

Evaluation of the effectiveness of the vaccination center's response

Introduction

In order to analyze the performance of the vaccination center, the center coordinator intends to check the number of clients arriving/departing the center at multiple time intervals previously chosen in a given day, in order to verify the effectiveness in the respective time intervals.

For this, a brute force algorithm was implemented that examines all contiguous sublists and determines the one that has the maximum sum, which is the interval where the center was least responsive.

Below we can visualize the algorithm mentioned in pseudocode:

| Line	Code
0	`Procedure findMaxSumSublist(integer, listToBeAnalyzed[1], listToBeAnalyzed[2],..., listToBeAnalyzed[n])`
1	`startIndex := 0`
2	`endIndex := 0`
3	`maximumSum := 0`
4	`arrayLength = n`
5	`for i:= 0 to arrayLength`
6	`currentSum := 0`
7	`for j:= i to arrayLength`
8	`currentSum = currentSum + listToBeAnalyzed[j]`
9	`if currentSum > maximumSum`
10	`maximumSum := currentSum`
11	`startIndex := i`
12	`endIndex := j`
13	`return array[] = listToBeAnalyzed [startIndex],..., list[endIndex]`

Runtime tests for inputs of varying sizes

In order to evaluate the execution time of our algorithm, a comparison was made with a reference algorithm (Benchmark Algorithm) for which variable sizes were used.

The variable sizes used were 6, 12, 24, 72, 360, 720.

For this analysis, several executions of the 2 algorithms were carried out and the execution times obtained were recorded, which are shown in the following table:

Size	Our algorithm	Benchmark algorithm
6	0,05	0,08
12	0,04	0,08
24	0,05	0,05+
72	0,06	0,05
360	0,34	0,06
720	0,44	0,06

The following graph shows a comparison between the two algorithms. A quick analysis shows that our algorithm is more effective for small sizes, but less so for large sizes. The Benchmark Algorithm, on the other hand, is exactly the opposite.
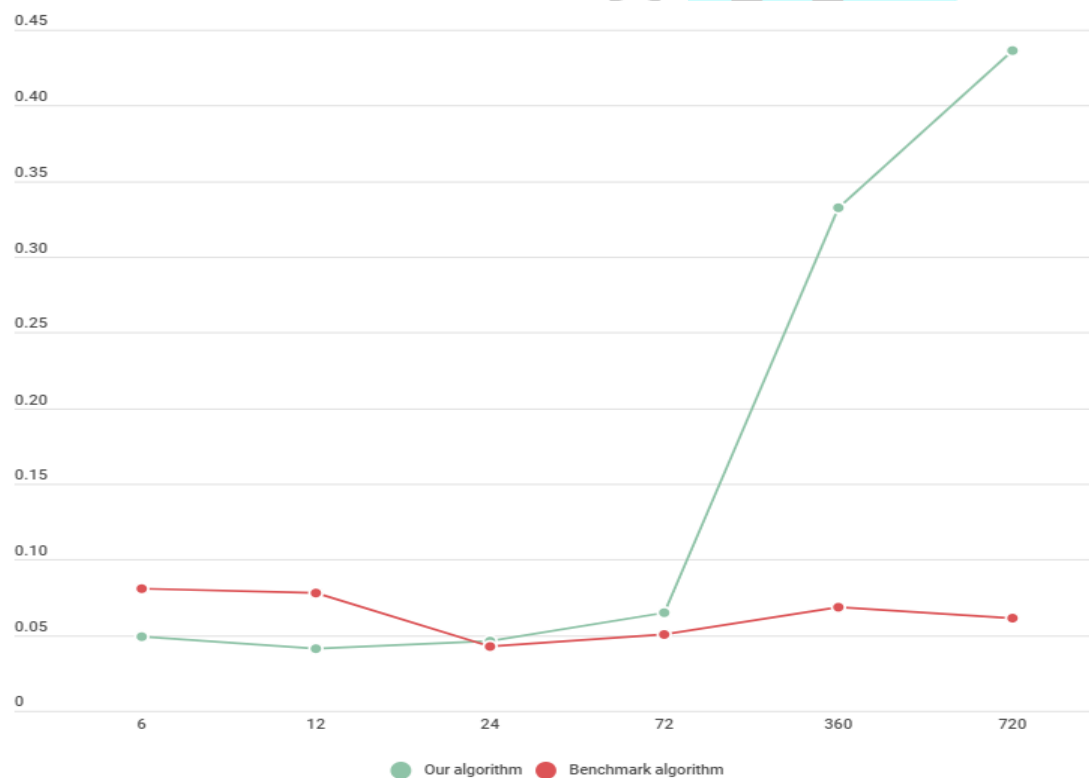
Worst-case time complexity analysis

The worts case time complexity analysis for the findMaxSumSubList procedure is as follows:

The primitive operation executed in the code are:

- o **A** (Assignment) associate a value to a variable;
- o **I** (Increment) increment a value or a variable to another variable;
- o **C** (Comparison) a boolean operation is done to obtain a logical value;
- o **OP** (Operation) an arithmetic operation;
- o **R** (Return) return the procedure result

The table presented below is a summary of the complexity analysis.

Line	Operations
1	1A
2	1A
3	1A
4	1A
5	(n+1)A + (n+1)I + (n+1)C
6	nA
7	n((n+1) A + (n+1)I + (n+1)C)
8	(n*n)OP+(n*n)A
9	n*C
10	nA
11	nA
12	nA
13	1R

In the first two lines of code, the variables startIndex and endIndex, respectively, are initialized to o. In the third line of code we initialize the variable maximumSum to zero.

In the first two lines of code, the variables startIndex and endIndex that indicate the lower index of the input list and the upper index of the list, respectively, are initialized to 0. Next, the value 0 is assigned to maximumSum.

Then we insert a "for" loop on line 5. We initialize the i to zero, which will be incremented up to the size of the array. In this loop I start by assigning zero to the currentSum value on line 6 and then another "for loop that initializes the j that is assigned the value of i and which will be incremented up to the size of the array in line 7.

In line 8 there is an assignment of the currentSum variable to its own value with the addition of the value of the array to be analyzed at position j.

Then there is a comparison between the current sum and the maximum sum. If the current sum is greater than the maximum sum, 3 assignments are performed.

First, the maximum variable sum is assigned to the current sum and the start index and end index are assigned to the variable i and j respectively.

Finally, in line 13, an array is returned with the contiguous sublist of the maximum sum found with the execution of the algorithm.