CERN Summer Student Programme Report

June 2021 – August 2021

Desktop and mobile app for CARA

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Keywords: CARA, python, SARS-CoV-2 virus, COVID-19, CARA desktop app, CARA mobile app

Summary

The COVID-19 Airborne Risk Assessment (CARA) tool is software designed to model the concentration of viruses in enclosed spaces, in order to inform space-management decisions. The goal of this project is to develop both mobile and desktop applications to distribute the CARA software. This paper outlines the steps taken to design a user interface with the software and how the applications and website were created.

Contents

1 Introduction

CARA is a risk assessment tool developed to model the concentration of viruses in enclosed spaces, in order to inform space-management decisions. CARA models the concentration profile of potential infectious viruses in enclosed spaces with clear and intuitive graphs. The user can set a number of parameters, including room volume, exposure time, activity type, mask-wearing and ventilation. The report generated indicates how to avoid exceeding critical concentrations and chains of airborne transmission in spaces such as individual offices, meeting rooms and labs. The risk assessment tool simulates the long-range airborne spread SARS-CoV-2 virus in a finite volume, assuming a homogenous mixture, and estimates the risk of COVID-19 infection therein. The results DO NOT include short-range airborne exposure (where the physical distance is a significant factor) nor the other known modes of SARS-CoV-2 transmission. Hence, the output from this model is only valid when the other recommended public health and safety instructions are observed, such as adequate physical distancing, good hand hygiene and other barrier measures. The model used is based on scientific publications relating to airborne transmission of infectious diseases, dose-response exposures and aerosol science, as of June 2021. It can be used to compare the effectiveness of different airborne-related risk mitigation measures. Note that this model applies a deterministic approach, i.e., it is assumed at least one person is infected and shedding viruses into the simulated volume. Nonetheless, it is also important to understand that the absolute risk of infection is uncertain, as it will depend on the probability that someone infected attends the event. The model is most useful for comparing the impact and effectiveness of different mitigation measures such as ventilation, filtration, exposure time, physical activity and the size of the room, only considering long-range airborne transmission of COVID-19 in indoor settings. This tool is designed to be informative, allowing the user to adapt different settings and model the relative impact on the estimated infection probabilities. The objective is to facilitate targeted decision-making and investment through comparisons, rather than a singular determination of absolute risk. While the SARS-CoV-2 virus is in circulation among the population, the notion of 'zero risk' or 'completely safe scenario' does not exist. Each event modelled is unique, and the results generated therein are only as accurate as the inputs and assumptions [1].

The main objective of this Summer Student project is:

- Create a mobile and desktop application based on the pre-existing CARA web app.

2 Basics of reference

Bootstrap is a free suite of tools for building websites and web applications. It includes HTML and CSS design templates for typography, web forms, buttons, labels, navigation boxes, and other web interface components, including JavaScript extensions. Bootstrap uses modern CSS and HTML, hence it might not support older browsers [2].Regarding the form page, in order to be responsive to the screen size, we:

1. Connected the bootstrap libraries (css and js) to the layout.html.j2.
2. Line up blocks in a row with the row class.

3. Added classes with adaptive settings to blocks with forms (the screen is divided into 12 parts thanks to the row class) (*col-lg-6* - will take up half the screen width on a large screen, *col-md-6* - on average and *col-sm-12* - on small screen sizes).

2.1 User guide

The user guide is one of the pages of the CARA website where you can find all the information about the app, how it works, what kind of results you can get and gives you a general idea of its functionality. We formatted the text on the user guide page, since that will affect both apps at the same time. We also added responsiveness of the font:

```
% block main %}
 <style>
 p,ul{
 font-size:2.5vh;
 }
 h1,h2,h3,h4{
 font-size:4.5vh;
 }
 </style>
<div class="container container--padding">
```

And fixed pictures for all resolutions:

```
</ul>
<img src="static/images/window_type.PNG" alt="Window type"
 title="How to determine the window type" width="100%">
 </ul>
<img src="static/images/window_opening.png"
alt="Window Opening Distance" title="How to measure window opening distance"
width="70%" style="margin:auto; display:block;">
```

and now the width is dynamic.

2.2 Report

A report page is a document that presents the results of the simulations and additional information in an organized format for a specific audience and purpose. The report page was also formatted, by adding indents before and after the headings, the list, where necessary, removed the centering of the headings, as well as changing font type and responsiveness (depending on screen height):

```
font-family:'Montserrat',sans-serif;
        font-size:2.5vh;
```

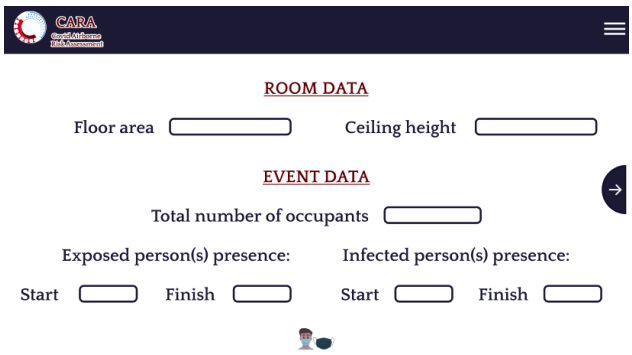
3 Design

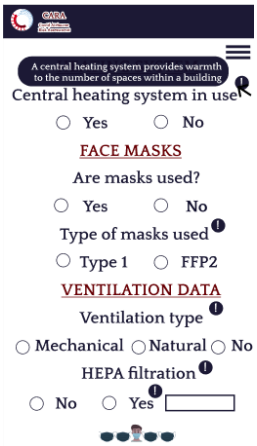
Design for mobile and desktop CARA application was made in collaborative interface design tool called Figma [5], which is a vector graphic editor used for developing apps mostly for MacOS and Windows.

Four different designs had to be created. Two of them were specific for CERN users, while the other two versions was created for general public users also in both (MacOS and Win) versions. In the later option, we decided to delete some miscellaneous fields like "Room number" or "Simulation name".

Within this task, we participanted in some additional tutorials and courses related with programming and app design, with foundations in HTML, CSS and JavaScript [6], [7], [8].

Some examples of designed pages:





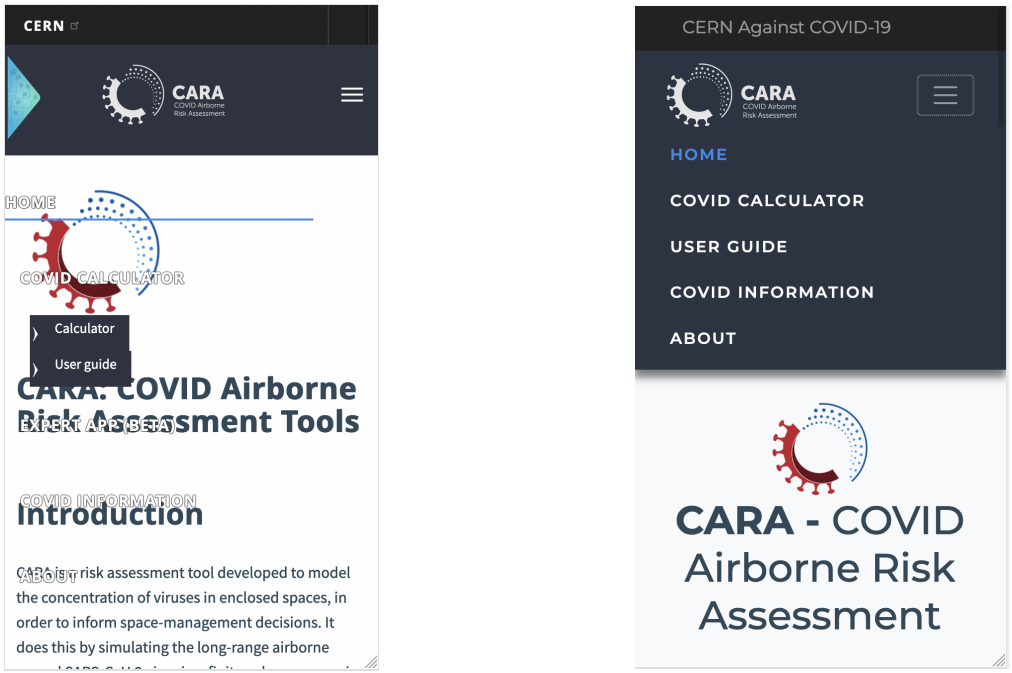
4 Website

Because of the quickly changing nature and growing amount of data regarding COVID-19, we chose to adapt the existing web application that both the desktop and mobile applications will access. This allows frequent updates to the website to be adopted by the applications immediately. This also means that this approach requires an internet connection to use the CARA apps, hence our project considers only Online apps.

The website was completely re-designed from the initial version to allow for compatibility with all screen resolutions. This allowed both the mobile and desktop apps, as well as the website, to all run from the same cohesive design. Many challenges needed to be overcome in order for this to solution to be fully responsive, including fixing the navigation bar and making the columns collapse to form one unique below a certain screen size. Below you will find a few key highlights of the new websites design.

4.1 Navigation bar

The original CARA website used a CERN theme but many of the css style sheets were already compressed and virtually impossible to edit. Due to this, we encountered a few issues that made the best choice to completely start over from a new design, one of which was to improve the navigation for mobile resolution. The difference is demonstrated in figure 1.



(a) Original navigation

(b) New navigation

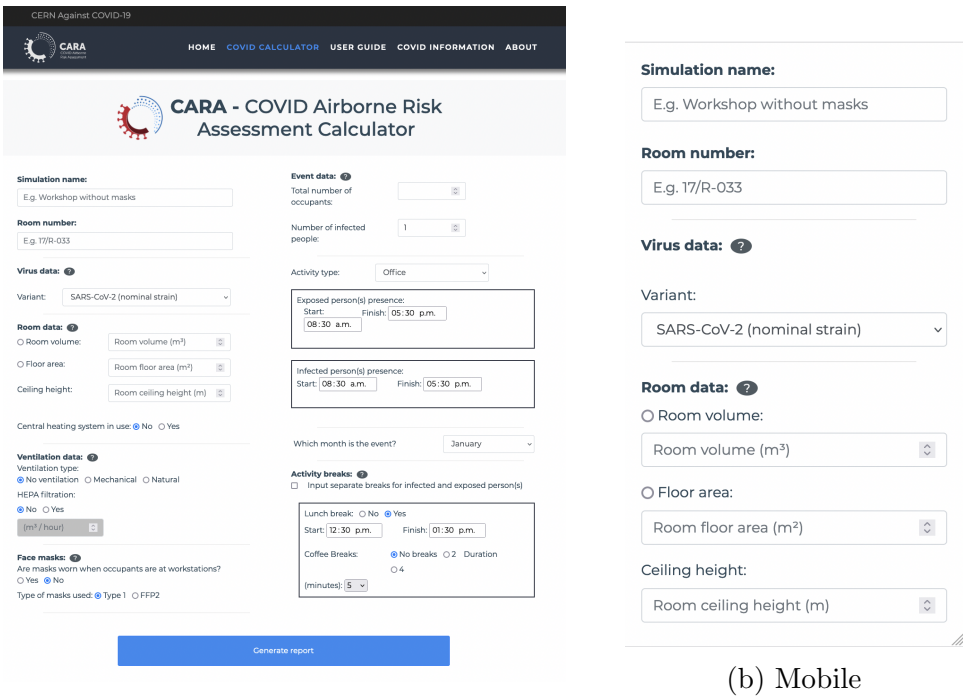
Figure 1: Comparison between the old and new navigation at mobile resolution

4.2 Calculator

By completely starting the css styling from scratch, lots of the responsive features needed for a mobile and desktop website had to be added back in to the new theme. This included an interesting method of making columns collapsible. The way this was done was by creating a split class with flex boxes, where using a media query we could set the flex direction to row or column based on the screen resolution. This way each div wrapped in a split class would become its own responsive column past 40em and below that all of the columns would collapse into one. The difference between mobile and desktop resolution of the calculator page is highlighted in figure 2.

5 Desktop Application

Due to the fact that the applications will be accessing the CARA website where they will actually interact with the back-end software, the creation of the desktop app is quite simple. The desktop application was created using electron [9] which allows the creation of



(a) Desktop

(b) Mobile

Figure 2: Showcase of how the two columns in the calculator page collapse to form one at mobile resolution

Windows, Mac, and Linux applications all from the same code. The desktop app essentially acts as a browser without all of the functionality and search features, which opens directly to the CARA website.

6 Mobile Application

The mobile applications were created using Vue Native [10]. The code transpiles into React Native code where Apple and Android apps can be created. Because of the simple nature of the applications, they were created similarly to the desktop app where opening the app essentially acts as a stripped down browser that opens directly to the CARA website. The application opened in a IOS simulator is shown in figure 3

7 How to create a mobile and desktop application based on CARA web application

The CARA website and the its code were reviewed to create the app [10]. This code is hosted http://localhost:8080/.

Desktop App

To run the CARA desktop app, go navigate into desktopApp directory folder and run

npm install

Figure 3: Mobile application shown on IOS simulator

Mobile App
To run the CARA mobile app, again enter the mobileApp folder and run,
yarn install.
This step is to install all dependencies. If it does not work properly you can try running ***yarn add react-native-webview*** , and then run *yarn install* again.
The next step is to run
npm start,
and you will be brought to a webpage where you can chose how to run the application either through a simulator or on your own device.

7.1 Meteor

Meteor is a JavaScript web platform for developing real-time web applications . To communicate with modern browsers , the Distributed Data Protocol (DDP) is used, which is supported using WebSocket 's, or, if there is no support for Websockets and DDP, AJAX [12] . Meteor code runs on top of node.js (however, it does not adhere to the asynchronous model accepted in node.js , which can make it difficult to integrate node.js and meteor

applications) [13] . The core of Meteor is DDP [14] . It is designed to work with collections of JSON documents, making it easy to create, update, delete, query, and view them. By default, MongoDB is used as the storage for such documents . One of the most important features of the platform is that it allows you to use the same code on both the server and client sides . Data is usually transferred between the server and the client, not HTML- code.

7.2 Vue

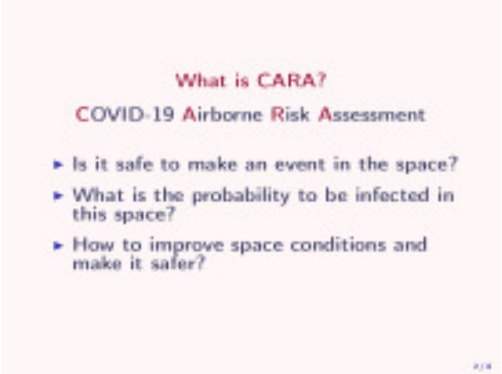
Vue.js - JavaScript - a framework with open source for creating user interfaces [15] . Easily integrates into projects using other JavaScript libraries . It can function as a web framework for the development of single-page applications in jet style.

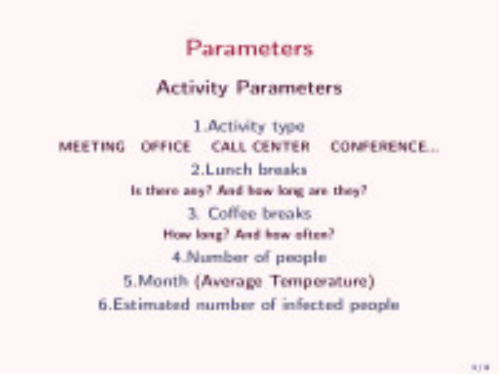
8 CERN Summer Student Session 2021

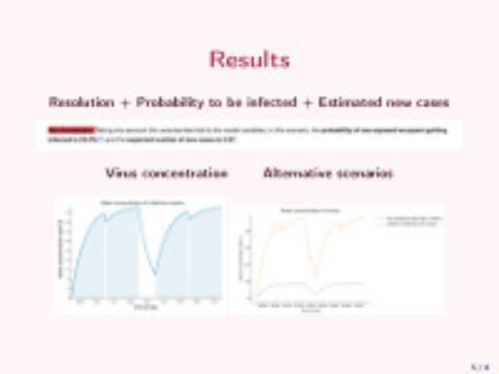
At the CERN 2021 Summer Student Session, this project was presented by Anna Efimova, which took place the 10^{th} of August 2021.

Link for the presentation video [3].

And the timetable of the session can be found here [4].







9 Conclusion

Within the timeframe our our Summer Summer programme, we were able to fulfill the objective and developed both mobile and desktop applications for the distribution of CARA software. The following tasks were completed:

1. Understand the interface of CARA web application.
2. Learnt about the programming commands used in the CARA web application.
3. Created a new design.
4. Changed the screen size for a mobile app.
5. Learnt about bootstrap, which was used to make the current website.
6. Created mobile and desktop apps

10 A little bit about us

Anel Massalimova: I'm Anel from Kazakhstan.I studied a Master's Degree in Medical Physics of Nuclear Medicine at the National Nuclear Research University "MEPhI". I received the good news from CERN about the internship and it was an absolute honor to have

been selected to participate in the CERN summer internship.

And so, like all good things, the program had to come to an end, but while it lasted, it was a wonderful experience. I met amazing people, learned about CERN, worked as a team, from which I learned a lot and gained good programming knowledge. This was more than I could ask for.

My career choice was predetermined long ago. From my school days, with the help of my teacher as a guide, I became deeply involved in science. In the near future I will apply to the IAEA MARIE SKLODOWSKA-CURIE FELLOWSHIP PROGRAMME.

Efimova Anna: My name is Efimova Anna. I was born in Saint Petersburg, however, did my bachelor in Moscow at M.V. Lomonosov Moscow State University. My research was in the area of theoretical particle physics and I am going to continue my studies at ETH Zürich.

This year I participated in CERN Summer Student Program second time, however, last year there was no opportunity to have a project, therefore, I am extremely happy to work on the CARA project this year.

Cole Coughlin: My name is Cole Coughlin and I am from Winnipeg, Manitoba, Canada. I am currently in my final year of a Physics and Computer Science joint honours degree at the University of Manitoba. My research experience is quite a mixed bag since I find many areas of physics interesting and would like to get a chance to work in many areas before I chose where to specialize. I started with computational astrophysics and then I worked on experimental data analysis from the ATLAS experiment looking for multiquarks. This summer I worked on studying holographic properties of certain tensor networks that are used to simulate quantum spin chains, where we are looking for possible gravitational aspects of quantum systems.

It was an incredible opportunity to participate in the CERN Summer Student Fellowship and I am very thankful to the CARA team for a great experience and chance to contribute to such an interesting project. I benefited greatly from the summer student lectures and enjoyed being able to get a more inside look at how particle physics research is conducted at CERN.

11 Acknowledgments

We are thankful to CERN for giving this amazing opportunity to participate in the Summer Student Programme, including people from all over the world, great lectures and an interesting project. A big thank you to Andre Henriques, Luis Aleixo, and CARA development team for helping in every step of the way going through with this project.

12 References

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