SeneCare. Supporting epidemiological surveillance with a digital system at Universidad de los Andes

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Abstract

COVID-19 has caused a large impact across society, in some countries more than others, generating some changes in our daily living activities; it also has motivated changes in laws and regulations that impact governmental and private institutions (*e.g.,* schools and universities). One of these institutions is Universidad de los Andes (Uniandes), a private Colombian university, which by law, had to implement mechanisms to daily report COVID-19 symptoms of those who attends the university campus. In order to provide a solution to that requirement, more than 30 volunteers from different disciplines (*e.g.,* software engineering, medical science and law) have joined forces to help the community, by designing a digital system (**SeneCare**) that has became a key tool to the epidemiological surveillance system. Since its release in October 2020, **SeneCare** has helped the Uniandes community to make informed decisions around the COVID-19 sanitary emergency.

CCS Concepts

• **Software and its engineering** → **Collaboration in software development**; • **Applied computing** → **Health care information systems**.

Keywords

COVID-19, Software Engineering, epidemiological surveillance

1 Introduction and Objectives

COVID-19 has impacted in a variety of ways society, causing health crises at different countries. As a reaction to this situation, governments have had to implement a series of regulations and laws. These laws regulate how some of the daily activities (*e.g.,*, work, transportation, etc..) have to be carried out by the population. An example of this are the regulations that the Colombian government (CG) has implemented [3–5], and in particular, regulation 666 of 2020 [5], which establishes that companies and institutions must provide their community/employees with a mechanism for daily reporting health symptoms.

Based on the regulations imposed by the CG, Universidad de los Andes (Uniandes), a private university in Colombia, decided to implement different mechanisms for facing the COVID-19 situation and for allowing the return of Uniandes community to campus. This required institutional adaptation through bio-security protocols, infrastructure adequacy of the campus, requirements for authorizations of the surveillance and control authorities, which raised the need to implement the COVID-19 Uniandes Epidemiological Surveillance System (UESS), framed in the strategies of Event-Based Surveillance (routine) and Innovative Surveillance

(Population and Digital Syndromic Screening) [5]. As part of the UESS, we wanted to build a digital system that not only helps to comply CG's regulations, but also helps us to provide continuous support to the Uniandes community. For pursuing this purpose we envisioned three principal objectives, that are related to the regulatory laws and specific Uniandes needs: (i) give timely assistance and recommendations to the Uniandes community; (ii) provide a tool for personal use to register relevant information about health and mobility of the community; and (iii) assist the university to make informed decisions, such us restricting access to campus.

Following those objectives we are implementing **SeneCare**, which is composed of three main components (ie, mobile apps, a backend, and a web module). To accomplish it a group of more than 30 volunteers, composed by students of different levels, professors, alumni and staff, have worked voluntarily since May 2020 to design, implement, and maintain **SeneCare**. The team combines experience and knowledge from various areas, such us systems and computing engineering (Software development, data analytics, infrastructure and security), design, medical science and law. We involve such variety of knowledge, since we wanted to build a system that had some important pillars, (i) a user-centered system, (ii) which takes care of the privacy of the user, (iii) and uses best practices of software engineering (SE), iv) presents truthful and useful information to uniades community, and (v) could became a reference in Colombia.

The aforementioned pillars were a priority for us since we wanted to keep user engagement with the apps and web module, keep user's data safe, and transfer our experience to other institutions. Thus, since we started the project, we focused on the user experience (UX), taking into account different components like colors and fonts, color theory, expressive messages, and a clean interface. We built different prototypes, for the apps and the web module, and tested them with beta users, who gave us feedback to improve it before releasing to production. In addition, to facilitate the apps adoption, we involved the Uniandes community in an online contest for selecting the app name.[1]

We ensure the privacy of the user, following national laws [1, 2] for managing and storing sensitive data; therefore, we have followed best practices to encrypt the users data (*e.g.,* users identifiers) and manage safe protocols to transport data between different system's components (*e.g.,* https). **SeneCare** does not store additional users data that could help to identify or semi-identify them. Furthermore,

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[1]The **SeneCare** name was selected from 184 proposals made by the community. It combines *Seneca*, which is the name of Uniandes mascot, and the word *care*.

with the aim of ensuring security and app store policies for COVID-19 apps, only authorized Uniandes users can use the App and the Web module.

In addition, to the aforementioned reasons for using best practices of SE, we built native mobile apps in order to take advantage of both platforms (*i.e.,* Android devices and iOS devices) and provide users with the best on-device experience. Finally, during the development process Uniandes and the Central Military Hospital physicians have assumed the product owners role, helping us to define the product backlog, features, and business logic.

2 Current State

SeneCare [1] is composed with three main components, a mobile phone component (Android and iOS apps) a backend and a web module. The mobile apps provide Uniandes community userswith the following features: (i) report their symptoms on a daily basis; (ii) report a contact with a COVID-19 positive person or if the person is positive themselves; (iii) recommendation with the biosafety protocols implemented by Uniandes; (iv) report which transportation means are used to travel to the university. The backend is a bridge between mobile apps and the web module; it also allows to analyze data by authorized personnel (*e.g.,* physicians and epidemiologists), related to the historic symptoms of the community. The web module is for medical purposes, in which only physicians can constantly check and verify the health status of the users (See Fig. 1). Senecare is available in tablets at the campus entrances in order to support users with incompatible devices.
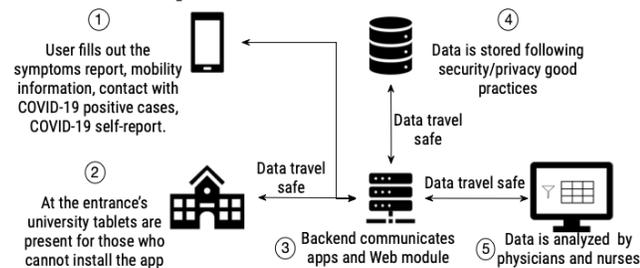

Figure 1: SeneCare components and data flow.

As of Abril 30th (2021), the system is composed by +317k lines of code distributed in backend, web module and mobile apps, and +100 assets (*e.g.,*, images, icons). 20 people have contributed to our private repositories. This code is being continuously upgraded, not only with the addition of new requirements and functionalities but also by improving performance, security and resource consumption. Since the first release on October 2020, 9 additional versions have been released on the Google Play and App Store markets.

It is worth mentioning that we have built **SeneCare** from scratch without using existing source code/apps (for similar purposes) because we wanted to fulfill the aforementioned pillars and also Uniandes needs, including specific requirements for the Colombian context. Some existing apps at the time we started this project were not as user friendly as required or had some privacy issues.

3 Deployment

The **SeneCare** system is part of the UESS defined by the Colombian National Institute of Health as Innovative Syndromic Digital Surveillance, which aims to perform a timely detection of COVID-19 symptoms for people in the community returning to campus.

Reinforcing case capture mechanisms helps contact tracing through participatory surveillance. This surveiillance type allows mobile technologies –for their easy use and wide dissemination– to be an important tool to identify possible cases of COVID-19 as a complement to traditional surveillance, adding and visualizing real-time data, thus allowing research to be carried out in probable cases [3].

With the aim of facing the sanitary emergency caused by the COVID-19 pandemic, the management of the University expressed political will to offer the community a bio-safe campus. We developed and presented to local health authorities a bio-safety protocol based on trative interventions, engineering, and interventions on people. Through the concept of a *Safe Community*, we implemented an epidemiologic vigilance system that allows us to carry out timely actions to prevent and control COVID-19 infections in the best way possible. One of the key components of this system is the digital syndromic vigilance supported on the **SeneCare** system. In addition to symptom reports, the app provides the community with information about the pandemic, and physicians have access to the kind of information that allows them to make epidemiological analysis in real time, and hence make appropriate decisions. That is why its contributions are and will continue to be paramount.

Since October-2020, until April-2021 we have collected with **SeneCare** +50k mobility reports, and +88k symptoms reports. On average we have collected $\tilde{4}$55 symptoms reports per day with a maximum of 1287 daily reports on March 2021. The web module is helping 6 physicians and nurses to analyze data on a daily basis.

4 Future Work

In order to continuously support the Uniandes community, and respond to the Uniandes community needs, we continue evolving **SeneCare**. For instance, we are including a module for reporting vaccination status, in which a person could inform if she has been vaccinated and the respective information (*e.g.,* vaccine side effect); this will help Uniandes to analyze some implications of vaccines, such as herd immunity in the community. Moreover, since Uniandes hosts international students, we are working on internationalizing the app. We are working on implementing automatic contact tracing with PACT [6], in order to detect possible COVID-19 contact and establish epidemiological fences, respecting the privacy of the user. Finally, we will use **SeneCare** for capacity control in closed environments at the campus. As a way to contribute to other Colombian universities and institutions, through webinars and online meetings we are transferring our learned lesson.We will open system's source code and assets based on the needs ot other institutions.

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