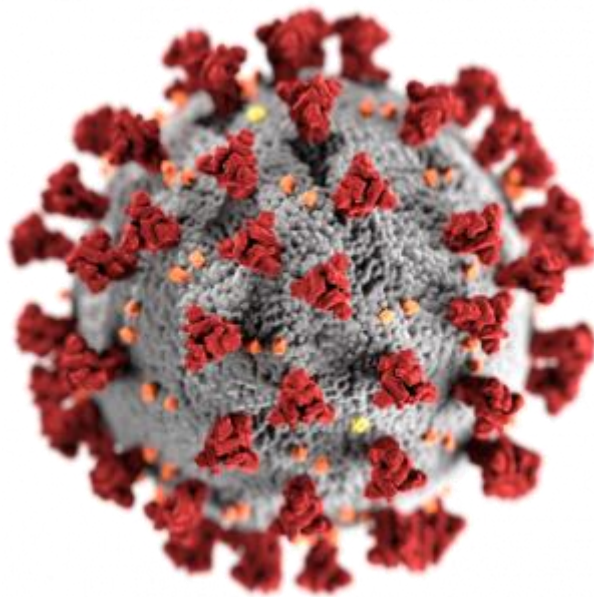


SCIENCE FAIR 2021 LOGBOOK

Ben Hume – Year 13 – MAGS

TOPIC:

COVID-19 Contact Tracker research and development



INQUIRY FOCUS

I will be designing and developing a digital technology outcome with the aim of solving or assisting the solution of a prevalent issue.

In order to identify the most suitable focus I first devised several focuses, before narrowing it down to the most appropriate option based upon the importance of the issue and my ability to solve it. I investigated issues faced by communities around the world on a regular basis, recording issues which showed a significant prevalence. Among these recorded focuses were:

- Emergency service call training
- Cyber security training, and
- Contact tracing during the ongoing COVID-19 pandemic.

Ultimately, I decided that contact tracing would be the most suitable focus for my inquiry. Firstly, most of the world still lacks access to a reliable method of contact tracing. This is a great concern as contact tracing has proven to be critical to the containment of COVID-19, especially in post-lockdown communities. Secondly, the COVID-19 pandemic is a far more prevalent issue in 2021 than either of the alternate inquiry focuses. For these reasons I decided to focus on COVID-19 contact tracing; if the effects of COVID-19 are to be mitigated, a simple but effective open-source tracing software should be developed with an international audience in mind.

BACKGROUND

As of the 24th of February, 2021, 112 million COVID-19 cases and 2.48 million COVID-19 casualties have been recorded worldwide. Health authorities have predicted that if action is not taken to control the spread of the virus, the global casualty count will grow exponentially, resulting in the death of further millions. Due to drastic global action and the development of a functional mRNA COVID-19 vaccine, a significant decline in the virus' spread has begun. If this decline is maintained, communities around the world will slowly begin moving out of lockdown as it becomes safe for businesses to resume operation. If procedures are not implemented to prevent the spread of COVID-19 in post lockdown communities, spread of the virus may resume. The virus that causes COVID-19 is mainly transmitted through droplets created when an infected person exhales, coughs or sneezes. As physical interaction resumes, the likelihood of this scenario occurring between people is greatly increased due to infected individuals coming into transmission distance with a wider range of people. Whilst face masks, social distancing and good personal hygiene work to reduce the spread of COVID-19 significantly, they alone cannot prevent the virus' spread entirely. Contact tracing, however, allows authorities to test and isolate potentially infected people, completely preventing the spread of the virus. I have decided to design and develop a digital technology outcome with the aim of assisting and optimizing contact tracing. Reducing the time it takes for authorities to follow an infection case can reduce the spread of the virus as the window of time in which the virus can be spread is reduced. For this reason, the primary aim of the technological outcome should be to optimize the contact tracing process as much as possible.

I will be designing and developing a python program to suit this aim. Before I can design a functional technological outcome, however, I should record enquiry questions that will allow me to conduct effective research to inform the design of the program.

INQUIRY QUESTION(s)

I followed a similar selection process with my inquiry questions, generating lots of questions and refining the list to a manageable size. Whilst I initially recorded ten inquiry questions, I only decided to investigate two, those being;

- *What factors contribute to the effectiveness of contact tracing?*
- *What parties take part in the contact tracing process and how?*

These questions were chosen as their investigation would be greatly insightful in designing the program; in order to design an effective program, I must have a good understanding of the contact tracing process and what can be done to optimize it. The chosen questions relate to this information. By investigating how different parties take part in the contact tracing process, I can gain a better understanding of how the end users will interact with the program and how I can facilitate efficient interactions between the program and the user. Furthermore, I will use this information to facilitate the needs of all end users. This is particularly important as, whilst I am familiar with how the public take part in the process, I have no knowledge of how contact tracing services participate. Researching what factors contribute to the effectiveness of contact tracing is essential if I am to develop a program that is able to make contact tracing more effective. This is also important as the ultimate goal of the program is to optimize the contact tracing process.

The above inquiry questions are inherently linked to digital technologies as, in the 20th century, data management is handled almost exclusively by computer software. The data processing possibilities made available by computers make a digital technology outcome perfect for efficient COVID-19 contact tracing.

That being said, I have decided to develop a python application that allows users to easily log their activity. Contact tracing services can then extract this information to trace the spread of COVID-19, find sources of infection and subsequently contact individuals who should self-isolate. I will use the above inquiry questions to gather appropriate research that will inform the design of the application.

OPINION(s)

Wider Scientific Community - The wider scientific community agrees that effective contact tracing is critical in containing the spread of COVID-19 outside of lockdown. WHO, CDC and NHS studies have independently found that contact tracing in conjunction with individual isolation reduce the spread of COVID-19 significantly.

48% of the American Population – Despite this, 48% of the American population claim that they are unlikely to speak to a public health official via call or text if they are contacted in this way. Throughout this inquiry I will discuss how digital technologies can be utilized to ensure that the vast majority of the population are likely to interact with the contact tracing system.

I will be using a webapp called Trello to manage milestones and record my progress. Trello features the ability to move milestones between *to do*, *in progress* and *done* sections, making Trello perfect for recording my progress as I go.

RESEARCH

What factors contribute to the effectiveness of contact tracing?

After conducting research into how different factors contribute to the effectiveness of contact tracing I was able to format my findings into a list of summaries below:

- *“Appealing to customers’ brains (knowledge) rather than their hearts (emotions) can increase the effectiveness of contact tracing as people are more likely to participate”* - Dr Raymond Xia. An individual is more likely to participate in a contact tracing system if they think that it is reliable. In systems where there is scepticism, far fewer individuals tend to participate, reducing the effectiveness of the contact tracing system. In order to increase the effectiveness of contact tracing the system should demonstrate *“demonstrate professionalism, competence, and reliability”*.
- Contact tracing systems rely on the ability to respond quickly to a case, the efficiency of a system will be reduced if it is not time optimized as the timeframe the infected individual has to spread the virus before they are isolated is increased. Reducing the time taken for authorities to follow an infection case can reduce the spread of the virus as the window of time in which the virus can be spread is reduced.
- Personal benefit has also been identified as a key factor which increases the likelihood of an individual participating in the contact tracing process. If an individual can gain something by participating, for example entry to an establishment, they are far more likely to participate. Adding some form of personal gain or euphoric response can increase the effectiveness of a contact tracing system.

Sources:

Prof Mirjam E Kretzschmar, PhD ., Ganna Rozhnova, PhD ., Martin C J Bootsma, PhD ., Michiel van Boven, PhD ., Prof Janneke H H M van de Wijgert, PhD ., Prof Marc J M Bonten, MD ., (2020), [*Impact of delays on effectiveness of contact tracing strategies for COVID-19: a modelling study*](#), (1st ed.), The Lancet Public Health – Recent (2020), No bias identified as the organization is non-profit with no clear agenda, peer reviewed, Verdict: Credible

Jonatan Almagor., Stefano Picascia., (2020), [*Exploring the effectiveness of a COVID-19 contact tracing app using an agent-based model*](#), (1st ed.), Nature.com - Recent, Possible bias as Nature.com profits from their articles however there appears to be no bias as there is no clear fear mongering or click-baiting, peer reviewed, Verdict: Credible

Unknown NCIB Scientist., (2020), [*Facilitators and barriers to engagement with contact tracing during infectious disease outbreaks: A rapid review of the evidence*](#), (1st ed.), NCIB - Recent, NCIB is a reliable government organization which is held with high esteem in the scientific community (no bias identified), peer reviewed, Verdict: Credible

Matt J Keeling., Deirdre Hollingsworth., Jonathan M Read., (2020), [*Efficacy of contact tracing for the containment of the 2019 novel coronavirus \(COVID-19\)*](#), (1st ed.), BMJ Journals - Recent, Possible bias as BMJ profits from their articles however there appears to be no bias as the information is presented for purely scientific purposes, peer reviewed, Verdict: Credible

Dr Raymond Xia., Mark Hathaway., (2021), [*Study examines keys to success for contact tracing*](#), (1st ed.), University of Otago - Recent, No bias identified, peer reviewed, Verdict: Credible

What parties take part in the contact tracing process and how?

Once I had conducted research into how different parties take part in the contact tracing process, I was able to summarise my findings in the list below:

- Individuals logging their activity make up most contact tracing system users, accounting for over 99% of all system interactions. For contact tracing to be effective, all individuals within a community must take part in the process to track their activity.
- Contact tracing services then retrieve information entered into the database by the aforementioned individuals in order to track down and isolate possibly contagious contacts. Whilst contact tracing services make up only a small amount of total system interactions, they are vital in ensuring that the process is effective.
- Occasionally government officials may retrieve information similarly to contact tracing services in order to aid an investigation or collect epidemiological statistics.

Sources:

Unknown New Zealand Government Representative., (2020), [*How contact tracing works*](#), (1st ed.), New Zealand Government - Recent, No bias identified due to the reliability of the source's scientific methodology, peer reviewed, Verdict: Credible

Unknown CDC Representative., (2020), [*Case Investigation and Contact Tracing : Part of a Multipronged Approach to Fight the COVID-19 Pandemic*](#), (1st ed.), Centre for Disease Control and Prevention - Recent, No bias identified due to the reliability of the source's scientific methodology, peer reviewed, Verdict: Credible

Unknown WHO Representative., (2017), [*Infection control: Contact tracing*](#), (1st ed.), World Health Organization – Relatively recent (within an acceptable range), No bias identified, peer reviewed, Verdict: Credible

REFINED INQUIRY FOCUS

After conducting research into my initial inquiry questions, I reconsidered and refined my inquiry focus. Whilst my original inquiry focus was developing a contact tracing software during the ongoing COVID-19 pandemic, my refined inquiry focus will be designing a contact tracing software intended for tracking COVID-19 cases with the specific aim of optimizing the contact isolation process. Most contact tracing software focuses on optimising the activity logging process, however there is rarely much thought put into optimizing the contact isolation process, which can have a large effect on the effectiveness of contact tracing. I will also aim to focus on issues faced by small communities who may not have access to reliable methods of contact tracing. This way I can ensure that a greater amount of people have access to effective contact tracing.

PROPOSED DIGITAL OUTCOME

Proposed outcome

I am proposing a python contact tracing application intended for tracking COVID-19 cases with a focus on challenges faced by communities which have no access to reliable and effective forms of contact tracing. This application's main feature will be automatic generation of COVID-19 case reports which include recommended precautionary steps and potentially contagious individuals. The application will also make logging the user's activity as efficient as possible.

Problems this will solve

Firstly, adapting a pre-existing contact tracing system or developing an entirely new one can be time consuming and costly for smaller communities. By developing an easily adaptable open-source Python program with an emphasis on easy modification, I am able to provide reliable contact tracing to smaller communities at a very low cost. Rather than allocating funds to their own contact racing program or an outsourced alternative, authorities of smaller communities can, with little technical experience, adapt this pre-existing application to facilitate their community's needs. Furthermore, developing this application in Python allows smaller communities to easily adapt the program to work with their own API's and even integrate their own language settings.

Secondly, the proposed application places an emphasis on efficient contact isolation. Automatic report generation and suggested action cuts out the time-consuming planning and proposal of action stage which is often unproductive and comes to an easily predictable conclusion. This feature is especially helpful for smaller communities which may not have an abundance of epidemiological professionals to consult.

Target audience

My intended end users are authorities of small, independent communities who have access to the internet and the people of said communities. Almost all communities large enough to be independent have access to the internet, this means that even the smallest communities have the ability to look into, acquire and utilize the proposed software. Whilst it is unlikely that every individual within the community owns a device compatible with the application, most will. Individuals who do not own a compatible device may use the device of their friend, or a dedicated device owned by the establishment they intend to record their activity at. These make up all the parties who will take part in the contact tracing process.

Requirements

- The application must be intuitive and easy to use for a wide variety of people from different backgrounds and with differing technical experience.
- The application must be able to record the time, date, and an individual's location effectively.
- The application must be able to produce case reports quickly in order to optimize the contact isolation process.
- The application must be compatible with IOS and Android.
- Modifying the application's code to suit a community's needs must be relatively easy.
- The application's GUI must be visually appealing and professional.
- Copyright and privacy must be addressed
- Information about the user's privacy and what is done with the information they enter into the application must be easily accessible.

Resources

In order to develop the application, I will need a laptop or desktop running an operating system comparable with Python's IDLE, internet access and around 4 months. As I am not confident with Python GUI development, I will use Real Python's Tkinter tutorials to learn how to create a Python GUI. I may also need to use a python geolocation API to track the user's location. I will be using information and statistics from the New Zealand Government, the Royal Society of New Zealand, the CDC and the WHO in order to develop the report generation feature of the application.

RISK/THREATS AND OPERTUNITIES

Strengths

- I am relatively confident in Python
- I have a good understanding of how data management works in Python
- I have UI and UX design experience and am familiar with UI and UX concepts / considerations
- I understand how contact tracing works
- I have deigned a contact tracing relational database in the past

Weaknesses

- I have minimal experience developing python GUIs

To address this weakness, I will be following Real Python's Tkinter tutorials before I begin development of the application, this should give me all the experience I need to develop the application's GUIs. If I am still unable to create the GUI I want I can use other online tutorials to improve my Tkinter knowledge.

- I have no experience with the python geolocation API I plan on using

To address this weakness, I will research the API and read through the API forum page before I begin development of the application.

- I am unaware of issues faced by small communities regarding COVID-19 contact tracing

To address this weakness, I will conduct research into the specific contact tracing issues small communities may face. I may also interview someone who has experienced these issues if I cannot inform myself through online research.

Opportunities

- Improve my own python GUI abilities
- Gain experience using a python API
- Potentially help to make the world a better place by contributing to the global COVID-19 effort

Threats

- Risk to users' privacy as personal information such as address, activity and contact details will be collected

To mitigate this risk, I will write a robust privacy agreement and ensure that any information collected is stored securely and only accessible to the intended parties.

- Incorrect functionality

To mitigate this risk, I will ensure that I am confident in developing all the appropriate features including GUI and geolocation API compatibility.

- Excessive amounts of time spent on the project

To mitigate this risk, I have planned how much time I should aim to spend on each goal using a Gantt chart in conjunction with a webapp called Trello. I have documented this in "*Inquiry Milestones*".

STRENGTHS AND WEAKNESSES

Strengths

- Automatic report generation and suggested action cuts out the time-consuming planning and proposal of action stage which is often unproductive and comes to an easily predictable conclusion. This is undoubtedly one of the most useful proposed features as it's implementation could help optimize contact isolation greatly.
- Automatic next-step suggestions are particularly helpful for smaller communities who may not have an abundance of local epidemiological professionals to consult. Utilizing this feature allows these communities to take action quickly, mitigating the spread of COVID-19.
- Writing the program in python makes it significantly easier for authorities to modify the code to implement their own language settings, integrate an API or change the application to suit their community's needs.
- The application's data management system makes information easier to find and edit; the application will feature an interface which allows certain authorized users to search, edit and delete records from the database. In the event that specific records should be found for contact tracing purposes, officials can easily and effectively locate and extract records using this feature.

Weaknesses

- I currently have no way to implement language settings into the application, this means that non-English speaking communities will have to implement their own language settings before they can utilize the application. In order to address this issue, I should structure the code so that implementing custom language settings can be done easily and in an intuitive manner. I should comment on my code where necessary and make any GUI text obvious by using breaks above and below the line. By doing this I ensure that others can easily see what text they need to translate to implement custom language settings or, alternatively, create a foreign language version of the program.
- Because the application collects information regarding users' contact information, address, and recent activity there is a risk of personal information being mishandled, leaked, and used with malicious intent. In order to address this issue, I should ensure that the security of information is maintained using methods like encryption. I should also incorporate a robust privacy policy and make sure the user is aware of this so that there is no ambiguity around how information is being handled and who can access information the user enters into the application. Featuring a policy such as this also makes it easier for users to trust the application and the professionalism of it's development, as previously mentioned this has been shown to increase the likelihood of user interaction with the system.

SUMMARY

After investigating my inquiry questions, I was able to draw conclusions about what factors contribute to the effectiveness of contact tracing and what parties take part in the contact tracing process. I found that the three main factors that increase the effectiveness of contact tracing are users perceiving personal benefit, users viewing the system as professional or efficient and mitigating the amount of time it takes to isolate contagious individuals. I also discovered that the two main parties that take part in contact tracing are individuals, who simply record all establishments they have visited, and contact tracing services, who use the recorded information to locate and isolate potentially contagious individuals. I also found that occasionally government officials may retrieve information similarly to contact tracing services in order to aid an investigation or collect epidemiological statistics. I have recorded my sources above in the "*Research*" section and assessed their reliability individually. Generally, all the sources I used to aid my investigation are reliable as they are all relatively recent, unbiased and most of them have been peer reviewed. My findings were undoubtedly relevant to my proposal. My initial inquiry questions had been designed to collect information relevant to the proposal, without the conclusions I drew from my inquiry I would be unable to propose an effective solution to the inquiry. I needed an understanding of the contact tracing process, what variables contribute to it's effectiveness and who my end users would be in order to successfully propose an effective outcome. I can be fairly sure that my findings are accurate as I used reliable sources and ensured that all conclusions I came to were based upon relevant statistics and facts. In conclusion, I believe that my proposed digital outcome is the best solution to the issue of contact tracing based on the research I have conducted.