Technological Feasibility Analysis

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Team Name - Efficient Tester

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1. Introduction

In the United States, testers in a lab routinely test millions of samples to detect thousands of disease cases. In particular, during the novel Coronavirus epidemic, laboratories in the United States were testing at least 600,000 samples a day. Obviously today we are testing more samples at present than this time last year, prior to the pandemic. Although this detection method is effective, it requires a lot of time and detection reagent, which can seriously restrict the detection ability.

With the ongoing COVID-19 outbreak and the reopening of public places, people are returning to work and school. We are coming into contact with more people. This increased contact could drastically increase the number of people who need testing. It has revealed a huge challenge to our ability to detect pathogens. We have to expand the capacity to test more people. Traditional personal testing is equally good at detecting pathogens, but if the prevalence of infection is low in a population, many tests are wasted. If rates of infection are low, this means that the majority of tests will be used on healthy individuals. In these situations, it can be more effective to group samples into a single test tube and look to see whether any of the individuals are infected. If the pooled test is negative, then the researcher has saved n – 1 tests (where n is the pool size). If the pooled sample is positive, this group is subdivided into smaller pools and the process is repeated. This method was developed by Robert Dorfman and is used by our sponsor Tara Frustenau's research group who help testers in labs doing more efficient work.

For rapid testing, our clients have developed their own protocols for group testing on a 96-well plate. The positive samples can be quickly detected in three steps. First, we create six pools with 16 test samples in each pool. After passing the first test, we select the pool with a positive population test, divide each pool into two pools on average, and conduct the second group test. After the second population test, samples from each positive pool are tested one by one. While the current approach is already effective compared to other approaches, the team testing process could be improved by a workflow assistant. The app helps technicians to correctly record and capture results. Make the detection process more simple and accurate.

Our solution is to develop a mobile application that runs across android and ios. It will run on a smartphone or tablet carried by a researcher or lab technician. The main function of this application is to help researchers design an optimal pool and track samples during testing. First, we will select a cross-platform framework to generate identical versions of Android and ios. Our second task is to select a relational database in order to store test results and update protocols in real-time. We will also build a database to store researchers' lab notebooks for real-time recording of experimental data. Finally, we will develop a Guided User Interface (GUI) for visualizing protocols, monitoring protocol execution, and reviewing results.

The document is organized in such a way as to first list the major technical challenges that we have or expect to face in developing the application. Then, we will analyze the possible technical solutions and choose the best solution. Finally, we described how to integrate our technologies.

2. Technological Challenges

Below are the technological challenges that we will be analyzing throughout this document. These challenges are cornerstones of our project and it is extremely important that our research into these topics help us to discover the best options for each separate challenge.

2.1 Image Generation

We will need to be able to generate and edit images of the well-plates in accordance with the way our software will need to create images based on information generated through the algorithm created by our project sponsor. These images will need to be quickly and easily editable and interact easily with python code.

2.2 Web / Mobile Frameworks

We will need a framework or frameworks to be able to develop our web/mobile application that will be able to handle data being passed in and the ability to save that data within the application itself. The optimal code base would be python since we are already given python scripts from the client for the algorithms within the lab.

2.3 Database Technologies

We will need the ability to store and retrieve experiment data, protocols, and lab notes. A database backend with the proper format and storage utilities will enable this feature to be used in our project.

2.4 Security / Back-End

We will need some efficient and practical methods to improve the security of our app. These methods need to be suitable for our app and be accepted by the majority of users and companies.

2.5 Version Control

We will need a strong repository of code to manage and merge code changes and reviews. This way the code repository will be consistent and changes will not cause compatibility errors. By using a version control system we can keep the code updated in real time and easily view the history of the development version.

3. Technology Analysis

3.1 Image Generation

3.1.1 Overview of the Problem

One of the major problems we identified is the image processing and generation that needs to occur. Through each different use case of the program for different pathogens will use different protocols which will include different sample sizes and different rates of positive tests. Each will require a different subdivision of wells within each well plate. At each level in the experiment as well we will need to identify where any positive cases potentially occurred and display it easily to the user. The user must also be able to easily touch on the image for each properly pipetted and tested well, meaning the image generation must be extremely speedy, with little lag time. We will need to generate these images at each step for each experiment so proper graphic generation is extremely important.

3.1.2 Characteristics

- Compatibility
  - We want some software that will be that will work with the required python algorithm for correct well division.
  - The software must be able to send the image to the web and mobile components with ease.
  - Scoring method: 0-2. A score of 0 means that it is not compatible with our software needs at all. A 1 means that it is compatible with our needs but there would otherwise be significant hurdles. A score of 2 means that the library is already for Python or written in Python so it can easily communicate with the aforementioned code.
- Guidance
  - Clear and complete documentation about how to use software or library. More than one reference is important in helping us to understand the software.
  - Widespread use and explanation is important. We want to use software or a library that has modern and updated discussion around its use and many tutorials and explanations of how to use the software.

    - Well-documented and well explained software is important to help us stay on track. It allows us to quickly upskill and improve our abilities with software we may be inexperienced with.
    - The metric used to determine this will be through: Tutorials, StackOverflow posts, Wiki pages, Books, Git Repositories, and if the software is Open Source with good documentation.
    - Scoring method: 0-6. One point is granted for each of the above listed metrics we wish to use.
- Image Editing and Generation
    - The software must be able to draw simple geometric shapes on top of an image, at specific points with specific colors and sizes.
    - The ability to combine images together and lay them across each other.
    - Our software must be able to open a pre-existing image continue to edit it then save that new image
    - This is important because this is our plan for adding color to the blank well plate image specifically where required by the algorithm.
    - Scoring Method: 0-3. 0 Can not do image editing or generation in the specified ways. 1, is able to open an image, draw geometric shapes and exit the image. 2, is able to overlay different photos on top of each other as required. 3, is able to change color and position and hue of the images we are working with.

3.1.2.1 Python Pillow fork of PIL

About

Pillow is a fork of the original Python Imaging Library (PIL) that makes PIL more user friendly and more accessible to the programmer. PIL has not been updated or maintained in a considerable time so Pillow is in many ways a spiritual successor to that original library. Pillow is also open source with all code available through GitHub, and is under the PIL license meaning it is free to use. We found this library through one of our group member’s previous experience with photo editing in Python.

Analysis and Overview

First we will score the compatibility of Pillow to our other software requirements as discussed above. The library is a Python library meaning it is written mainly in Python and aimed at usage in Python as well. This means that it will be easy to interchange information between the original Python code and any new code we add. Pillow is also very well documented and maintained actively, with open source repositories and clear documentation along with tutorials explaining it. As can be seen in Table 1 showcasing Pillow's clear guidance and documentation. Pillow is able to generate images and do all of our required tasks in terms of image generation and editing.

Documentation and Guidance Analysis							
	Tutorials	StackOverflow Posts	Wiki Pages	Books	Git Repositories	Open Source	Total Points
Pillow	1	1	.5	0	1	1	4.5

Table 1: Documentation and Guidance Analysis for Pillow.

Results Overall:

- Compatibility: 2
- Documentation and Guidance: 4.5
- Image Editing and Generation: 3

3.1.2.2 PyCairo

About

PyCairo is a python variant that allows us to use the cairo API with python code. The main features of Cairo are its 2D graphics ability. However the main Cairo code is written in C, and freely available to be modified and redistributed and the API is public. PyCairo is a python implementation of this API with a public Git Repository and documentation. It can be used to draw basic shapes and lines.

Analysis and Overview

As discussed in our software requirements we need software that will be compatible with our other libraries and code that needs to be run in order for our application to function. PyCairo is written in Python which is useful as it will allow for easy interaction between the two pieces of different software. However, it is written on top of Cairo which is based in C and not Python, this may create some issues down the line. Also, PyCairo has good public documentation and is open source which is important to us. However, PyCairo is not super widely used which means there is less helpful information online about its use. See Table 2 for more information on this. PyCairo is capable of drawing different basic geometries and shapes, which is another important piece.

Documentation and Guidance Analysis							
	Tutorials	StackOverflow Posts	Wiki Pages	Books	Git Repositories	Open Source	Total Points
PyCairo	0	0	.5	0	1	1	2.5

Table 2: Documentation and Guidance Analysis for PyCairo.

Results Overall:

- Compatibility: 1
- Documentation and Guidance: 2.5
- Image Editing and Generation: 3

3.1.2.3 Magick

About

Magick is a library that exists within the R programming language, however it touts itself as, "... the most comprehensive open-source image processing library available." Which shows just how good at image processing it is, with many file formats and functionalities supported. It is open source with some publicly available documentation.

Analysis and Overview

One major problem with Magick is that it is written in a different language than the other scripts we need to run. However, both Python and R are able to communicate through some means so it is possible that this will work. The software is open source with a git repository with some documentation. However, the easy to use documentation is short and limited, whereas the in-depth documentation is found in a lengthy and difficult to digest PDF. There is some other use of the library and posts on StackOverflow but less than other the Python equivalent packages. See Table 3 for more information. The package is able to draw geometric shapes with other images, however the main target of this appears to be for graphing functionality and not actual photo editing, but it is possible.

Documentation and Guidance Analysis							
	Tutorials	StackOverflow Posts	Wiki Pages	Books	Git Repositories	Open Source	Total Points
Magick	1	0	0	1	1	1	3

Table 3: Documentation and Guidance Analysis for Magick.

Results Overall:

- Compatibility: 1
- Documentation and Guidance: 3
- Image Editing and Generation: 2

3.1.3 Chosen Approach

Overall, the approach we have decided to go with is the Pillow library in Python. It had the highest total score of 9.5. See table 4 for the totals comparison between the 3 options discussed previously. The reasoning here is we believe that using a Python library will make things less difficult for us later on in the project. Also Pillow seems to be the most widely used and well documented amongst the options we looked into. Many of the StackOverflow posts related to Pillow showcased things very similar to what we plan to do and what we want to do with the software.

Image Generation				
Tools	Compatibility	Documentation and Guidance	Image Editing and Generation	Total
Pillow	2	4.5	3	9.5
PyCairo	1	2.5	3	6.5
Magick	1	3	2	6

Table 4: Image Generation Results Total

3.1.4 Proving Feasibility

To prove feasibility, we are going to use Pillow in our Technology Demonstration at the end of the semester. This will solidify that it is the right choice for this task. We have also begun to create some early images to test what the possibilities of creating images in this software are, as can be seen in Figure 1. Using it in our Tech Demo will give us more insight into how we want to use it and making sure to solidify our choice. While we are testing, we will continue to learn more about it and continue to follow tutorials and read documentation relating to Pillow.

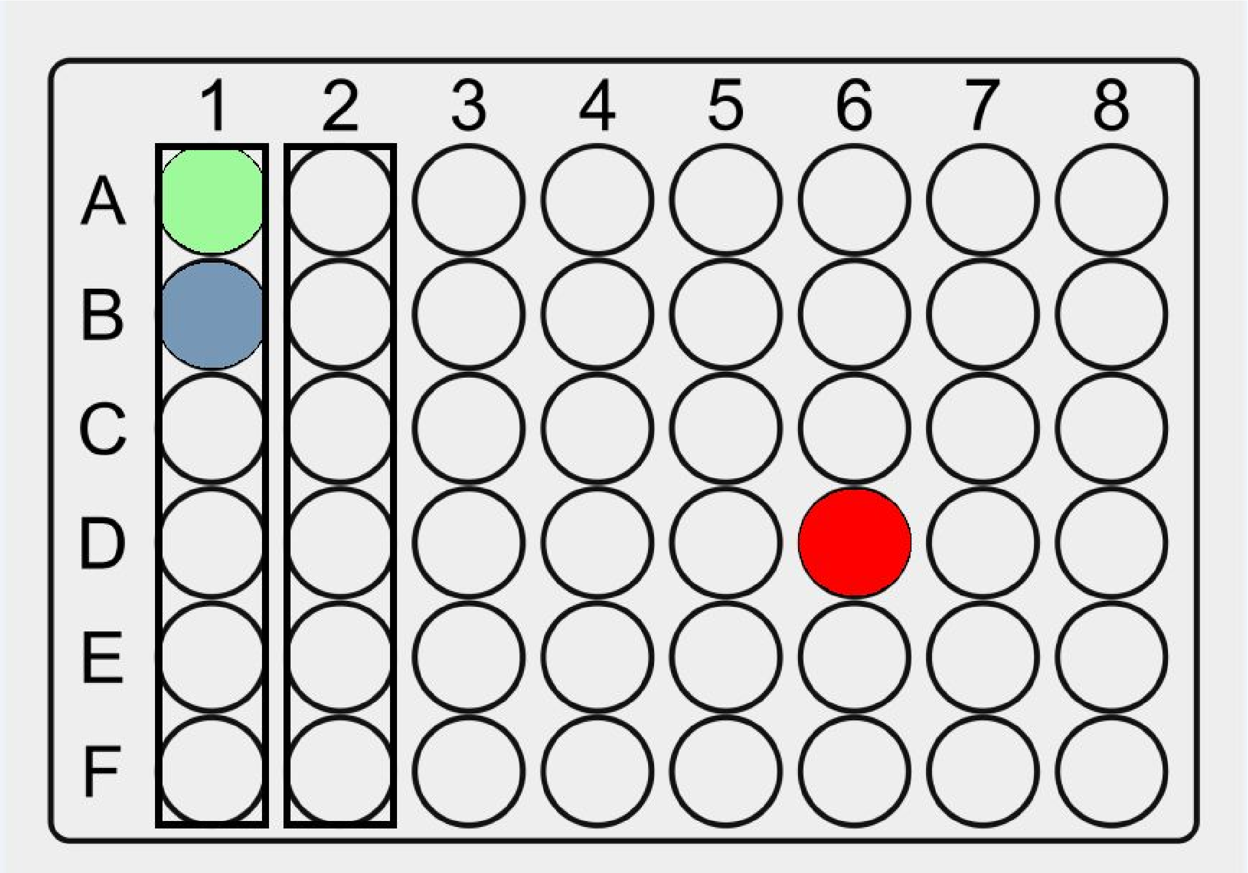

Figure 1. A test of geometric shapes in Pillow.

3.2 Web/Mobile Frameworks

3.2.1 Overview of the Problem

The issue at hand is finding what mobile/web development framework would work best for us and the project we are tasked with completing. The framework chosen needs to be one that is powerful yet reliable and also one that is compatible with the database we wish to use as well as the code (python) that is already given to us in respect to the algorithm that we will be using. Below we will be outlining 4 different frameworks that are possible for us to use and they will be broken down and discussed in 4 main categories.

3.2.2 Characteristics

- Compatibility
    - This has to do with the compatibility with the database chosen by our team as well.
    - This will be scored on a 0 - 5 scale, with 0 being the lowest/least desirable score and 5 being the most appropriate and desired score. 5: A, 4: B, 3: C, 2: D, 1: F , 0: Not applicable
- Ease of use
    - The learning curve for us as a team to be able to get a good understanding of how to use the framework to fit our needs.
    - This will be scored on a 0 - 5 scale, with 0 being the lowest/least desirable score and 5 being the most appropriate and desired score. 5: A, 4: B, 3: C, 2: D, 1: F , 0: Not applicable
- Code base
    - The coding language that is used by the framework.
    - If the language is suitable for us to use as a team and to use with the scripts that were already given to us by the client.
    - This will be scored on a 0 - 5 scale, with 0 being the lowest/least desirable score and 5 being the most appropriate and desired score. 5: A, 4: B, 3: C, 2: D, 1: F , 0: Not applicable
- Security
    - The level of security has to do with the framework and the libraries used within the framework, how they will work for us and how long they will be able to work for us without the need for updates.

- ○ This will be scored on a 0 - 5 scale, with 0 being the lowest/least desirable score and 5 being the most appropriate and desired score. 5: A, 4: B, 3: C, 2: D, 1: F , 0: Not applicable

These will be scored on a 0-5 scale. 0 being least applicable to 5 being the most applicable.

3.2.2.1 React

This is a frontend JavaScript framework that gives users the ability to create high quality user interfaces for mobile and web devices. This is a fairly easy to use framework that does not have a steep learning curve for new users mostly because the library used is small so there is not much to learn and is highly flexible. React is great for collecting changing data with the ability to record and edit the data collected. One downfall however is that react does not have support for databases such as mongoDB which is one that our team is looking at too. This is because react is front end only so we would need to pair this framework with another so that it would be compatible with mongoDB if we end up going that route. It would not be so difficult to integrate this framework within our project but I do believe it would be easier if paired with another framework.

Web/Mobile Application Framework Analysis				
	Compatibility	Security	Ease of Use	Code Base
React	0	4	3	2

Table 5: React Web/Mobile Application Framework

3.2.2.2 Xamarin

Xamarin is a cross platform .NET and C# framework that was created by Microsoft. Xamarin is used mostly for making large and complex applications which could be useful but may not be needed in our case. It is an open source framework and is free which is favorable for us since we do not want any additional fees. One downfall in this framework is that it does have a .NET and C# code base which are languages that our group is not really familiar with so the learning curve may be steep in some cases. It is compatible with many different databases so I do not see compatibility being a problem. This framework is a highly secure framework with few updates needed, so the security aspect of this framework is very desirable.

Web/Mobile Application Framework Analysis				
	Compatibility	Security	Ease of Use	Code Base
Xamarin	3	4	2	1

Table 6: Xamarin Web/Mobile Application Framework

3.2.2.3 Django

Django is a web framework with a python code base that is open source that can be used as a backend framework. This framework has been around for a long time and has been tested and used by many companies such as Uber and IBM. The learning curve on this framework is not steep especially if the users already have prior knowledge of python which all of our team does have. It is a very dependable framework that is high on security with built in libraries that can be used to prevent attacks and SQL injections. I do not see a problem with integrating this framework into our project since we will be using python scripts given to us by the client and libraries that will be used for image generation in python. This framework is also compatible with many different databases such as MySQL, Oracle, SQLite and can be used with mongoDB as well so compatibility will not be a problem.

Web/Mobile Application Framework Analysis				
	Compatibility	Security	Ease of Use	Code Base
Django	4	4	3	5

Table 7: Django Web/Mobile Application Framework

3.2.2.4 Ionic

Ionic is an open source framework used for mobile and web application development with the use of HTML, CSS, and JavaScript or Angular. The learning curve for this framework is not very steep one, there are many documents and tutorials on how this framework works and how it can be used. There are many plugins that can be used and tools that could be helpful in the creation of our application. The security of this framework is highly reliable as there are plugins that allow for user authentication as well as other plugins that could be used throughout the design of the application. The compatibility of this framework is also very good since it is compatible with mongoDB and other databases such as MySQL. This framework should be a fairly easy one to integrate into our project and application.

Web/Mobile Application Framework Analysis				
	Compatibility	Security	Ease of Use	Code Base
Ionic	3	4	4	4

Table 8: IonicWeb/Mobile Application Framework

3.2.3 Chosen Approach

In conclusion, the approach we have decided to go with is to integrate Django as a backend and Ionic as a front end for our web/mobile application. The reasoning behind this is because out of all the frameworks we looked at these two scored the highest and we believe that using django as a backend with its Python code base will make it easier to integrate in the algorithms given to us by the client as well as make it easier to integrate in our image generation with the python libraries. We decided to go with ionic as a front end because it will integrate better with django and our database since it is compatible with more databases than react. Ionic is also better suited for us as a group since more of us have experience with html and css than we do with javascript.

3.2.4 Proving Feasibility

To prove feasibility we will implement a small demo application showing the use of taking in data and storing that data to be collected and saved within the app in the end of the semester. As well as showing the user interface made with the ionic interface that will allow a user to login and enter their workspace where the data can be recorded.

3.3 Database Technologies

3.3.1 Overview of the Problem

For this project, we need the ability to retain and access previous test data and notes. This data needs to be accessible later on, both for the same user and for other users that might need access to the data. This introduces a need for a backend database that can store our data and enable accessing data later on.

3.3.2 Characteristics

- Usability
  - The software should be reasonably easy to set up and use as a database; some required learning is acceptable but it should not be overly complex or involved.
  - The software should be able to be connected to the other components of the project.
  - Scoring method: 0 - 2. 1 point will be given for each of the above requirements a software fulfills.
- Compatibility
  - The structure of the type of database needs to be compatible with the type of data we will be storing, including but not limited to text, test results, and protocol information.
  - The software should not cause compatibility issues with other technologies we will be using.
  - Scoring method: 0 - 2. 1 score point will be attributed for each of the above requirements a software fulfills.
- Cost
  - The cost to use a particular software needs to be low, preferably free.
  - Scoring method: 0 - 2. A score of 0 indicates a particular software is prohibitively expensive to use and maintain. A score of 1 indicates the software is not free, but is low cost. A score of 2 indicates the software is free to use, potentially with limitations on features.

3.3.2.1 Desktop Databases

About

Desktop databases are software one installs for use on their personal computer; examples would be Microsoft Access, FileMaker, or Bento. They are typically easy to install and use. They are intended for use within groups and for storing small to medium amounts of data. They are easy to use, as they are intended to be usable for people without a programming background. There are open source options for this type of database as well, so low cost options are available.

Analysis and Overview

Desktop databases do not exactly fit what we are looking for for this project: they can generate a front end, which we will not need as we will be building our own front end, and they are not compatible with websites, which could cause compatibility issues for developing a webapp component to our project, which we will likely do.

Results Overall:

- Usability: 1
- Compatibility: 2
- Cost: 1

3.3.2.2 Relational Databases

About

Relational databases are the typical database management systems used for most projects. They use tables to store data and foreign keys to indicate relationships between data points. They have an advantage being the most common type of database, as a lot of support online exists for learning how to properly use them. Many programming languages have their own library for SQL, so it could be used with any language we would like to program in.

Analysis and Overview

Relational databases are very popular and easy to use on a small scale, so this was the first option that came to my mind when researching. However, for our project, using the relational database model does not make much sense, as the type of data we plan to store will not have entries that are related to one another. The structure and support provided by SQL databases is nice, but we do not have any need for indicating relationships between data. They also can become tedious to maintain with large amounts of data, which could become a problem in the future.

Results Overall:

- Usability: 2
- Compatibility: 1.5
- Cost: 2

3.3.2.3 Object-based Databases

About

Object-based databases store objects rather than attributes within rows and columns. This type of database is most useful when working with objects or XML to store data. They have the ability to relate objects (in object-oriented programming) in another codebase to a database and vice versa. This type of database tends to be less popular than relational databases as there are frameworks that enable object to database mapping while using a relational database. There are frameworks for some programming languages that enable the use of this kind of database, but it would restrict what we could program it in.

Analysis and Overview

This type of database would be useful if we planned on converting our data into a particular format for storage in the database, but since we likely will not be storing XML exclusively, it becomes less applicable. It may also be a bit more difficult to learn since frameworks for this database only exist in Java, Objective-C, and Ruby, so there would potentially be a steeper learning curve in order to use it. For our purposes, it is not the most helpful way to implement a database.

Results Overall:

- Usability: 1
- Compatibility: 1
- Cost: 2

3.3.2.4 NoSQL Databases

About

NoSQL databases do not utilize SQL as a query language, and do not require relationships like relational databases. There are a few different types of NoSQL databases, since it technically includes any database that does not exclusively use SQL, but for my analysis I looked specifically at document databases and key-value databases since those seemed the most relevant to this project. There is a bit of overlap between document databases and key-value databases, but they can be defined simply as a database that stores a self-contained document (document databases) or storing and retrieving data based on a key without any predefined structure (key-value databases), which is unlike relational databases as they require a predefined structure.

Analysis and Overview

This type of database makes the most sense conceptually for the project we are working on, as we do not need to indicate relationships between data. Many implementations of NoSQL databases are open source or free to use with some restrictions, so cost would not be prohibitive. This type of database could be considered easier to use than relational databases as there is no need to learn SQL; however, learning how to work with one implementation of this type of database does not necessarily mean gaining any knowledge about other implementations, unlike learning SQL would, so I would consider the two comparable in ease of use.

Results Overall:

- Usability: 2
- Compatibility: 2
- Cost: 2

Backend Database Analysis				
Tool	Usability	Compatibility	Cost	Total
Desktop Database	1	2	1	4

Relational Database	2	1.5	2	5.5
Object-based database	1	1	2	4
NoSQL database	2	2	2	6

Table 9: Database Analysis

3.3.3 Chosen Approach

For our project I have chosen to use a NoSQL database such as MongoDB (although I will continue looking into comparable options to find any others that have advantages over MongoDB). When examining each type of database for the desired criteria, it seemed that the only two workable options were a relational database or a NoSQL database. What pushed a NoSQL database to the top for me was that, conceptually, a relational database would not make sense for our project and would likely create additional work without any improved outcome. I believe that a NoSQL database will provide the functionality that we need to be able to store and retrieve data.

3.3.4 Proving Feasibility

In order to prove feasibility, we will be creating a small sample database to connect with our other codebases, to prove that it will be compatible with other components, and that data can be safely stored and retrieved from it. We will use this in our tech demo to prove its feasibility and functionality.

3.4 Security/Back-End

3.4.1 Overview of the problem

Security issues are crucial in any software development process. Once a security breach is exploited by criminals, it is very likely to infect the user's computer or steal the user's personal information, resulting in many economic losses. Therefore, at the beginning of the development and design of software, we must pay attention to security issues, here we mainly analyze the back-end security issues.

3.4.2 Characteristics

- Practicality
  - These methods should be the current mainstream methods of protecting the backend.
  - This characteristic will be scored on a 0-5 scale, with 0 being least score and 5 being the most applicable and desired score.5: A, 4: B, 3: C, 2: D, 1: F , 0: Not applicable
- Usability
  - Compatibility with the database and project.
  - This characteristic will be scored on a 0-5 scale, with 0 being least score and 5 being the most applicable and desired score.5: A, 4: B, 3: C, 2: D, 1: F , 0: Not applicable
- Cost
  - The cost should be as low as possible.
  - This characteristic will be scored on a 0-5 scale, with 0 being least score and 5 being the most applicable and desired score.5: A, 4: B, 3: C, 2: D, 1: F , 0: Not applicable

3.4.2.1 Protocol

The HTTP protocol sends content in the exact text and does not provide any means of data encryption. If an attacker intercepts the transmission message between the web browser and the website server, the information in it can be directly read, so we should use the HTTPS protocol-secure transmission based on SSL to ensure transmission security. SSL is the standard technology for keeping an internet connection secure and safeguarding any sensitive data that is being sent between two systems, and it uses encryption algorithms to scramble data in transit, preventing hackers from reading it as it is sent over the connection. This information could be anything sensitive or personal, which can include credit card numbers and other financial information, names, and addresses. At the same time, for all protocol specification documents, a separate HTML page is written for each protocol. All protocol descriptions and interface debugging are carried out through the page.

Security/ Back-End Analysis			
	Practicality	Usability	Cost
HTTPS Protocol	5	4	4

Table 10: HTTPS Protocol Analysis

3.4.2.2 Login Throttling

In our back-end app, we should limit the number of login-in attempts that users can make per unit of time. If the user fails to log in after a few attempts, such as 3 failed attempts, then we should lock it for a short period of time (e.g. 5 minutes), and then if it continues to fail, we should lock it for a longer period of time, if it fails after a certain number of times, such as 10 failed attempts, then we should temporarily freeze his account. After waiting for him to provide relevant materials to prove his identity, we then unlocked his account and asked him to change his password immediately to prevent information leakage. This way, attackers **can’t** make brute force attacks easily.

Security/ Back-End Analysis			
	Practicality	Usability	Cost
Login Throttling	5	5	5

Table 11: Login Throttling Analysis

3.4.2.3 Audit Log

Our app must keep an audit log to know who did what. The more critical the activity, the more logging that we need to do. This way, we can check for suspicious activities if needed, and team members can know what people did at what time and what's the previous value before the change and the value after. Each log entry should have the time, user who did the action, the action, and the old and new values. It can be stored as a separate log file, part of the regular application log, or in the app database so that we can query the entries.

Security/ Back-End Analysis			
	Practicality	Usability	Cost
Audit Log	3.5	3	5

Table 12: Audit Log Analysis

3.4.2.4 Public Networks

Public networks are likely to have security risks. Attackers can leak malicious software to your electronic devices in a variety of ways without your knowledge. At the same time, they can monitor what you do and allow attackers to visit you. Everything you do online-from viewing the entire webpage you've visited (including all the information you may fill in when you visit the webpage) to being able to capture your login credentials and even hijack your account. Therefore, our app should never send credentials over like SSH keys and passwords over a public network unencrypted.

Security/ Back-End Analysis			
	Practicality	Usability	Cost
Public Network	4	3	5

Table 13: Public Network Analysis

3.4.3 Chosen Approach

In conclusion, we use HTTPS protocol based on SSL and login restriction as the main methods to improve the security of our app, because these two methods are the mainstream methods of the contemporary era, which are adopted by many enterprises in the world, and users are also familiar with and rest assured of these methods. At the same time, these methods are also very suitable for our project, and the cost is relatively low. Therefore, these two methods are worth affirming. As for other methods, if necessary, we can add them later to further enhance the security performance of our app.

3.4.4 Proving Feasibility

To prove the feasibility, we can use some well-known application security testing tools (such as SAST, DAST, SCA, etc.) to test our app, and if possible, we can collect some user experience questionnaires to evaluate the security of our software. We will use it in a tech demo to prove its feasibility.

3.5 Version Control

3.5.1 Overview of the problem

The biggest challenge for a development team is to synchronize code. The version control manager will be a great help to the team. It will provide a code repository. Version control helps us keep track of any updates to the project. Our goal below is to find the right version control system.

3.5.2 Characteristics

- Productivity
    - The speed at which developers extract, update, and commit changes in the codebase. It also includes code contradiction reviews.
    - This will be scored on a 0 - 5 scale, with 0 being the lowest/least desirable score and 5 being the most appropriate and desired score. 5: A, 4: B, 3: C, 2: D, 1: F , 0: Not applicable
- Governance
    - Ensure that all change permissions for the repository are developer only. Ensure code integrity and security.
    - This will be scored on a 0 - 5 scale, with 0 being the lowest/least desirable score and 5 being the most appropriate and desired score. 5: A, 4: B, 3: C, 2: D, 1: F , 0: Not applicable
- Documentation
    - Updating the documentation while updating the code helps both the customer and prospects
    - This will be scored on a 0 - 5 scale, with 0 being the lowest/least desirable score and 5 being the most appropriate and desired score. 5: A, 4: B, 3: C, 2: D, 1: F , 0: Not applicable

- Security
    - Protect your code from visitors. Make sure that the code is only modified by the developer

- This will be scored on a 0 - 5 scale, with 0 being the lowest/least desirable score and 5 being the most appropriate and desired score. 5: A, 4: B, 3: C, 2: D, 1: F , 0: Not applicable

3.5.2.1 Github

Github is a very popular repository, which provides both public and private repositories. Github provides content and support for developers to help developers quickly share and manage code snippets. To make the development team clearer, developers can update project documents with code, and the branch comparison view is the fastest way to find contradictions and collaborate online. All data transmission in the new user Github has the security support of SSL, SSH, and https. Github also supports viewing previous working versions at any time during the development process. The storage limit is high. However, the disadvantage of Github is its lack of security. If the repository is public, it is likely to be exploited.

Version Control					
	Productivity	Governance	Documentation	Security	Total
Github	4	4	5	3	16

Table 14: Github Analysis

3.5.2.2 BitBucket

The BitBucket repository can host a wiki page by request. BitBucket allows developers to use code with integrated comments at the same time. Like Github, it checks for code conflicts through pull requests and branch reviews. In the bitbucket repository, you can also view the original working version and support the storage of larger files. BitBucket can also be easily integrated with Trello, allowing developers to review the development progress at all times. However, BitBucket is not free for development teams of more than five people. And the stability is low.

Version Control					
	Productivity	Governance	Documentation	Security	Total

BitBucket	2	3	5	4	14

Table 15: Bitbucket Analysis

3.5.3 Choose Approach

Based on the above comparison, github has a higher score than Bitbucket, so we decided to choose Github as the repository. While GitHub is not as good at governance and security as Bitbucket, GitHub does a better job of productivity and governance. And we're more familiar with GitHub, making teamwork and technical communication easier.

3.5.4 Proving Feasibility

To prove the feasibility, we will test the security of the code repository through a non-developer account. And invite sponsors to review the progress of the project through Github. We will also investigate the user experience of developers and sponsors using GitHub as different roles.

4. Technology Integration

While there are many concerns that have been raised throughout this document, we accounted for the technology looking at the best options in each category and what is important to us and our project sponsor. Each technological challenge is crucial, and we must be able to tackle them all with the best possible solutions available. Even so, it is imperative that we make sure that our separate solutions are able to become unified and work together to achieve the overall main goal of the project.

Many of the challenges were stand alone and not intertwined with each other but an in-depth analysis into their compatibility is key. Our technologies also must be compatible with the algorithm created by our project sponsor that takes in the information of a given virus protocol, data like amount of wells to be tested and predicted number of positive cases, and returns information about how the well plate should be divided into different groups. This piece of code is written in Python so first off our image editing software had to be able to work with this very well, which was an important factor in why we eventually decided to go with a Python based library over one in a different language. It was also important that these code bases are able to integrate well with our application framework.

In our application framework analysis the integration with the other Python based code sets was extremely important. We had to make sure that the framework we chose to build our application in would work well with these two codebases. So, choosing Django was in part because of how that is Python based and can easily interact and share information with other Python code bases. This front-end framework also had to connect easily to our backend database system.

For our database system we have decided upon MongoDB which while not Python based it is easy to connect to our front end with Django. This also influenced our decision-making process here as it was important our front-end be able to talk to our back-end and easily exchange information between the two. Overall, connection between different technological aspects of our project was extremely important.

The connection between these three technologies was most important to us as these are the main cornerstones of our project, being able to load test results, save test results and see them easily and plainly displayed on a front end system is the most important thing. Our other two technologies, while extremely important, were less reliant upon other technologies we have chosen. The way we keep track of changes to our existing codebase and allow all team members to access it is important and we have decided that GitHub is the best option as it is the largest existing platform that will allow us to have the most productivity possible. Also we have decided for our login system that will require security and communication with the backend database to use HTTPS with SSL as it is widely used throughout the internet and will allow for our platform to be safe and secure from potential attacks.

5. Conclusion

The creation of an application that allows labs and lab testers to easily conduct grouped testing in a lab based setting with any type of internet connected device. The application is designed as an optimal system to help increase the speed at which tests are conducted within the lab setting through the means of grouped testing. One of the main reasons that grouped testing is not as widely used is how it can be difficult to follow which group is which at each step in the process, our application seeks to stop that issue. This document has discussed the technological feasibility of separate aspects to this project, including logging in, back-end databases, front end systems, image generation, and version control, are all extremely important aspects of the project that we sought out to better understand and make sure we are choosing the tools that will best help us to complete and understand this project. As can be seen in Table 16 we have provided our chosen solution and our associated confidence level with that chosen solution. We are now ready to continue moving forward with the rest of our project. Next, we plan to begin working with our client to completely lay out the specifications they require for the application to be up to their specifications. In tandem, we will also be working on our tech demo here, which will allow us to showcase these chosen technologies in more of a real setting that we have not yet had.

Technical Challenge	Solution	Confidence Level
Image Generation	Pillow	High
Application Framework	Django Backend / Ionic Frontend	Medium-High
Database Challenges	NoSQL Database	Medium-High
Security	HTTPS based on SSL	High
Version Control	Github	High

Table 16: Summary of Feasibility Decisions