Design Document

DataSafety

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Executive Pitch

Our innovation is an Android application-based research tool that hosts application-based surveys. This research tool informs on and addresses an user's understanding and knowledge of data safety labels. A gap exists in the technology market between the accessibility and readability of data safety labels with the end user's comprehension of privacy concerns. Android, one of the leading phone operating systems, has created this gap in their attempts to make privacy documentation more accessible and readable for users in a condensed format of a data safety label. Data safety labels are relatively new, as they were not required by all applications in the Google Play store prior to July 20, 2022 [1]. Multiple questions remain surrounding the effectiveness of these labels and if/how users interpret these condensed messages that list the functionality of apps and services. The use of the research tool will provide a user with a method to inform themselves on how and where data safety labels are presented to users effectively. The Android application research tool aims to help users make the most informed privacy decisions that will integrate into the Google Play Store.

The application-based research tool is not only designed to help users make informed decisions, it is also designed to support multiple different users of the final product. The first users our application is designed to help are the end users of the application, those who actively make informed decisions regarding their digital privacy. The first user group provides the data set that we will analyze and use to evaluate the effectiveness of the privacy labels; and the general interpretation of these labels; the first users are those who will answer the survey questions. The second set of users, of our final product, are the Google developers that will use the results provided by the first users, taking the surveys, to implement and design new nudging tools. The nudging tools are designed with the goal of providing users with the most helpful information regarding their privacy at the most effective time. Additionally, the third and final users are other researchers interested in the effectiveness and understanding of data safety labels. The goal of our application is to be able to expand it in order to run future research studies on the effectiveness of other elements of data safety.

The area of user understanding of data safety labels is underdeveloped and pertinent given the recent release of the requirements surrounding data safety labels. Our application is one of the first of its kind. A significant difference in our application is that it prompts the first users to answer a survey, within an abbreviated period of time, after a new application has been installed on the first user's device. Our innovative application will collect the name of the newly installed application and gather the most up-to-date version of the data safety label. Based specifically on the gathered data safety label, our application will then generate a small set of questions for the end user to respond to. An element of our design, that is still in the development stage, is determining what questions will provide the most useful information. We want to avoid redundancy, which is vital because installed applications collect a significant amount of data from their users. In addition, we want our end users to be engaged when answering the survey questions so they provide meaningful feedback. These are just a few of the things that make our product different from the current research tools available.

Notably, while many people are concerned about digital privacy, many users feel the benefits of the product outweigh the possible risks associated with having that data collected in the first place [2]. Because of this, our application will have a significant societal impact. Our application will continue to provide insights into how and why a user makes decisions regarding their digital privacy. The continuous collection of data will allow for the development of future tools that work to protect and inform users of the risks associated with their actions, continuing an ongoing societal impact.

Technical Summary

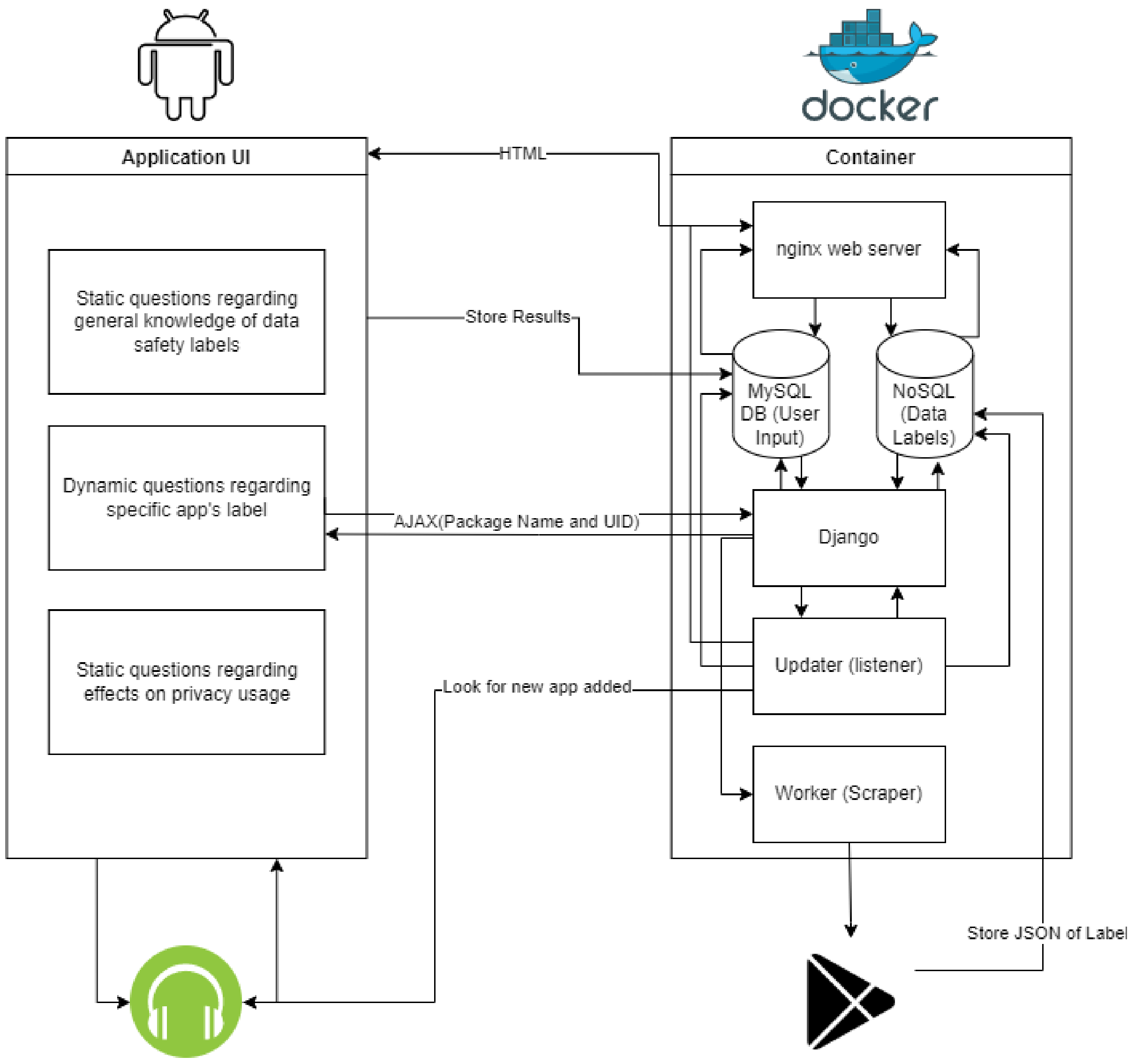
Our first objective is to generate dynamic surveys that will assess the user's knowledge of a specific data safety label once they download a new application. Second, our backend should allow for this generation of surveys with the least number of updates to the frontend. Our final product application should consider: *latency* (when should the user be prompted to answer a survey) and *sufficiency* (number of questions asked to users). Within the backend we aim to have some form of logic that will limit the number of questions asked based on factors of the label that are deemed more important.

Our frontend is built in Android studio which allows us to see front end interactions on a google device. Our user interface will interact with backend servers hosted in docker containers. NGINX will be the primary web server that allows for frontend communication specifically to notify the backend when to initiate the web scraping process after a user downloads a new app. Once the web scraper obtains the label, this label will be stored in Mongodb. Our team will utilize angular and django to create dynamic and static survey questions. The responses will be stored in a MYSQL database where they can easily be queried by a researcher. A diagram of the backend is shown in Figure 1 below.

Making the backend work in the most efficient way possible with the least amount of code will be technically challenging, however we are planning testing periods between each prototype to make the application more efficient. Due to the various communication routes our application needs to perform tasks we foresee the need to test for latency. Additionally, our generation of survey questions will require some ranking system to determine which questions are shown to participants. Therefore, there will be testing rounds dedicated to deciding which questions are generated based on safety labels.

This research is funded in its entirety by Google. Therefore, any materials needed such as test phones, database credits, or other escalated versions of open source software will be funded by the budget given to the Usable Security and Privacy Lab. We estimate that this project will have a really heavy backend which will include data querying, building a web scraper, and forming points of communication between databases, servers, and the user interface. Therefore, we estimate around 1,000-3,000 lines of code. We expect to put our research application through multiple iterations of testing prior to starting our first study. Our first testing period will begin once our alpha prototype is complete. This prototype should scrap the web store when a user downloads the application, generate questions using Survey JS, send the questions to the user, and obtain user input. This prototype will be demo-ed to a Google Researcher for feedback. Our second milestone is to create the Beta prototype that will have all the capabilities that we outlined above. This Beta prototype will go through formal pilot testing to receive feedback before our final product is used for testing.

Figure 1.


docker
Application UI
Container
HTML
nginx web server
Static questions regarding general knowledge of data safety labels
Store Results
MySQL DB (User Input)
NoSQL (Data Labels)
Dynamic questions regarding specific app's label
AJAX(Package Name and UID)
Django
Updater (listener)
Static questions regarding effects on privacy usage
Look for new app added
Worker (Scraper)
Store JSON of Label

Project Specifications

User Stories

As a user participating in the study, I would like to download the Data Safety Research Tool application from the Google Play Store.

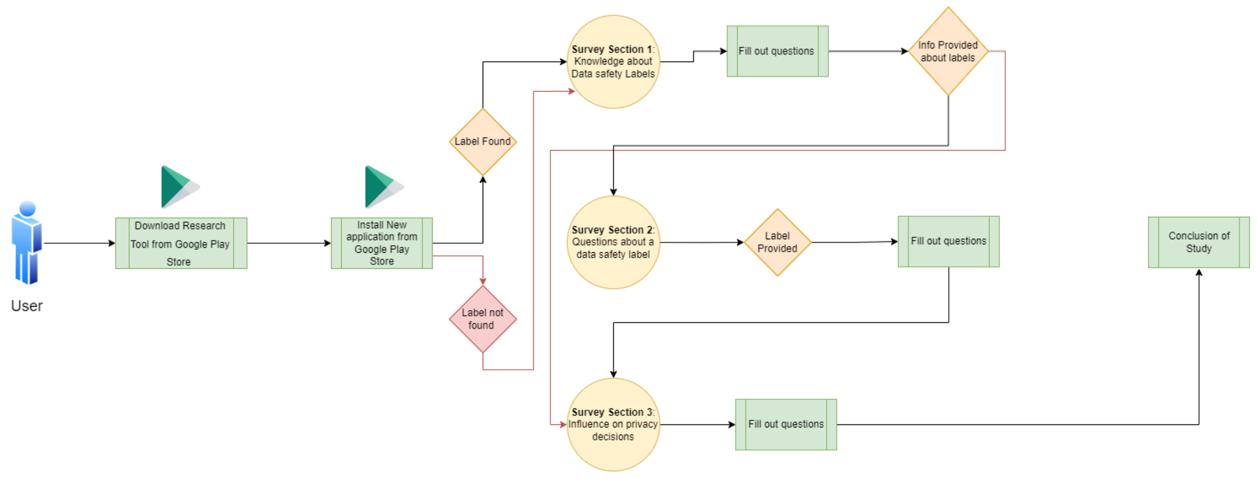
As a user participating in the study, I would like to see the notification prompt to start the survey when downloading a new application from the Google Play Store. When clicking the notification it should redirect me to a survey.

As a user participating in the study, I would like to answer the questions on the survey without any technical difficulties. I would also like the survey to be readable and easy to understand.

As a researcher, I would like to see the user having a unique id after making a prolific account. This ID should be sent to the backend so that multiple users can use the system at once.

As a researcher, I would like to have the user results in an organized format in a database. This would allow me to analyze the data and derive results based on user input.

Flow Diagrams


User
Download Research Tool from Google Play Store
Install New application from Google Play Store
Label Found
Label not found
Survey Section 1: Knowledge about Data safety Labels
Fill out questions
Info Provided about labels
Survey Section 2: Questions about a data safety label
Label Provided
Fill out questions
Conclusion of Study
Survey Section 3: Influence on privacy decisions
Fill out questions

Summary of Flow Diagram:

- User creates a Prolific Account
- User downloads our application
- Their user ID is sent to backend
- User downloads an application. That application’s id is sent to the backend and scraper will parse Google Play Store for the label.
- If no label is found, the user will answer survey section 1 and 3.
- If a label is found then the user will answer all questions of the survey.
- Results are stored in the database.
- Researchers should be able to look in the database and see data inserted by participants.
- Researchers will use data to analyze and determine results of research questions.

User Mock-Ups:

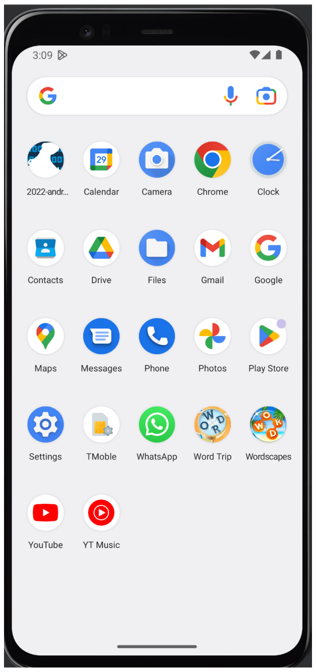
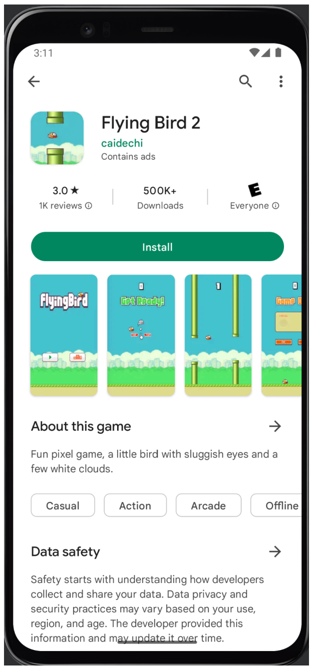


Figure 1



Fun pixel game, a little bird with sluggish eyes and a few white clouds.

Safety starts with understanding how developers collect and share your data. Data privacy and security practices may vary based on your use, region, and age. The developer provided this information and may update it over time.

Figure 2

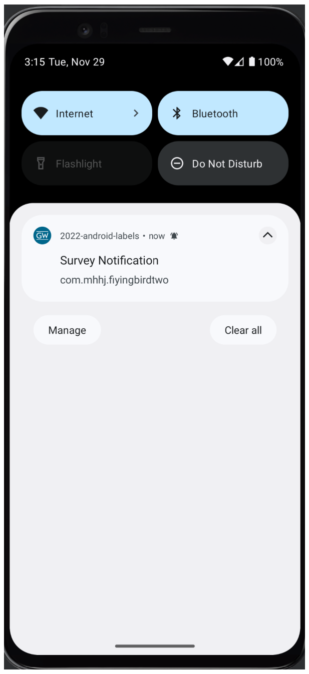
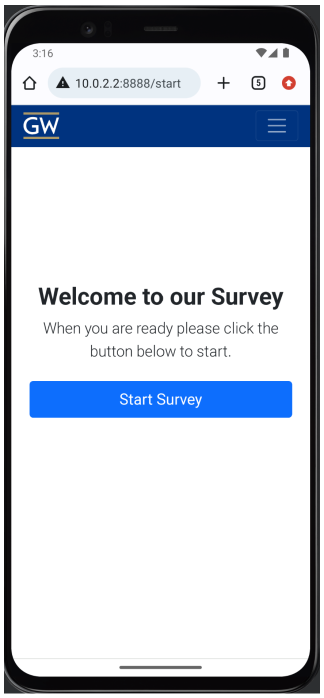


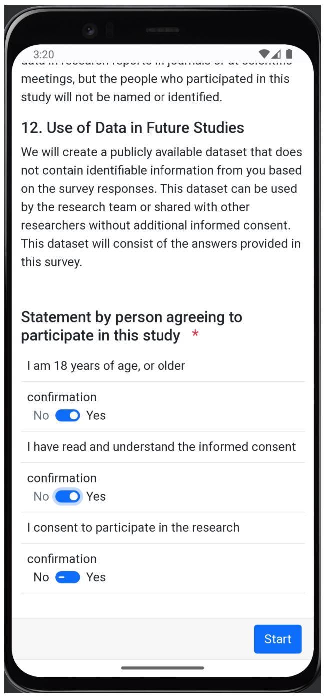
Figure 3



Welcome to our Survey

When you are ready please click the button below to start.

Figure 4



meetings, but the people who participated in this study will not be named or identified.

12. Use of Data in Future Studies

We will create a publicly available dataset that does not contain identifiable information from you based on the survey responses. This dataset can be used by the research team or shared with other researchers without additional informed consent. This dataset will consist of the answers provided in this survey.

Statement by person agreeing to participate in this study *

I am 18 years of age, or older

confirmation
No [✓ Yes]

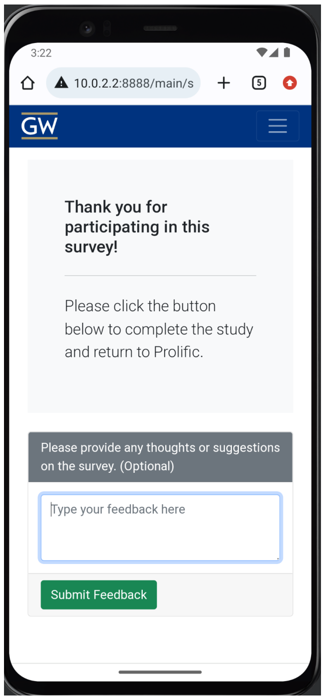
I have read and understand the informed consent

confirmation
No [✓ Yes]

I consent to participate in the research

confirmation
No Yes

Figure 5



Thank you for participating in this survey!

Please click the button below to complete the study and return to Prolific.

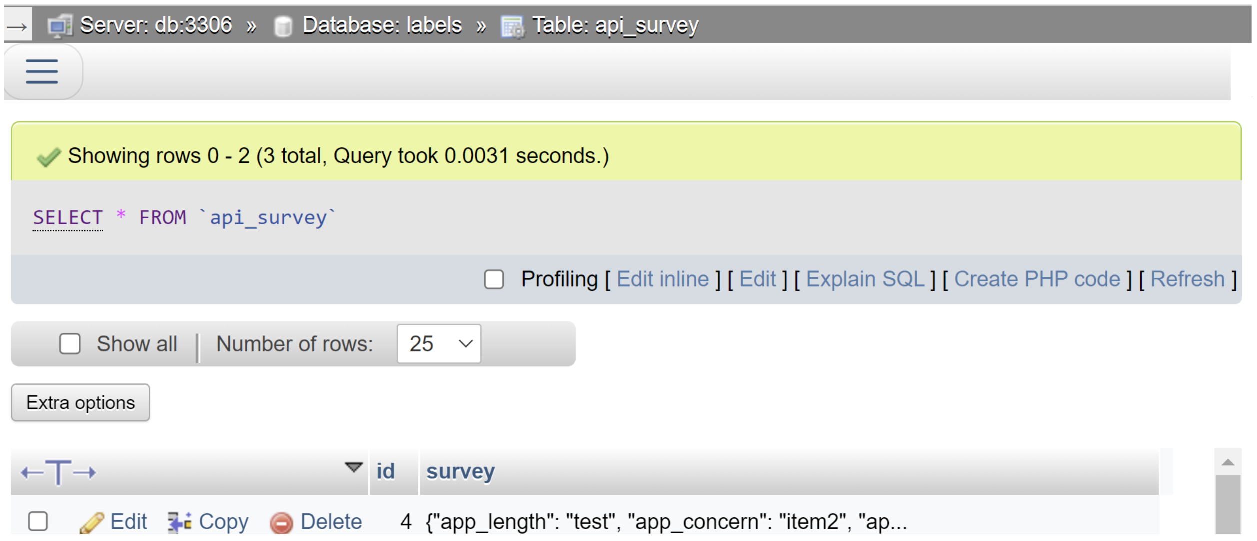
Please provide any thoughts or suggestions on the survey. (Optional)

Type your feedback here

Figure 6

The user will download our android application as shown in figure 1. The user will then download a new application as seen in figure 2. Our application will then populate a notification as shown in figure 3. The user will then be prompted to start the survey as seen in figure 4. Some of the questions structure and final feedback can be seen in figure 5 and 6.

Researcher Mock-Ups


Server: db:3306 » Database: labels » Table: api_survey

Showing rows 0 - 2 (3 total, Query took 0.0031 seconds.)

```
SELECT * FROM `api_survey`
```

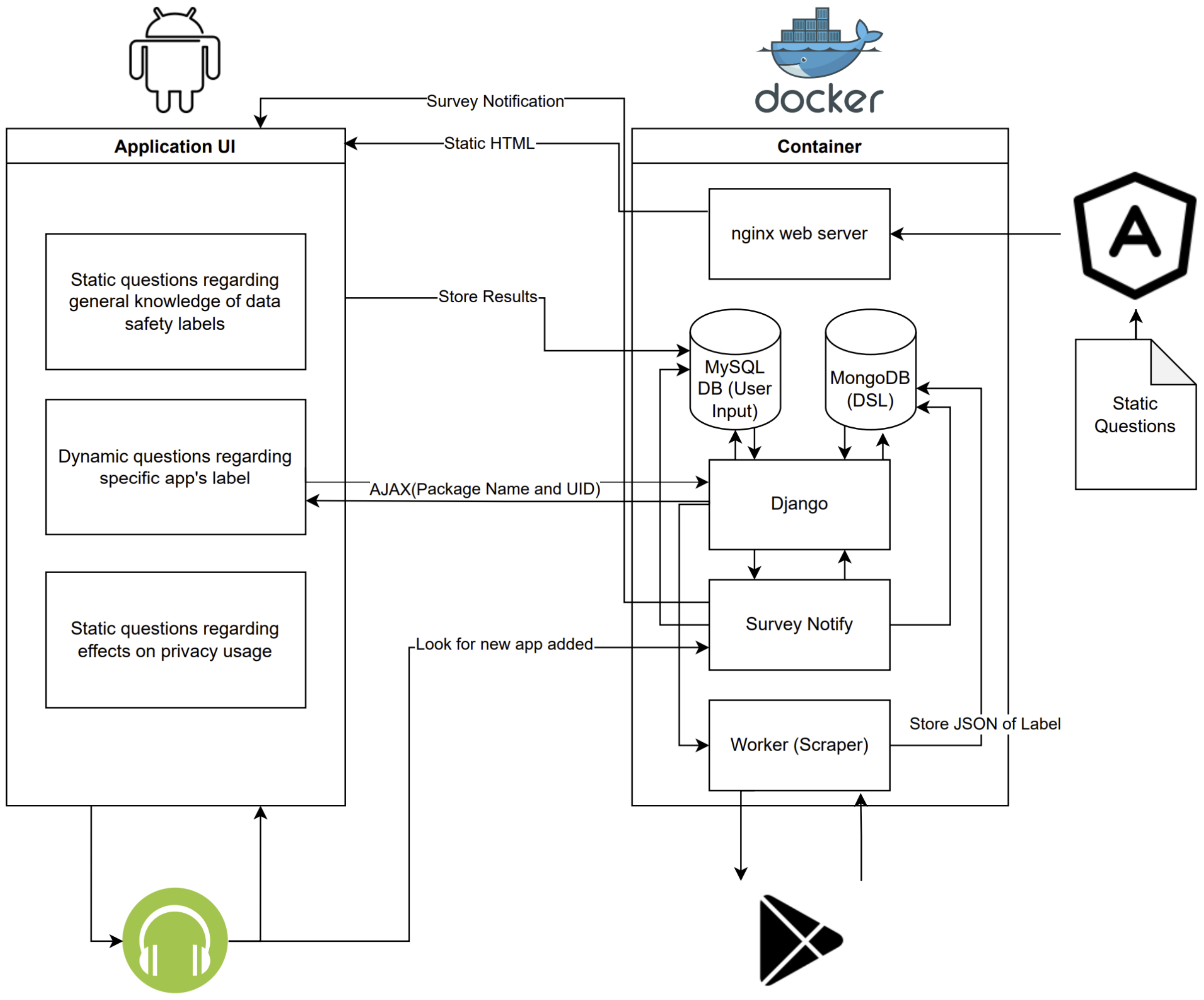
Profiling [Edit inline] [Edit] [Explain SQL] [Create PHP code] [Refresh]
Show all | Number of rows: 25
Extra options

	id	survey
Edit Copy Delete	4	{"app_length": "test", "app_concern": "item2", "ap...

Results will be stored in a MySQL Database for analysis that the research can access.

Technical Specifications

Architecture/System Diagrams



External APIs and Frameworks

Backend APIs:

Promise API:

Goal: Use this API to parse Google Play Store for labels and map them into array objects. This will allow us to easily manipulate the data into a format we wish to use such a json file that is broken up by category.
Description: This API is used in the scraper.js file in our web scraper.
Endpoints used: This web scraper will access:
${BASE_URL}/store/apps/data safety

Where BASE_URL is the playstore link plus the unique ID for the app that was downloaded.
https://play.google.com/store/apps/details?id=com.whatsapp

Ramda API:

Goal: Placeholder value used to specify "gaps" within current functions.
Description: This API is used in the scraper.js file in our web scraper.

Express API:

Goal: Use this as a built-in middleware function. It parses incoming requests with JSON payloads.
Description: Using this to communicate between docker containers in the backend. The backend consists of multiple docker containers that need to trigger certain actions when something is completed. For example, when a user downloads an application, the json format of the label will be sent to MongoDB. Then, when the user clicks on the notification to take the survey, this JSON file will be sent through the backend to create a list of dynamic questions. Once the user fills out these questions a JSON string will be sent to a database where it will be stored. This will also be helpful when threading. We will need to thread each of these processes as multiple users may be using our app or doing the research study at once. This framework can also allow us to interact and obtain data from the web framework as well.

Endpoints:

Frontend APIs:

Intent API:

Goal: Access the package name of the new application that the user downloaded.
Description: This API is used in MainActivity.java and MyReciever.java in the App repo for our project. It connects to the internal OS of the phone and is called when the ACTION_PACKAGE_ADDED intent occurs. The application is always listening for this intent to populate within a device, and the result of the intent is sent to the notification API.

Notification API:

Goal: Populates a notification with the added package name and redirects the user to start the survey
Description: The API is used in MyReciever.java in the App repo for our project. This API connects to the internal notification center for Androids and is called after the Intent API has collected the package name. The parameters passed in to the API include the package name and the redirect link and the results are shown in the notification for the user.

Endpoints Used: GET http://10.0.2.2:8888/start?appname={appname}

<u>Frameworks/Other External Tools</u>

Angular

Goal: Use angular framework to build the Survey. Angular has features which convert it to mobile format using android studio.

Description: Using angular to create static questions for the survey. All stylistic elements on our survey will use angular.

Django

Goal: Framework for the backend web application based on python.

Description: Communicates between the frontend and the backend for accurate survey generation.

Ports: Connected on 8000:80

Android Studio

Goal: Builds basic front end application

Description: Provides a unified android based environment to independently build, test, and debug our application. Android Studio is an IntelliJ based IDE which we use for our entire APP repo.

MySQL - PhpMyAdmin

Goal: Saves all survey results from users

Description: This database connects through our Django framework and the NGINX web server to store the results the user enters into the survey.

Ports: Connected on 8080:80

NGINX

Goal: Hosts the static angular questionnaire

Description: This web server connects through the Docker Compose and the Django framework to host the static questions of section 1 and 3 of our survey.

Ports: Connected on 8888:80

MongoDB

Goal: Saves all JSON strings of data safety labels

Description: This database connects through our Docker Compose framework and the web scraper to store the results of the scraped data safety label from the Google Play Store.

Ports: Connected on 8081:8081

Docker-Compose

Goal: Hosts the numerous moving components of application backend

Description: This tool allows us to define each backend component and run multiple containers as a single service. Each of the containers can run in isolation but they interact with each other when needed for the purposes of the application. The docker container system is described in the docker-compose.yml file.

Algorithms

Web Scraper:

Our first algorithmic operation is our web scraper. This is designed to parse the Google Play Store and obtain the data safety label information of a specific application. If the label is found, a json string will be sent back to the server and stored in MongoDB.

The web scraper consists of a couple of main components. The Promise API which allows the mapping of the data into an array format. Then there is a request and throttle js class. The request class makes a request to the Google Play Store which allows us to parse. The throttle class allows a limit to be placed on the number of requests obtained at a certain time.

The scraping should occur once the user downloads a new application. So there will be a listener on the actual device itself that will send a request to the backend which will then trigger the scraping to occur. Our goal is to have this request contain the user ID obtained from prolific and then the ID of the application itself so we can scrape the store. This process should repeat itself for every application downloaded. If multiple users are downloading and using our application at once, there will be threaded processes that will perform the scraping simultaneously.

Dynamic Survey Question Generation:

This algorithm uses the data present in the JSON of the data safety label to generate questions in relation to each specific application. The Django framework will pull from the MongoDB to access the label for the particular application. Our algorithm will then make questions visible to the user depending on if the particular set of data is collected by the application. There will be a cap on the number of dynamic questions a user can be asked in order to prevent answering fatigue and provide the researchers with the most informative set of data.

Generation of User IDS:

Randomly generates a user ID using alphanumerics. It uses an 8 digit combination of numbers and letters. It is in the views.py file which should be triggered when we build the docker compose. This will assign a unique ID for every user that is using our application. So this is per device basis. Having a unique ID is important because if we have multiple users accessing our application and carrying out these processes at once we will have multiple threads that are executing the scraper, the survey question generation, and the storing of data. We need the ID to make sure that all the data stored relates back to the data entered on each device.

Bibliography

[1] Google. (n.d.). Provide information for Google Play's data safety section - play console help. Google. Retrieved October 13, 2022, from https://support.google.com/googleplay/android-developer/answer/10787469?hl=en

[2] Auxier, B., Rainie, L., Anderson, M., Perrin, A., Kumar, M., &amp; Turner, E. (2020, August 17). Americans and privacy: Concerned, confused and feeling lack of control over their personal information. Pew Research Center: Internet, Science &amp; Tech. Retrieved October 13, 2022, from https://www.pewresearch.org/internet/2019/11/15/americans-and-privacy-concerned-confused-and-feeling-lack-of-control-over-their-personal-information

[3] *Study reveals iOS privacy labels miss the mark*. (n.d.). Www.cylab.cmu.edu. Retrieved October 17, 2022, from https://www.cylab.cmu.edu/news/2022/07/25-ios-privacy-labels-miss-mark.html