A Web Application for Location Analysis

Team Location Analysis
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***Abstract*—There is strong potential to realize some benefit to software that would perform an in-depth analysis and presentation of a user's location data. This software outlined in this document includes a mobile and web application to obtain a user's location data and visualize the data in a browser.**

I. Introduction

The project detailed in this document will result is an end-to-end suite of software to discover location data of a user, upload the data to a remote database, perform analysis on the data, and visualize the data in a consumable and simple format. Such software would provide several benefits to a user:

- Observing exactly where a user spends the most time, both in their local town and in the context of the entire globe.
- Observing the furthest and shortest distance a user has traveled. These data points could even reveal information to the user such as how many miles they have added to their vehicle in a timeframe.
- Allowing a user to remember where they have been recently, in the event that they have forgotten, or they need to provide evidence of their travel history.

The motivation behind such a project stems from the general curiosity of the members. Understanding where time is spent is useful for potentially making decisions in the future. For example, one can observe how long they spend at class and at what time they tend to leave campus. Based on this information, one can then tell their peers when to expect them to be free on any given day. Additionally, having the ability to rank one's furthest trips across the world is a fun fact to share with peers. This data could also be able to calculate the total average speed of a user, both walking and driving, that could satisfy some users' curiosity.

II. Technology

This project requires the usage of several technology stacks to be able to acquire, store, and analyze the data. Specifically, this data collection process uses a different technology for each step.

To acquire the data, a mobile application is installed on the user's phone. This application is written in Swift to target most iOS devices. Apple provides several development kits to developers to utilize the phone's built-in functionality, with one development kit being the core location service. This service allows the application to obtain the geographic location of a device, with detailed information such as latitude, longitude, altitude, and accuracy. This service makes use of Wi-Fi signals, GPS, Bluetooth, magnetometer, barometer, and cellular hardware to obtain a highly accurate reading of the user's location. The crucial aspect of this service is its ability to run in the background without the application being open. Therefore, any time the user's location changes, the data is instantly available and ready to be transferred.

The readings coming from the mobile device are immediately transferred to a remote database operating in the Amazon Web Services (AWS) cloud. The database is based on Amazon's DynamoDB database system. To interface with the database, a RESTful API service was constructed with Node.js via the AWS Lambda Function capability. This API performs rudimentary data transformation to conform to the table structure of the database. The most important aspect of the API is its ability to asynchronously receive user's location data and securely store it in the database.

Finally, a React frontend web application is utilized to analyze and visualize the data. For example, a heatmap is used to observe which locations on the globe are most frequently visited. This heatmap visualization could have been performed through a plethora of open-source libraries, but we ultimately chose Google Maps API for its ease-of-use and its simple installation process. Basic grid web layout standards are used to present information such as furthest distance traveled, total distance traveled, number of different states visited, and average trip length.

The completed React program consists of multiple reusable components and a linted codebase that allows for simple contributions in the future. Additionally, the location analysis code is easy to read, and new information blocks can be added to the main page with very little effort.

III. Data

As described previously, the data coming from the mobile device will include information such as latitude, longitude, altitude, and accuracy. This data is sent directly to a remote database. Therefore, one table in the database describes each user of the application, including their unique identifier number, their name, and their status to describe whether they currently wish to upload location data. Another table in the database hosts each individual location gathered throughout the lifetime of the application. This table has columns including a unique identifier number, a reference to the corresponding user's unique identifier, the latitude, longitude, accuracy, and retrieval timestamp.

IV. Team

The team behind this software consists solely of Joey Lemon. Therefore, the responsibilities include the development of every aspect of the software, including the mobile application, the API, and the web application. Below is a tentative schedule to describe the timeline of the project and its milestones:

Date	**Activity**
Tuesday, Sep. 28	Finalize the project proposal to outline the technology and development of the project. Begin work on the project.
Tuesday, Oct. 12	Finalize the API and database to store and retrieve all of the collected data.
Tuesday, Oct. 26	Finalize the mobile application with location tracking capabilities.
Tuesday, Nov. 16	Finalize the web application with data analysis and visualizations.

Table 1. A tentative week-by-week schedule for project milestones

V. Expected Outcome

This project was intended to result in a usable and helpful suite of software designed to perform analysis on a user's location data in a completely hands-off manner. The frontend web application was intended to be designed using modern frameworks and technologies to provide an easy-to-use and simplistic visualization of the analyzed data. The mobile application was intended to work entirely in the background and will require no effort by the user. The mobile application would hopefully be entirely invisible to the user as the location data is constantly streamed to the remote database. Additionally, the user will always have the option to pause and resume the streaming of location data as they please to respect their privacy.

VI. Achieved Outcome

We believe this project achieved all the expected outcomes we defined earlier in the project timeline. We developed a working mobile application that constantly streams location data to the cloud. Currently, this cloud database hosts over 30,000 location pings spanning over the last year and a half. Downloading this data to the client-side application takes up 4.78 megabytes of storage. The completed web application displays a modern design that is extremely simple to digest. It also provides a nice heatmap of the location data that provides a very intuitive visualization to the user.

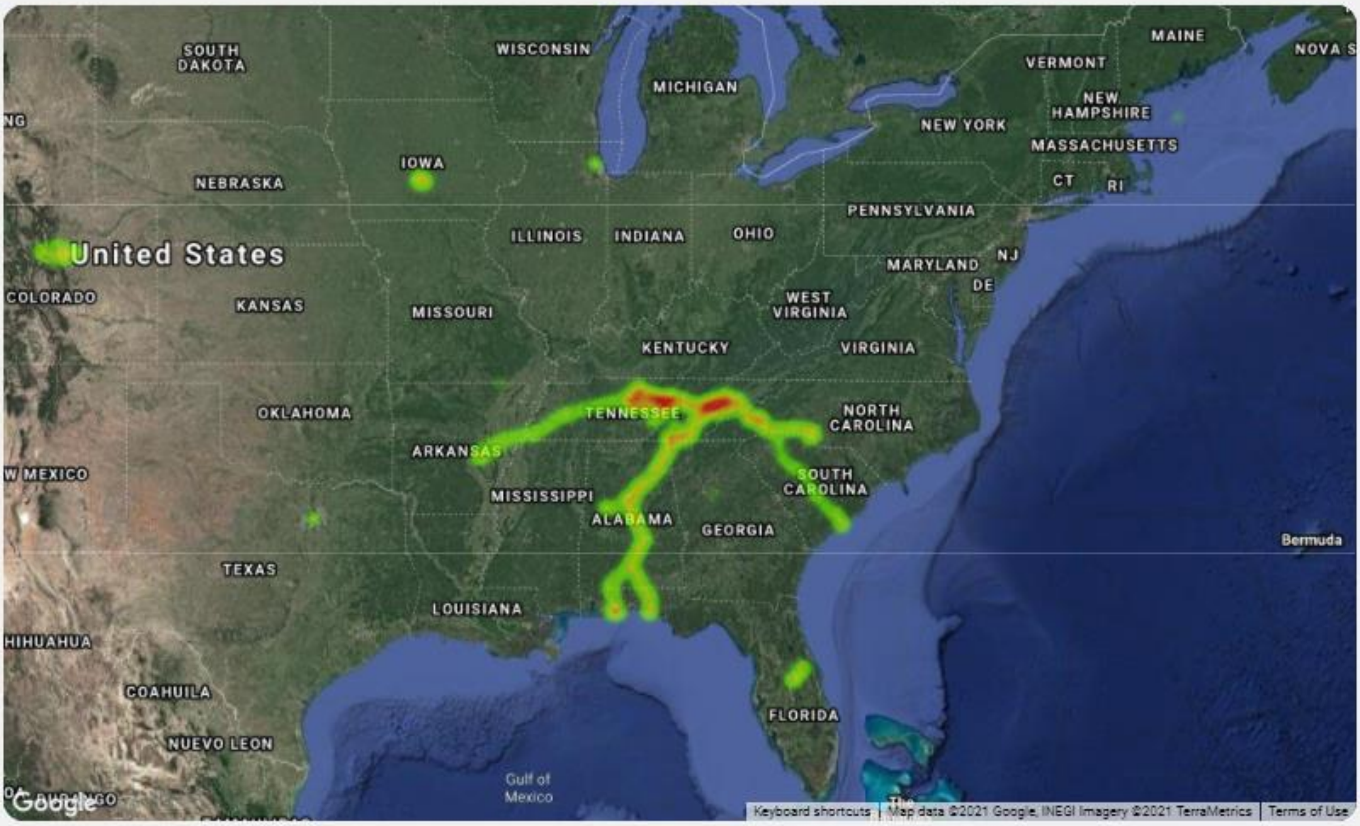
An overview of the web application can be viewed in Appendix A. The application has a main component featuring the heatmap that is interactable. This means the user can pan and zoom the map to anywhere on the globe. Below this main component are the information blocks where some data is extracted from the user's location data. As of now, there are only a few blocks. However, more blocks can be added very easily.

An overview of the database structure can be viewed in Appendix B. This database hosts all the individual location pings received from the mobile application. It provides the latitude, longitude, accuracy, and date of each location ping. This data is provided to the web application directly via AWS Lambda where it is then analyzed and visualized.

Appendix A

Location Analysis

Created by Joey Lemon



7 States Visited	37,444 Miles Traveled
2,532mi Longest Trip	29mi Average Trip

Appendix B

id	user_id	latitude	longitude	date	accuracy
31,488	1	35.903	-84.088	2021-11-18 19:24:06	40.667
31,487	3	35.913	-84.103	2021-11-18 18:29:17	10
31,486	3	35.913	-84.087	2021-11-18 18:24:17	10
31,485	3	35.929	-84.043	2021-11-18 18:19:17	10
31,484	3	35.959	-83.968	2021-11-18 18:14:17	10
31,483	3	35.954	-83.938	2021-11-18 18:09:17	10
31,482	3	35.957	-83.933	2021-11-18 18:04:18	10
31,481	3	35.956	-83.927	2021-11-18 16:02:59	1,414
31,480	1	35.903	-84.088	2021-11-18 15:03:37	40.667
31,479	3	35.956	-83.93	2021-11-18 13:03:10	10
31,478	3	35.963	-83.936	2021-11-18 12:58:09	10
31,477	3	35.932	-84.029	2021-11-18 12:53:09	10
31,476	3	35.918	-84.089	2021-11-18 12:48:09	10
31,475	3	35.948	-84.156	2021-11-18 12:43:09	22.744
31,474	3	35.936	-84.176	2021-11-18 12:38:10	10
31,473	3	35.921	-84.21	2021-11-18 12:33:09	10
31,472	1	35.903	-84.088	2021-11-18 09:33:38	40.667
31,471	3	35.924	-84.213	2021-11-18 06:33:07	18.843
31,470	1	35.903	-84.088	2021-11-18 06:01:36	40.667
31,469	1	35.877	-84.097	2021-11-18 05:53:39	1,414
31,468	1	35.903	-84.088	2021-11-18 02:34:10	40.667
31,467	3	35.924	-84.213	2021-11-17 23:10:39	18.843
31,466	3	35.93	-84.186	2021-11-17 23:05:17	68.667
31,465	1	35.903	-84.088	2021-11-17 20:23:32	40.667
31,464	1	35.908	-84.089	2021-11-17 20:17:48	4.742
31,463	3	35.936	-84.181	2021-11-17 20:10:43	112.333