Location Diary – Web-based Interactive Analysis and Visualization for Google Timeline data

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1 Introduction

The advance in location acquisition technologies has generated a myriad of spatial trajectories representing the mobility of various moving objects. Such trajectories offer us unprecedented information to understand moving objects and locations.[1] Location Diary's concept comes from the idea to help people record everyday life and discover the pattern from location data. To create a new way to look at the past using human movement data for everyone, we developed an interactive dashboard to display both informative and intuitive spatial statistics with the utilization of Google Timeline data.

Google Timeline is an inbuilt function of the Google Maps Application. Once activated, it provides users with the possibility to track everyday locations at a low sampling rate, and to visualize the collected data on a daily basis. Compared to what Google Timeline provides as shown in Fig. 1, our project will focus on giving more summary information on different temporal and spatial scales using Timeline data.

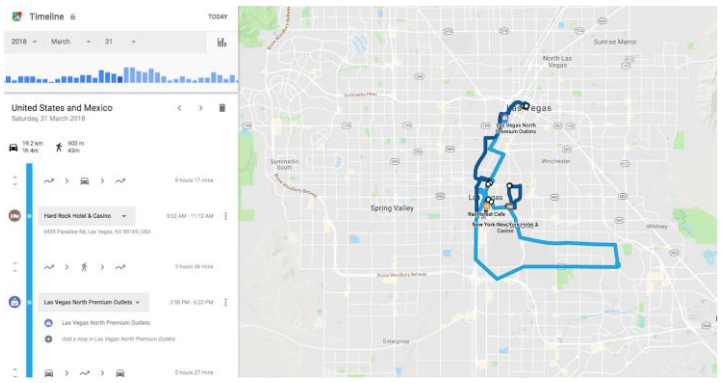

Fig. 1. Visualization on Web page of Google Timeline example.

2 Study Overview

In this project, we collected GPS data within one month, 2020 April, from altogether nine volunteers. Then, we analyzed the data using Python and QGIS to extract valuable information, finally visualizing the results by maps and charts for each individual. One pre-questionnaire was delivered to learn the background information of participants. One post-questionnaire was used to collect the evaluation of our final product.

We did a full workflow for individual location data analysis. First, we detected stay points from raw data provided by Google Timeline, and clustered places based on stay points. Home and workplace were further detected. For all places, semantic information was added. Afterward, trips were clustered and aggregated. Using the aggregated results as the input, the schematic map was generated by calling geo.zpheres API provided by Hitouch company. Finally, useful information was extracted and displayed in different kinds of statistical diagrams and charts.

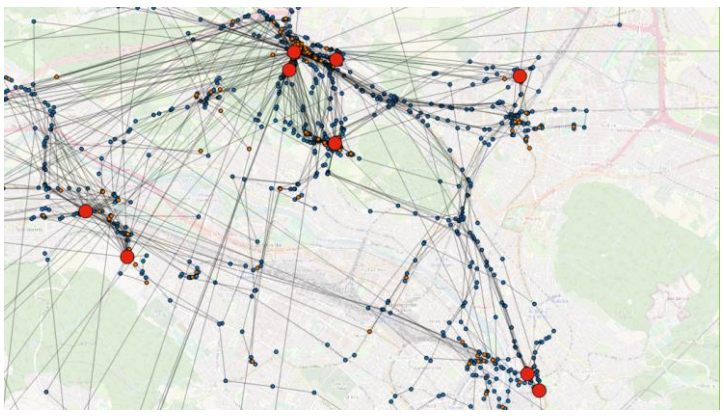

Fig. 2. Intermediate status of analysis. Blue dots: raw GPS points exported from Google Timeline. Orange dots: detected stay points. Red dots: clustered places from stay points via DBSCAN. Black lines: all trajectories between clustered places.

3 Results and Discussion

The final dashboard is given in Fig. 3. The left *Place Panel* shows the top ten visited places for each participant. Each bar chart shows the stay time during 24 hours of one place. The middle *Map Panel* gives the trajectories in three forms, the original, aggregated, and schematic one. The right *Home-Work Balance/Commuting Diagram Panel* respectively visualizes the home and work stay time on each weekday, and CO_2 emissions by each transportation modes (switching by clicking *Change Diagram*). Below some *Basic Statistics* information is given.

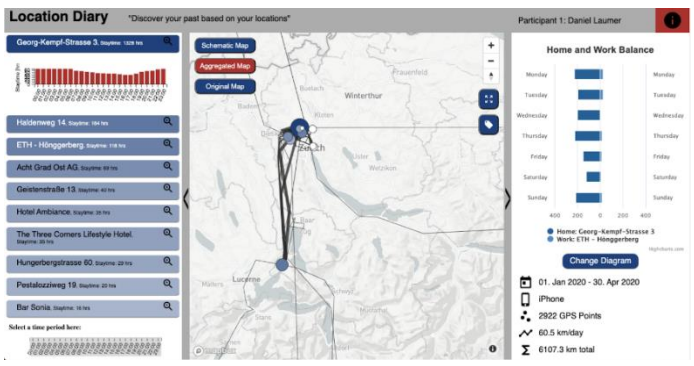

Fig. 3. User interface of the final dashboard. Learn more at http://stu01.ikgipa2020.ethz.ch/

We asked nine participants to rate how likely they will use a product like this regularly to get a summary of mobility. We got a mean score of **7.44/10**. Besides, the feedback was collected in the following four aspects.

Usefulness All panels received positive feedback about the usefulness with a mean score of over 3 (out of 5). Participants are especially satisfied with the aggregated map in Map Panel by all ranking the highest score 5.

Accuracy Home addresses were correctly detected for all participants. The location of most visited places, which corresponds to the analysis of stay point detection and clustering, is ranked second high of 4.67.

Website design The feedback on Website design is great. Participants feel the product is quite easy to use with a mean score of 4.78.

Further usage of Google Timeline Seven out of nine participants will continue to use Google Timeline afterward. The other two will not due to the worries about privacy issues.

4 Conclusion and Outlook

In our project, individual location data showed its strong power to present certain mobility patterns. In short, our work can be summarized as:

- We came up with the idea of Location Diary to discover past behavior patterns through individual location data.
- We conducted a full pipeline of individual GPS data analysis and visualization, and experimented with the schematic map from Hitouch,
- We created an interactive dashboard, presenting more valuable spatio-temporal information compared to Google Timeline function.

As for future work, two main aspects could be further focused:

- Make the pipeline work automatically, i.e., the thresholds for analysis are set automatically, possibly with some user involvement.
- Provide the possibility to let users upload their own location data; then, the analysis could be done in the back-end to generate the dashboard.

In summary, this project deepened our understandings of both theoretical and practical aspects of processing individual's mobility behavior.

5 References

[1] Zheng, Yu (May 2015). \Trajectory Data Mining: An Overview". In: ACM Trans. Intell. Syst. Technol 6.3. issn: 2157-6904. doi: 10.1145/2743025. url: https://doi.org/10.1145/2743025.