# DetourNavigator – Using Google Location History to Generate Unfamiliar Personal Routes

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## ABSTRACT

With the ubiquity of turn-by-turn navigation on toady's smartphones, personal exploration of the unseen has been drastically diminished. Such services make it less likely for users to conquer their less frequented parts of the urban environment. In this paper we present the DetourNavigator, a navigation service that creates routes based on Google Location History along areas that are unfamiliar to the user. Our preliminary user study indicates that these personalized graphs are well suited to generate routes that might lead to more holistic knowledge about the built environment.

## CCS CONCEPTS

• **Human-centered computing** → **Ubiquitous and mobile devices**;

## KEYWORDS

Navigation System; Spatial Familiarity; Turn-by-turn navigation; Google Location History



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## INTRODUCTION

In the past years we have seen the rise of services such as Google Maps, Apple Maps or HERE Maps that provide turn-by-turn navigation for their users. Such services have become ubiquitous with increasing smartphone penetration. By today even in pedestrian settings these services provide sophisticated support in navigation by choosing suited paths. Recently also a variety of services emerged that are meant to create either the fastest, shortest, most fuel-efficient, or most scenic route [2]. In doing so they are removing the need for personal exploration of the unseen. By imposing the tyranny of the pre-calculated route that was found most suited, on the user, such services prohibit to conquer less frequented parts of the urban environment [4, 7].

Our aim with the work presented here is to raise awareness for unsung parts of the urban environment and allow the user generate a more holistic image of their urban surroundings; allowing them to escape their daily routine. We try to accomplish this by creating a navigation service that creates routes along paths around areas that the user is most likely unfamiliar with. By leveraging the data from the user's Google Location History we create personalized graphs that allow them to navigate along routes that they have not yet explored even if they have been living in the city for a long time. By facilitating the exploration of uncommon places, we additionally hope to complete the users spatial memory about their city.

## RELATED WORK

Computer calculated navigational instructions have become for many a ubiquitous part of our daily lives. While in the past they often focused on the shortest route, recently they started to diverge from this mantra and a variety of work focused more on the hedonistic qualities of the route. Zheng et al. [8] for example incorporated a scenic factor into the routing. By including the geospatial distribution of photos form online services such as Flickr, their proposed approach allows to discover pleasing roadside sight spots and Points-Of-Interest (POIs) along the route. Similar to this Quercia et al. used crowd sourced data to train an image analysis systems to determine aesthetic qualities of a city and create routes that are emotionally pleasant along beautiful, quiet and happy areas [5]. Runge et al. followed up on this and automated the process using Google Street View imagery and deep neural networks [6]. These approaches also come with potential pitfalls as Johnson et al. [2] showed in their examination of the externalities. DetourNavigator in comparison, is very unlikely to create such effects. As it takes the personal location history into account, routes will differ for the same start- and destination point for different users and even the daily commute of a single user will change over time.

The closest related to the DetourNavigator is the GetLostBot by Kirman et al. [3]. It is able to detect certain routines of the users based on their Foursquare check-in behavior and recommend

[1] http://deriveapp.com/s/v2/

[2] http://serendipitor.net/site/

[3] http://www.brokencitylab.org/drift/

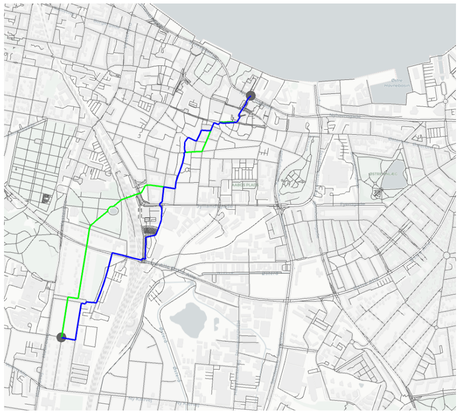

**Figure 1: Route visualization interface - Green based on the *NormalGraph*; Blue based on the *DetourGraph***

[4] https://takeout.google.com/

[5] https://www.openstreetmap.org/ downloaded via Mapzen https://mapzen.com/

unknown places. The acceptance of this system was very low as it did not make the user aware of the destination beforehand. The GetLostBot was based on the idea of the dérive from the Situationists in Paris of the 1950s. Through continuous drifting the dérive tries to reach total disorientation and a variety of applications exist that allow for dérive style navigation (e.g. Derive[1], Serendipitor[2] or Drift[3]). These systems don't have a fixed goal and might lead the users along parts that are well known to them. DetourNavigator on the other hand creates routes that are unfamiliar to the user with a fixed-, user chosen destination.

## DETOURNAVIGATOR

By creatin routes along paths of the urban environment that are unfamiliar to the user DetouNavigator should allow users to explore more parts of the city and over time build a more holistic image of the city. DetourNavigator will suggest new routes for daily commutes as the user would get more familiar with the last suggested route given the user has taken it. To achieve this we use a graph for the route calculation that reflects the familiarity of the user with the different segments. For this we first have to estimate the knowledge of the users about their environment. The GetLostBot used for this Foursquare check-ins [3], this has the disadvantage that only at times when the user decides to actively check in, their position is archived. As our goal was to develop a system that could be used by a large user group while at the same time having a good estimate about the user's spatial familiarity we opted to use the Google Location History which is a part of Google Maps. If the user opts in to use it, every time the user's Android phone acquires a location (independent from which app requested it) it would be saved in the location history. While this is far from a complete log, it still collects a high amount of locations. Besides simply revisiting the data in the Google Maps App, users can also download it from Google Takeout[4] as a JSON file.

### Graph- & Route Calculation

As the basis for the DetourNavigator we use OSM[5] data for our graph, with all walkable connections as edges. The geographic lengths of these edges are the initial weight in the graph of the edges. For the *DetourGraph*, each location in the Google Location History of the user with an accuracy of less than 50 meters, we calculate the closest edge in the Graph. If the distance to the this edge is larger than 50 meters the location is discarded. For each location in the location history that matches these requirements for a specific edge we add the original weight – the geographic length – to the edge's current weight. Thus the edge $e_x$ weight $w_x$ is determined as follows:

$$w_x = l_x + \sum_{0}^{i} l_x \tag{1}$$

where $l_x$ is the geographical length and $i$ the number of locations $l_n$ for which:

$$(\delta(e_x, l_n) < 50) \cap (\alpha(l_n) < 50) \tag{2}$$

where $\delta$ is the geographical distance in meters between an edge and a location and $\alpha$ is the accuracy of the location in meters. Besides the *DetourGraph* we also create a graph using the geographic length as the weight for each edge, in the following we will refer to it as *NormalGraph*. To calculate the route between a given start- and destination point in the graph, we used our own implementation of the A* algorithm [1]. The system was implemented using PostgreSQL, PostGIS and Unfolding Maps [6] for visualizing the data.

For each set of start- and destination points the user selects on the map the system calculates two routes, the shortest path (using the *NormalGraph*) and a route that the user is most likely rather unfamiliar with (using the *DetourGraph*). An example can be seen in Figure 1. The final routes can be exported as GPX files and used with common navigation apps. Furthermore the developed system is also able to simulate the routes using Google Street View data (compare Figure 2).

[6] http://unfoldingmaps.org/

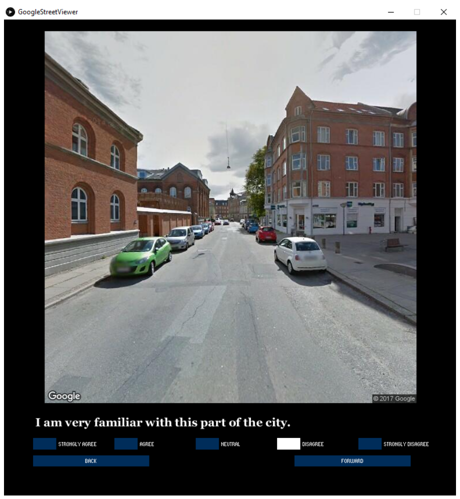


**Figure 2: Simulation Interface - The routes are presented as a sequence of Google Street View Images. In the user study, participants were asked to rate their familiarity on a 5-point Likert scale.**

## PRELIMINARY USER STUDY

To evaluate the idea of the DetourNavigator and get an estimation of how much of the suggested routes are unknown we conducted a preliminary user study in the city of Aalborg, Denmark.

### Apparatus & Procedure

The study was divided into two parts. In the first part we would create two routes from one starting point to two defined end-points; One using the *NormalGraph* and one using the *DetourGraph* (personalized for each participant). The participants had to walk along those routes together with an experimenter. The routes were exported and then the participants were guided using the off-the-shelf navigation part of the Komoot Mobile App. During these walks the experimenter would ask the participant in 45s intervals to self-assess her familiarity with the last part of the route on a 5-point Likert scale, where 1 being very familiar and 5 being very unfamiliar. The experimenter would meet the participants at the starting point (University building), walk the first route, then back to the starting point, taking a different route and then the second route. We also measured the time the participants needed for the routes. The starting order of the routes generated with the different graphs was counter-balanced. After the participants finished the second route they would start the second part of the study. Ten more routes for each participant were created, five using the *DetourGraph* and five using the *NormalGraph*. The participants were shown these routes on the simulation interface depicted in Figure 2. The routes were divided in 100 meter intervals and the Google Street View imagery facing the direction the participant would walk was shown. For each image the participant had to self-assess her familiarity with that area on the 5-point Likert scale. After this a short semi-structured interview was conducted, in which we inquired about the users impressions about the created routes and their interest in such navigation system. The procedure took around 2hours and participants were compensated with the equivalent of roughly 15USD.

### Participants

The study was conducted with 9 participants (4 female) aged between 21 and 28 years (median 23 years). Participants were recruited via social media and all were university students. All participants reported to have used navigational aids in the past. Furthermore, all participants were living in the city were the study was conducted for at least one year (ranging from 1 to 3 years, average 1.6years). All participants were Android users (for at least a year) and had opted-in for the Google Location History for at least one year as well. Before the study participants were asked to download their location history for the generation of the *DetourGraph*. All data was deleted after the study was conducted.

### Results

In the first part the participants self-assessed the routes generated with the *DetourGraph* on average 3.82 ($SD = 0.75$) and the routes generated with the *NormalGraph* on average 2.1 ($SD = 0.91$). An ANOVA showed a statistical significant difference between the two graphs $p < 0.03$, with the *DetourGraph* creating routes that are more unfamiliar to the participants. In terms of time it took the participants to complete the *DetourGraph* routes 14 minutes and 23 seconds on average (SD = 4minutes and 12 seconds). For the routes created with the *NormalGraph*, it took the participants on average 12 minutes and 37 seconds (SD = 3 minutes and 43 seconds). An ANOVA showed again a statistical significant difference $p < 0.05$, with the routes created using the *NormalGraph* being significantly faster to complete. For the second part part participants self-assessed the routes generated with the *DetourGraph* on average 3.27 ($SD = 0.86$) and the routes generated with the *NormalGraph* on average 2.31 ($SD = 0.47$) (where 1 being very familiar and 5 being very unfamiliar). An ANOVA showed a statistical significant difference between the two graphs $p < 0.05$, with the *DetourGraph* creating again routes that are more unfamiliar to the participants.

## DISCUSSION

Overall the routes created from the personalized *DetourGraph* were significantly more unfamiliar to the participants. This confirmed our assumption that using the Google Location History could be a good data source to assess the users familiarity of the urban environment. However the study has several limitations, first of all we only conducted the study in a single city and all participants were students with a high smartphone affinity. These factors are very likely to have worked in favour of the proposed system. Furthermore, in the current states the created routes from the *DetourGraph* are not adjusted for length, meaning they could potentially be very long. In our evaluation this factor already showed in the significantly longer time it took the participants to complete the routes. The participants also commented that they would only use such systems on a day to day basis if the routes are only slightly longer. However, all participants agreed that they would like to use the system when being on a relaxed walk with no time pressure.

## CONCLUSION & FUTURE WORK

Overall our results demonstrate that the Google Location History can be utilized to create personalized navigation graphs that allow users to explore uncommon places in the urban environment they live in. The participants reacted very positively towards the created routes as well as the overall idea behind the system that reflects the spatial familiarity rather well. Nevertheless, the current evaluation is very limited in extend and further investigation is needed. One aspect is to limit the length of the route, which was crucial for many participants with respect to daily use. Another point of investigation is how the routes will change over time if such a system would be used in a longitudinal fashion.

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