sccer mobility
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Efficient Technologies and Systems for Mobility

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Conserved Quantities in Human Mobility Patterns

The availability of large-scale datasets recording human digital traces has flourished the field of human mobility and provided novel insights on the characteristics of human movement. In this study, we analyze the evolution and composition of individually conducted trips. We first calculate high-level mobility indicators to delineate the mobility patterns of the population. Then, we provide evidence for the long-term stability concerning trip parameters over time. Furthermore, we identify mobility behavior packages by trip similarity measures and clustering analysis. Studying these package evolutions enables the identification of mobility preferences and the detection of possible mobility behavior changes. The analysis and results of this study greatly deepen our understanding of the travel behaviors of people.

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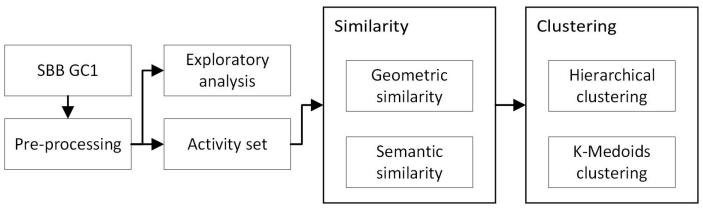
Introduction

Studying human mobility deepens our understanding of modern society and the environment, and has a profound impact in a wide range of areas [1]. While the importance of locations in daily mobility has been extensively studied [2], our understanding of how people travel to reach these locations is still limited.

In this study, we analyze the long-term evolution and composition of trips that individuals travel to reach their important locations, using a dataset collected by the SBB Green Class1 (SBB GC1) pilot study [3]. The dataset contains 24/7 user-labeled GPS tracking points of 139 participants over 12-month).

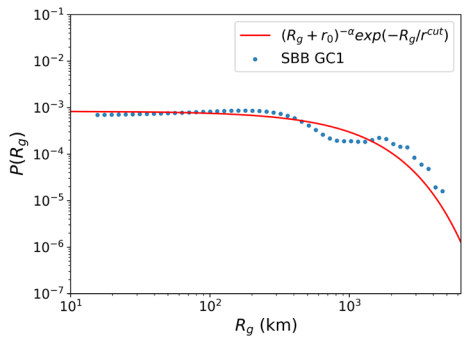
Data & Methodology

We employ the same preprocessing steps for SBB GC1 data as in [3]. The exploratory analysis with mobility indicators reveals participants' travel patterns over a long period. By introducing the concept of activity set [2], which is defined as the set of the most-stayed locations for an individual during a time window, we can capture important locations and thus extract the traveled trips between them. These trips are decomposed into groups with pre-defined similarity measures and clustering methods.



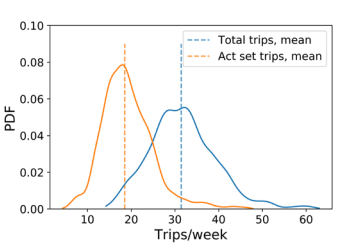
Mobility Pattern

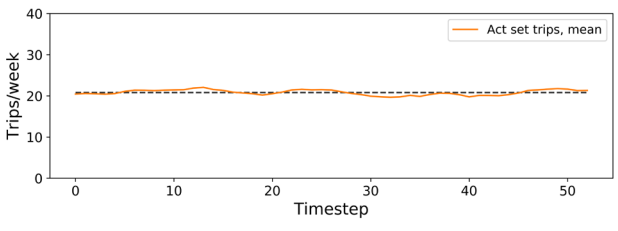
We calculated the characteristic distance traveled by an individual for the SBB GC1 population using the radius of gyration measure R_g [1]. Compared to the results in [1], the population in our dataset traveled significantly more. The reason could be that the user sample is biased towards a high-income group with high mobility demand and nearly unlimited mobility options are provided through the pilot study.



Stability in trip parameters

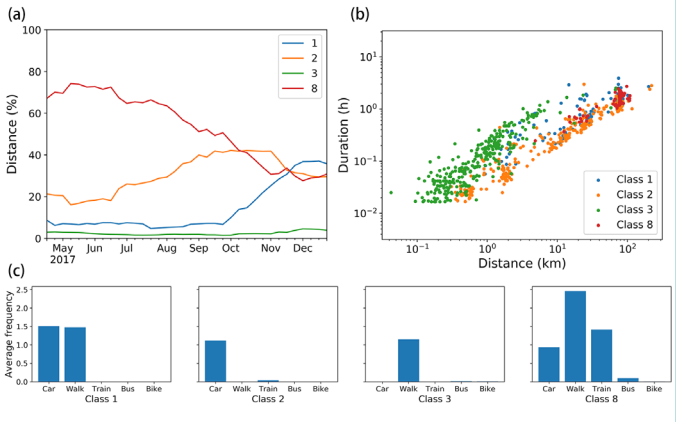
We split the individual conducted trips into activity set trips and non-activity set trips. The distribution over the population suggests that an average user conducted approx. 20 activity set trips per week. Expanding this distribution along the time reveals surprising stability – the user always travels the same number of trips between locations in the activity set. Various statistical tests are conducted to verify this result, and similar conclusions are found for trip distance and trip duration.





Mobility preferences

We regard travel mode, distance, and duration as the input features for clustering activity set trips. The resulting classes could represent different mobility behaviors. The plot below is an example of such a result, where subfigure (a) shows the percentage of distance traveled by each mobility behavior class over time. The detailed composition of each trip can be found in the distance-duration scatter plot (b) and the mode distribution histogram (c).



Conclusion and expected impact

The continuously recorded and semantically enriched GPS dataset provides us access to the spatio-temporal localization and movement of users. In short, our work can be summarized as follows:

- We conduct an in-depth analysis of the population using high-level mobility indicators.
- We provide evidence for the stability of important trips.
- We propose a pipeline for delineating personal mobility preferences.

The stability of trip parameters suggests that people roughly take the same number of trips to their important locations. We argue that these trips have a higher potential of switching to more sustainable alternatives since behavior change in such situations is easier and can be planned in advance. Besides, the mobility preferences identification result gives us the possibility to detect mobility behavior changes – a feasible way to check whether a person has become more sustainable or not.

References

[1] Gonzalez, M.C., Hidalgo, C.A. and Barabasi, A.L., 2008. Understanding individual human mobility patterns. *nature*, *453*(7196), pp.779-782.

[2] Alessandretti, L., Sapiezynski, P., Sekara, V., Lehmann, S. and Baronchelli, A., 2018. Evidence for a conserved quantity in human mobility. *Nature Human Behaviour*, *2*(7), pp.485-491.

[3] Martin, H., Becker, H., Bucher, D., Jonietz, D., Raubal, M. and Axhausen, K.W., 2019. Begleitstudie sbb green class-abschlussbericht. *Arbeitsberichte Verkehrs-und Raumplanung*, *1439*.

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