

論文 / 著書情報
Article / Book Information

| | |
|-------------------|---|
| 題目(和文) | |
| Title(English) | Stochastic and Deep Learning Approaches for Understanding and Generating Daily Human Activities and Mobilities |
| 著者(和文) | WANG Weiyang |
| Author(English) | WANG Weiyang |
| 出典(和文) | 学位:博士(学術), 学位授与機関:東京工業大学, 報告番号:甲第12790号, 授与年月日:2024年3月26日, 学位の種別:課程博士, 審査員:大佛 俊泰,藤井 晴行,斎尾 直子,鍵 直樹,沖 拓弥 |
| Citation(English) | Degree:Doctor (Academic), Conferring organization: Tokyo Institute of Technology, Report number:甲第12790号, Conferred date:2024/3/26, Degree Type:Course doctor, Examiner:,,,, |
| 学位種別(和文) | 博士論文 |
| Category(English) | Doctoral Thesis |
| 種別(和文) | 要約 |
| Type(English) | Outline |

Thesis Outline

Human activity-travel patterns have raised significant interest among researchers for a long time. The analysis and prediction of them have been conducted in various scientific disciplines, such as urban planning, traffic management, disaster prevention, epidemiology, geography, etc. Although there are many studies in the domain of human activity-travel patterns, existing algorithms to synthesize daily activities and movements are not yet sharp enough to give reliable results. In addition, knowledge about human activity-travel is essential to formulate generative models, while our understanding of people's behaviors is still limited. This dissertation is dedicated to the above research gaps.

Objectives of the Dissertation

Throughout the dissertation, we focus on constructing generative models to reproduce/predict activity and mobility diaries. The constructed models should output behavior datasets that are similar to the real ones. Moreover, when a new scenario (with respect to urban transportation, policies, etc.) is given, we want the models to inform us about people's behavior patterns in the new case. Meanwhile, by analyzing the models and the generation results, useful insights may be obtained. In summary, there are two outcomes from the dissertation:

- 1 Generation models to synthesize/predict human daily activities and mobilities.
- 2 Insights of human activities and mobilities, including how they are scheduled, the spatiotemporal correlations of daily activities/mobilities, people's perceptions about their activity-travel, etc. This topic is done mostly by analyzing the constructed models.

The proposed models (for the first topic) have practical usage in several scientific domains. First, generated or predicted human mobility data could be applied to evaluate traffic flows on roads. Traffic congestion could be predicted, providing suggestions for the investment of traffic facilities. Second, when disasters happen, it is critical to know the distribution of the population and their sociodemographic attributes to make mitigation plans. Predicted human mobility data allows us to estimate the population in each area at any time. Meanwhile, insights from the second topic provide theories to improve the models in the first topic. The two topics (i.e., (1) model construction for activity-travel generation and (2) model analysis to understand human behaviors) are conducted iteratively throughout the thesis. After presenting the models and theories, a detailed discussion about model applications, as well as limitations, is given in Chapter 8.

Architecture of the Dissertation

In the dissertation, daily activities and mobilities are mostly modeled and discussed separately. This approach provides convenience for model construction and interpretation. Admittedly, human mobilities and activities are correlated. Some existing models have been designed to convert activity diaries into mobility diaries. However, in-depth analyses of their relationships are out of the scope of the dissertation.

The overall architecture of the dissertation is shown in Fig. 1, and the important findings are listed. The first chapter introduces the background and several research streams in the domain. The research targets and the structure of the dissertation are also provided. Chapter 2 details all the datasets used. Chapter 3 presents a method to quantify the similarity of activities, as well as a clustering algorithm to understand the sequential patterns of daily activities. Three age groups and

three occupation groups are observed in terms of daily activity patterns. Knowledge from Chapter 3 provides insights for the classification of activities and people in later chapters. Chapter 4 examines the time-varying Markov chain model to generate daily activity sequences. Due to the high generation accuracy and the characteristics of the model, a new mechanism for daily activity scheduling is hypothesized. The mechanism recognizes the relationship between the time-varying Markov chain model and the multinomial logit model. Moreover, a reconstruction method is proposed to build the time-varying Markov chain model with six parameters. Further analysis of the six parameters shows that the activity diaries are similar for people living in regions nearby. Chapter 5 introduces a two-step Markov chain model to synthesize daily mobilities. Results indicate that people's future locations can be generated based on the travel patterns they have made previously, regardless of the locations they have visited or the time when trips were made. Furthermore, daily travel behaviors are examined using the energy concept. A simple regression model is proposed to estimate the proportion of long-distance trips. Chapter 6 talks about the lognormal distribution of daily travel time. A utility model is constructed to depict people's perceptions about travel time, according to which the lognormal distribution of travel time emerges. Chapter 7 proposes transformer-based models to synthesize and predict activity and mobility patterns. Some insights from Chapters 3 to 6 are integrated into the models. The outputs of models vary with the settings of urban environment and societal factors. Thus, the models can be used for predicting behavior patterns given a scenario. The generation power and the prediction power of models are high. Moreover, the models seem to have learned the spatial structure of the city and the temporal relationships between daily behaviors. Finally, Chapter 8 summarizes the previous chapters and provides a discussion.

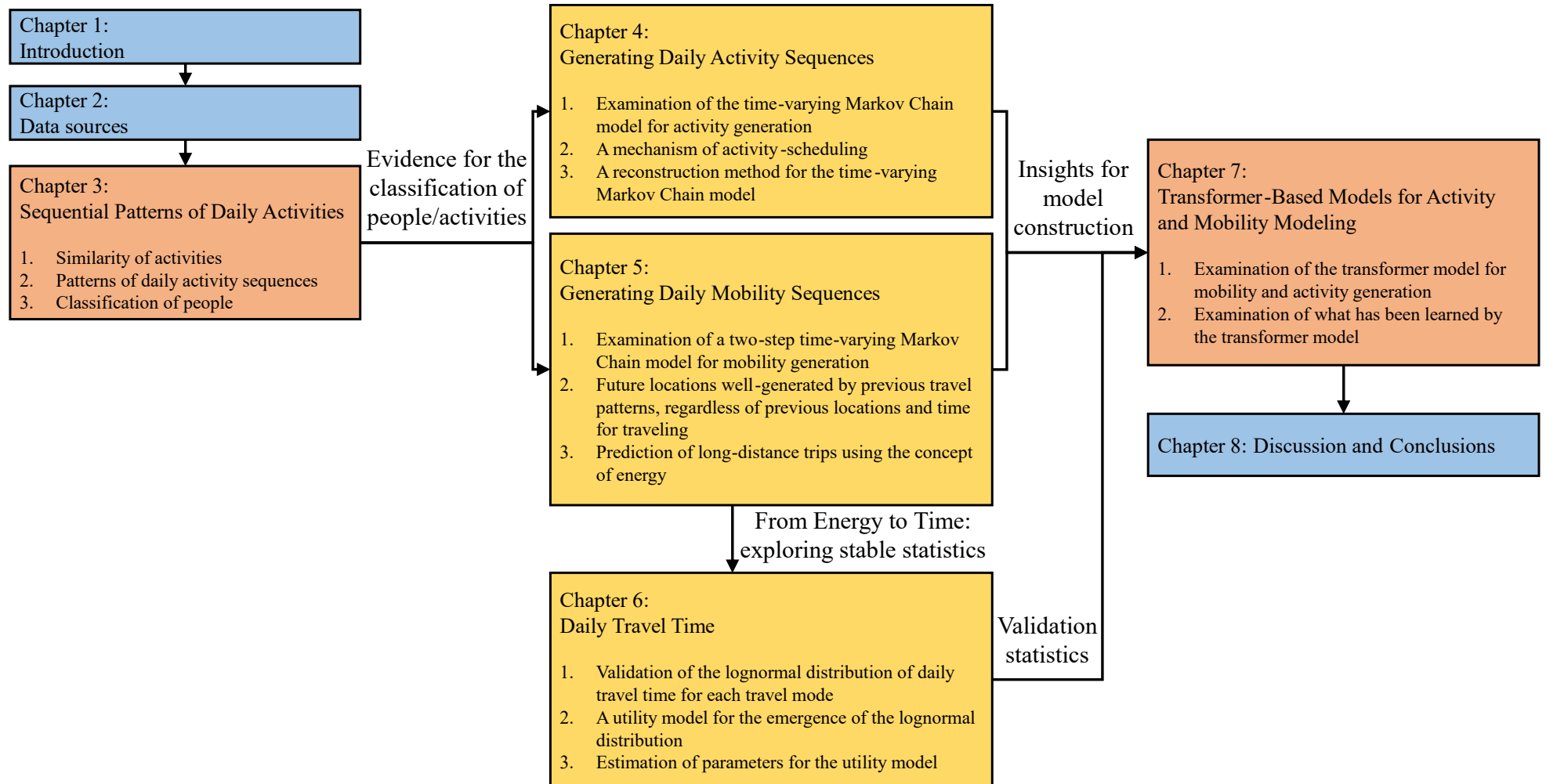


Fig. 1 Architecture of the dissertation.