Technische Universität München
Chair of Transportation Systems Engineering

Master Thesis Topic

Forecasting the subway crowding pattern evolution under special events with transfer learning using opportunistic data

Background

Special events, such as sporting events, concerts, and parades, can be categorized as planned or unplanned events. These events often attract a large population, exerting significant pressure on transportation systems in the vicinity of the event location. The unbalanced distribution of transport demand across the network can potentially lead to system failures. Therefore, it is of utmost importance to control and manage the operations of various transport modes in the face of special events so as to mitigate the negative impacts of these challenges. Accurate estimation of travel demand to the event venue is a prerequisite for the development and implementation of proactive control and management measures. Considering the important role public transportation plays in urban transportation systems, understanding public transport (PT) demand patterns during such events is paramount. Analysis of crowding patterns at subway stations is a key aspect of assessing urban PT demand patterns. Hence, forecasting crowding patterns at subway stations would be beneficial for controlling and managing the functionality of transportation systems under special events. The tremendous opportunistic data available in recent years provides a cost-effective yet reliable data source for addressing this challenge.

Methodology

This thesis proposes to develop a robust forecasting model to accurately reproduce the spatial-temporal evolution of crowding patterns at subway stations in the context of planned special events. Taking football matches as an example, the student is asked to collect opportunistic data containing crowding information of subway stations, such as Google Popular Times, within the subway network of consideration for months. Moreover, by recognizing the potential similarities in crowding pattern evolutions under the same type of events (here, football matches), transfer learning may be a reliable tool for improving the forecasting performance in target cities. In summary, this thesis primarily involves three steps as follows:

- Data collection. Collect data for at least three cities for more than three months.
- Model development. Develop an accurate forecasting model that can be used to forecast the crowding pattern changes across different time periods and stations.
- Knowledge transfer. Construct a robust transfer learning model to understand the possibility of transferring the knowledge learned among multiple cities.

Results

A model that can accurately forecast the evolution of crowding patterns at subway stations along the network being impacted by the special event.

Previous knowledge expected

- Completed the “Statistical Learning and Data Analytics for Transportation Systems” course or similar.
- Python programming basis.

Selected references

Chen, E., Ye, Z., Wang, C., & Xu, M. (2020). Subway Passenger Flow Prediction for Special Events Using Smart Card Data. IEEE Transactions on Intelligent Transportation Systems, 21(3), 1109–1120.

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Zhang, X., Sun, Y., Guan, F., Chen, K., Witlox, F., & Huang, H. (2022). Forecasting the crowd: An effective and efficient neural network for citywide crowd information prediction at a fine spatio-temporal scale. Transportation Research Part C: Emerging Technologies, 143, 103854.

Zhao, Y., & Ma, Z. (2022). Naïve Bayes-Based Transition Model for Short-Term Metro Passenger Flow Prediction under Planned Events. Transportation Research Record: Journal of the Transportation Research Board, 2676(9), 309–324.

Relevant projects

- DARUMA: https://www.mos.ed.tum.de/en/vvs/forschung/projekte/daruma/
- PANAMERA: https://www.mos.ed.tum.de/vvs/forschung/projekte/panamera/

Starting date

From March 2024

How to apply:

Interested applicants should contact Qinglong Lu (qinglong.lu@tum.de) and Cheng Lyu (cheng.lyu@tum.de) by sending an email including your resume, a short explanation of why you are interested in this thesis topic and your starting date.