Modelling and analysing the transit catchment areas

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Introduction
Catchment area is a concept that has been used in multiple disciplines, such as Hydrology, Human Geography, and Transportation. This project is focused on modelling and analysing the transit catchment areas. The project starts by revisiting the studies of catchment areas from multiple disciplines and try to build a comprehensive understanding of this concept and provide theoretical foundations for our research questions.

Then, the project is aimed at answering three research questions: 1) How to measure and model the catchment areas using a data-driven approach. 2) How to assess and improve the road network design within the catchment areas; 3) How to generate a network-based catchment area; Correspond to the research questions, there are three sub studies of this project, which are described in the following three sections.

Measuring and modelling the transit catchment areas
The catchment areas are commonly measured by using survey-based data, which is a costly and time-consuming way of collecting data. In recent years, the widely deployed GPS devices provide us an easy way to collect large amount trajectory data. A lot of previous studies have validated the usefulness of this type of data in transport-related research, which motivate us to explore the potential of trajectory data in measuring the catchment areas. In order to use the trajectory data, there are at least two technical challenges within need to be solved: 1) how to extract the access/egress trips of transit stations from the trajectory data; 2) how to process the big trajectory data for the aim of the measuring the catchment areas. Based on the measured station-level catchment areas, this study will further explore the factors that affect the sizes of catchment areas. In other words, how to explain the differences in the sizes of catchment areas.
Assessing the road network design within transit catchment areas

According to transit-oriented development (TOD) theories, there are three basic TOD principles: design, density, and diversity (Calthorpe, 1993). A well-designed pedestrian/bicycle road network is important for supporting a high-level of transit use. In this part, the aim is to develop a method to assess the road network design around transit stations. Specifically, the research questions are “where are the critical roads that impede the accessibility of a transit station and how to make strategies to improve the accessibility”. The study starts by using the morphological analysis of the road networks within the transit catchment areas. It is anticipated that a method will be developed that could automatically recognise the critical roads that impede the accessibility of transit stations. The method will be validated by using real trajectory dataset. At last, corresponding strategies will be proposed to improve the network design within catchment areas.

Developing an open-source toolset to support the analysis of catchment areas

The catchment areas are commonly measured by generating a circle buffer around the facilities. However, a network-based buffer area can represent a more realistic catchment area (Guerra et al., 2012), because users need to travel along with the road network in the real world (as shown by an example in Figure 1). However, how to generate this “network-based” catchment area is still a challenge and few publicly available tools can be used to generate the catchment areas. Most of the previous studies use the ArcGIS service area tool to generate network-based catchment areas. The algorithms behind this tool are still not clear because of confidential reasons. This aim of this study is to develop a methodology framework that can be used to generate the network-based catchment areas. Additionally, we plan to implement the framework as an open-source toolset that would be publicly available for the community and can be easily extended for support planning purposes (e.g. road network design around the transit stations).

Fig. 1: An example of catchment area generation

Conclusion

Based on the above three studies, the Ph.D. candidate hopes to build a comprehensive understanding of the analysis of transit catchment areas. The results of this project will provide support for urban planning. The proposed methods and developed tools would be interesting to researchers in GIScience and Transportation.

References
