Working Title:

Globally Optimal Configuration of Roadside Sensing Stations Based on Traffic Flow Generation and Community Detection Methods

Background:

As a company providing the solution for roadside sensing systems, essentially, traffic sensors, LiangDao cares a lot about how to globally optimize the configuration of the roadside sensing stations. They also received similar appeals from their partner companies. In transportation science, such a problem is categorized as the Traffic Sensor Location Problem (TSLP). So generally speaking, the globally optimal configuration problem of sensors is still deeply concerned by the industry. And the core demand can be summarized as **how to achieve the main sensing model of a city with the fewest sensors**.

In this case, we expect to provide support for location and quantity decisions before project implementation based on open-source data and other existing data. Therefore, the knowledge, (data, methods, and algorithms) in Geographic Information Science (GIScience), could be helpful in meeting this demand. Based on current limited research and experience, **traffic flow generation and community detection methods** could be helpful in this.

Research Objectives:

This thesis aims to propose a feasible workflow from existing geographic data to investigate on the required distribution and required number of roadside sensing stations to model the main traffic flow of a city. In this case, car flow will be prioritized. The case study of this thesis will be based on the industry partner's roadside sensing stations with LiDAR sensors, air quality sensors, computing units, etc.

(More detailed research objectives to be defined.)

Proposed Methodology:

1) Traffic Flow Generation: similar to traffic flow prediction, but it's more about how to use existing geographic information data, like POI data, to generate traffic flow so that without relying on sensing data, we can acquire the traffic flow data for further tasks.
2) Community Detection: communities, or clusters, are usually groups of vertices having a higher probability of being connected to each other than to members of other groups, though other patterns are possible. In this case, a community is defined as a group of vertices with similar traffic characteristics. With the generated traffic flow, we can detect relevant communities, and furthermore, formulate corresponding configuration rules according to different traffic characteristics. If we consider the characteristics that change over time, we can also introduce dynamic community detection method.

Proposed Workflow:

An initial and possible workflow is shown below:

Planned Chapters:

1） Introduction and Definitions: track and summarize the relevant progress, and clarify the core concepts and objectives of this thesis.
2） Methodology and Workflow: Explore and determine the available methods based on the current academic progress. Traffic flow generation and community detection methods will be considered first. Then sort out and clarify the workflow to meet the intended demands.
3） Data and Case Study: Identify suitable datasets to execute the workflow, it could be either some open-source data or some data from the industrial partner. Using the data to follow the workflow and carry out the case study.

4） Principles and Conclusions: Based on the results of the case study, generate some principles to optimally configure sensors, and the general workflow to perform similar tasks.

Follow-up Work Plan:

1) Literature Review: Track the relevant progress in this field, including the optimal configuration problem of traffic sensors, the intersection between GIScience and traffic sensor configuration, and more importantly, community detection and flow generation methods, and other possible methods from GIScience that can be used in this problem.
2) First Proposed Workflow: Based on the results of the literature review, propose a possible workflow for the first time.
3) Abstract Submitted for ICC 2023 [Deadline: 16 Jan. 2023]: Write down a short article (abstract) and submit it for ICC 2023. A possible title could be "A Workflow of Using GIScience Methods to Address the Sensor Configuration Problem".
4) Extended Research Proposal [Deadline: 22 Apr. 2023]: Further enrich the research proposal.