To: Professor Yang

From: Gang Su

Date: 24 October 2021

Subject: Proposal for the IGNNK Research Project

Introduction:

There is a growing appreciation of the importance in developed societies of networks of various kinds, such as water supply, energy supply, sewage disposal, communication and of course transportation. Real-time monitoring network information is a useful tool for the planning and management in smart city. However, placing traffic sensors with full network coverage may be impractical due to limited budgets. Those unobserved locations information can only be inferred from observed locations. Thus, the accuracy and reliability of the inferring/kriging model is vital importance. The shortage of traditional kriging methods is we have to retrain the full model even with only minor changes, like sensor adding or failures, which are ineffective to accommodate time-varying sensor network.

Recent researchers introduced Graph Neural Networks (GNN) and they also demonstrate the ability to real-time generalize the message passing mechanism to new graphs. Y. Wu et al (2021) develop an **Inductive Graph Neural Network Kriging** (IGNNK) to solve dynamic graph structures and introduce new methods to capture the "distance" between sensors. Although IGNNK shows better generalization and transferability, there are still huge improvement room.

This project is to conduct a real-time kriging model that can precisely and reliably infer the unobserved traffic flow information from observed detectors. In the process of project, we would like to adapt IGNNK in other larger network level datasets or even multivariate datasets. Additionally, we would try to combine the state-of-the-art temporal model, Liquid Time-Constant Network, to jointly capture the spatiotemporal information and hence achieve better performance. Finally, we would like to open a new topic that rethink the optimization problem in sensor locations, like how to install additional sensors from the view of improving kriging accuracy rather than traditional flow estimation objective.

Preliminary Research:

Inductive Graph Neural Networks for Spatiotemporal Kriging. Y. Wu et al (2021).

Research Plan:

Oct 26 - due: complete the Research Proposal
Nov 2 - due: Annotated Bibliography & Reproduce GNN code
Nov 9 - due: Introduction
Nov 16 - due: Literature Review
Nov 30 - due: Methodology & Code
Dec 7 - due: Research Paper Draft & Representation
Dec 13 - due: Research Paper Draft Review & Revision
Dec 14 - due: Research Paper Submit

Public Data Sources: Seattle Inductive Loop Detector Dataset (2015), which contains city-network-wide spatiotemporal speed information of the freeway system.