Integration of Crowdsourced and Traditional Data for Route Analysis and Route Finding for Pedestrians with Disabilities

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In the US and across most of the European Union, the population is aging. The fraction of the population in the US that is over the age of 65 has risen to 13 percent, while in the UK it is even higher at 17 percent. The US center for disease control (CDC) estimates the nearly 10 percent of adults have activity limiting arthritis, with more than twice that number suffer from physician diagnosed arthritis. And, more than 13 percent of older Americans have significantly impaired vision. These and other mild or more severe disabilities significantly reduce the mobility of older pedestrians. This research project will develop simple data collection methods that will allow pedestrians to record information about unsafe pedestrian routes, and, cutting edge machine learning and optimization techniques will produce usable real-time routes based on the specific needs of each user, and will provide transportation systems managers with tools to efficiently characterize, identify and analyze urban pedestrian networks.

The past two decades in particular have led to sharp improvements in tools to solve large scale optimization problems such as those that arise in transportation networks. Generally, these problems fall into the broad class of convex optimization, and more specifically combinatorial optimization problems. However, data sets have grown increasingly large and complex and even these new tools fail to scale well to the problem sizes encountered in transportation systems. In this research we will apply and extend a number of new machine learning techniques to large scale transportation network problems. The problems of interest are specialized multi-objective shortest path problems, which are fairly well solved, along with large scale network analysis and optimization models of pedestrian safety, comfort and security.

The analysis of pedestrian involved accidents and associated injury severity is of interest to transportation researchers and policy makers. The primary objective of such analyses is to understand the relationship between injuries and the many contributing and causal factors such as traffic conditions, weather conditions, roadway design characteristics and driver, passenger and pedestrian characteristics. This research, which is currently in progress aims to apply and extend a new computational model [1], the ”Network Lasso” in order to provide improved predictive and causal analysis of not just of accidents but of a wide array of conditions that impede pedestrian safety, comfort and security. A key contribution will be to enable the collection of data related not just to accidents, but

also near-misses and information related to network locations that are unsafe, or are perceived to be insecure.

The project analyzes traditional data sources and will augment those data with crowdsourced information on pedestrian routes. We are developing a simple phone application that will allow pedestrians to record information about unsafe, uncomfortable and less secure sections of road so that shortest paths which take this into account can be produced. We envision a data collection campaign that would request healthy users of the pedestrian network to watch for problems that could impact less able users so that data collected by the relatively small pool of disabled pedestrians would be augmented by data collected by all users of the network. The real-time data collection will be reinforced with data gathered using an on-line reporting tool and surveys as well as with data gathered from appropriate public agencies and pedestrian advocacy groups. Our presentation will introduce the mathematical models we are developing, but will mainly focus on the data collection, middleware and database management aspects of the project.

Our research combines distributed convex optimization with cutting edge machine learning algorithms and integration and management of big data in order to identify ways to improve transportation systems. Network Lasso for graph clustering provides a way of identifying unknown features for each of the transportation problems which cannot be collected easily. We believe it will provide an ideal hierarchical model capable of identifying such unknown features.

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[1] D. Hallac, J. Leskovec, and S. Boyd, “Network lasso: Clustering and optimization in large graphs,” in Proceedings of the 21th ACM SIGKDD International Conference on Knowledge Discovery and Data Mining. ACM, 2015, pp. 387–396.