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Final Report

Grant Number: DTRT12-G-UTC01

Project Title:

Cognitive Maps for Route Choice Modeling

Project Number:	Project End Date:	Submission Date:
UMAR24-20	December 31, 2014	August 24, 2015

Problem Addressed

The objective of this project is to investigate the utility of cognitive maps in modeling route choice behavior. Cognitive map is the knowledge of spatial objectives and relations stored in human beings' long-term memory, which is the basis for spatial reasoning (e.g., where one is) and decision-making (e.g., where to conduct a given activity, and how to go from one place to another). It is a long-researched area in environmental psychology, geography and artificial intelligence, and has been shown to be incomplete, distorted, and idiosyncratic (depending on travel history and personal traits). The current travel behavior and traffic network modeling literature however almost unanimously assumes complete and homogeneous perceptions of transportation networks and traffic information for individual travelers. This research contributes to the state-of-the-art by developing a methodology to account for heterogeneous network perceptions through user-class specific consideration sets (choice sets) in an econometric route choice model.

Approach and Methodology

Data Collection and Evaluation

GPS taxi data from two locations were collected through collaborative research with KTH (Royal Institute of Technology, Sweden) and SMART (Singapore-MIT Alliance for Research and Technology). The statistics of the data are listed below.

Statistic	Network	
	Stockholm	Singapore
♯ of Nodes	3,122	7,808
♯ of Links	5,845	11,106
♯ of Stochastic Links	617	554
♯ of Taxis	1,500	15,000
♯ of Support Points	56	59
Traces Time Gap	1-2 min	3-4 min
♯ of OD Pairs Evaluated	997	4684
♯ of Time Intervals	30	98
Time Interval Length	5 min	5 min in peak hours and 30 min in off-peak hours
Study Time Period	6:30 AM - 9:00 AM	24 Hours
Link Elimination Interval	10	10
♯ of Simulations	30	30

Choice Set Generation and Evaluation

Choice Sets are generated for two types of travelers who perceive the network differently. The first group is the path users, who view the choice as fixed from the origin to destination without en route diversion possibilities. The second group is the routing policy users, who view the choice as adaptive to real-time traffic conditions. Link elimination, simulation, and generalized cost minimization with various weighting schemes are employed to generate choice sets. For path users, a shortest path algorithm is the building block in the choice set generation, while for routing policy users, an optimal routing policy algorithm is used instead.

The generated choice sets are evaluated based on coverage, that is, the percentage of ODs for which the generated choice sets cover the observed routes, and adaptiveness, that is, the number of different paths over different days resulting from the same generated alternative.

Conclusions and Recommendations

The routing policy choice set is compared to a benchmark of path choice set based on static and deterministic link travel times, as conventionally used for route choice in the literature. In benchmark analysis, the travel times are changed to deterministic and static by taking average of the original link travel times over time periods and support points. The static shortest path choice sets are then generated utilizing link elimination and simulation. The following table illustrates the comparison of coverage between routing policy and static shortest path choice sets. This comparison is an indication that the routing policy choice sets could provide better coverage than the path choice sets.

Choice Set Type	Choice Set Generation Method	OD Pairs	Overlap Threshold	Matching OD Pairs	Coverage
Routing Policy Choice Sets	Link Elimination	997 997	1 0.8	633 788	0.64 0.79
	Link Elimination and Simulation	997 997	1 0.8	803 917	0.81 0.92
Path Choice Sets	Link Elimination	997 997	1 0.8	563 718	0.56 0.72
	Link Elimination and Simulation	997 997	1 0.8	583 737	0.58 0.74

Outcomes

Journal Publications

Ding-Mastera, J., Gao, S., Jenelius, E., Rahmani, M., Huang, H. Ma, L., Pereira, F. and Ben-Akiva, M. (Forthcoming). Routing Policy Choice Set Generation in Stochastic Time-Dependent Networks: Case Studies for Stockholm and Singapore. *Transportation Research Record*.

Conference Presentations

Ding, J., Gao, S., Jenelius, E., Rahmani, M., Huang, H. Ma, L., Pereira, F. and Ben-Akiva, M. Adaptive Route Choice Models: Specification, Choice Set Generation, and Estimation: Case Study in Stockholm, Sweden. TSLWS 2014: 3rd INFORMS Transportation and Logistics Society Workshop, Chicago, Jun. 30 - Jul. 2, 2014.

Ding, J., Gao, S., Jenelius, E., Rahmani, M., Huang, H. Ma, L., Pereira, F. and Ben-Akiva, M. Routing Policy Choice Set Generation in Stochastic Time-Dependent Networks: Case Studies for Stockholm and Singapore. The 93rd Annual Meeting of Transportation Research Board, Washington, DC, Jan. 12-16, 2014.