The Netherlands Research School for Transport, Infrastructure and Logistics
TRAIL

Sensitivity analysis of dynamic OD estimation methods

Introduction

Since OD estimation methods differ in so many aspects, it is difficult to make a priori statements as to which method is best suitable for a particular OD estimation problem. The indicator for the quality of an OD estimation method is the sensitivity of the method to random and structural perturbations of the input (data from sensors, prior OD matrices) on a few typical test networks. We propose such an assessment methodology based on the Latin Hypercube (LHC) method, which is an efficient alternative for Monte Carlo sampling and particularly suited for high-dimensional estimation problems. Using this benchmark framework, both researchers and practitioners will gain insight in which OD estimation methods are suitable for both off-line applications, such as ex-ante simulation studies, and on-line applications, such as short-term traffic prediction, decision support systems, etc.

Benchmark framework

The proposed benchmark framework is generic in the sense that a wide range of OD estimation approaches can be tested under a wide range of different circumstances related to data availability and quality, and network layout. Since the framework has to be applicable to a whole range of OD estimation approaches, a simulation based approach is considered. Central to this benchmarking framework is a well-known simulation-based stratified sampling technique that allows assessing the sensitivity without the need to perform an unfeasible number of simulations.

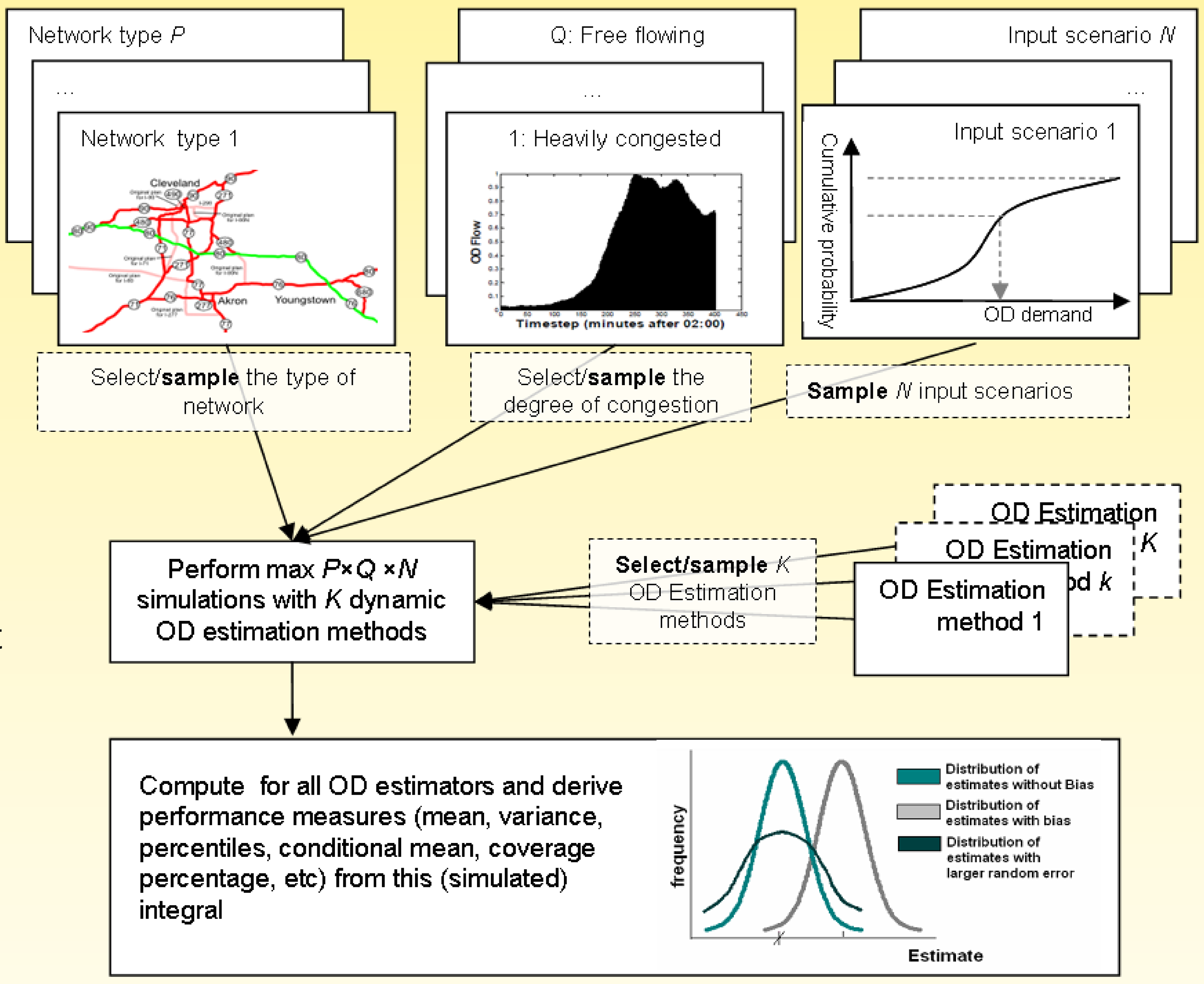
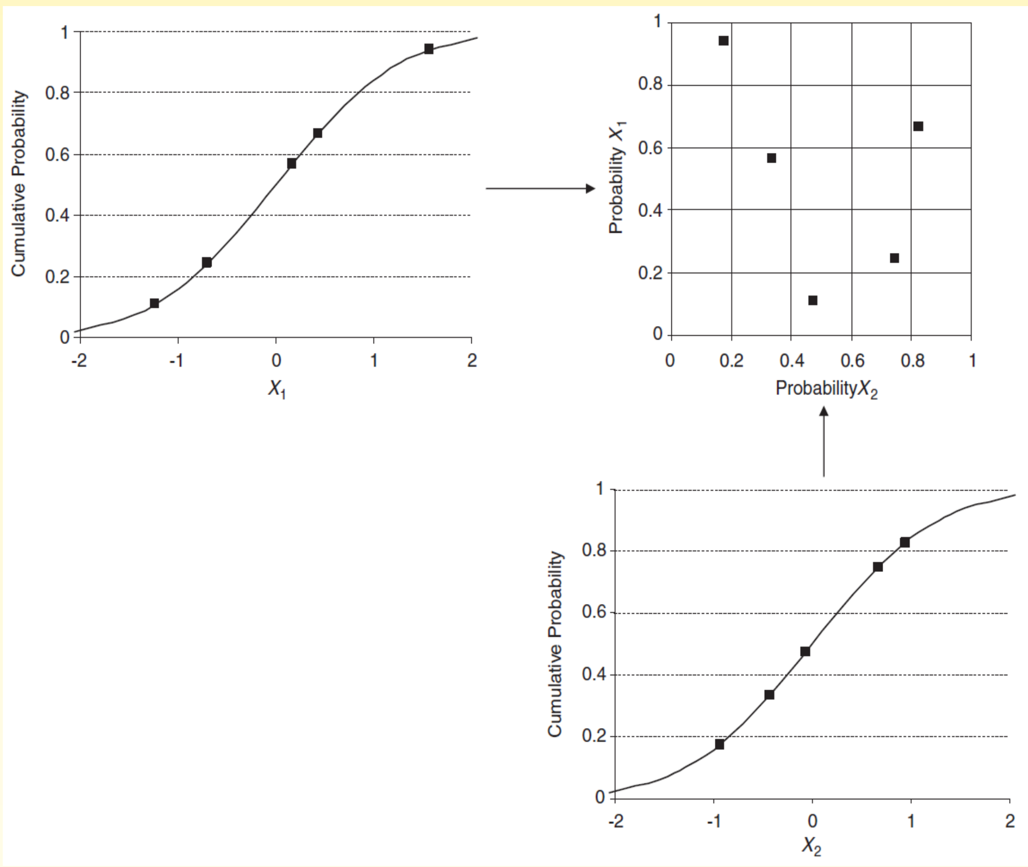


Figure 1. Framework for benchmark analysis of OD estimation methods



Latin hypercube method

The stratified sampling method Latin hypercube (LHC) method is applied that provides a computationally much more efficient alternative to random sampling for estimating the conditional distribution. The LHC method do not scale with the input dimensionality.

Figure 2. Example of LHC method for two variables with normal distribution

Sensitivity of the Entropy Maximization method

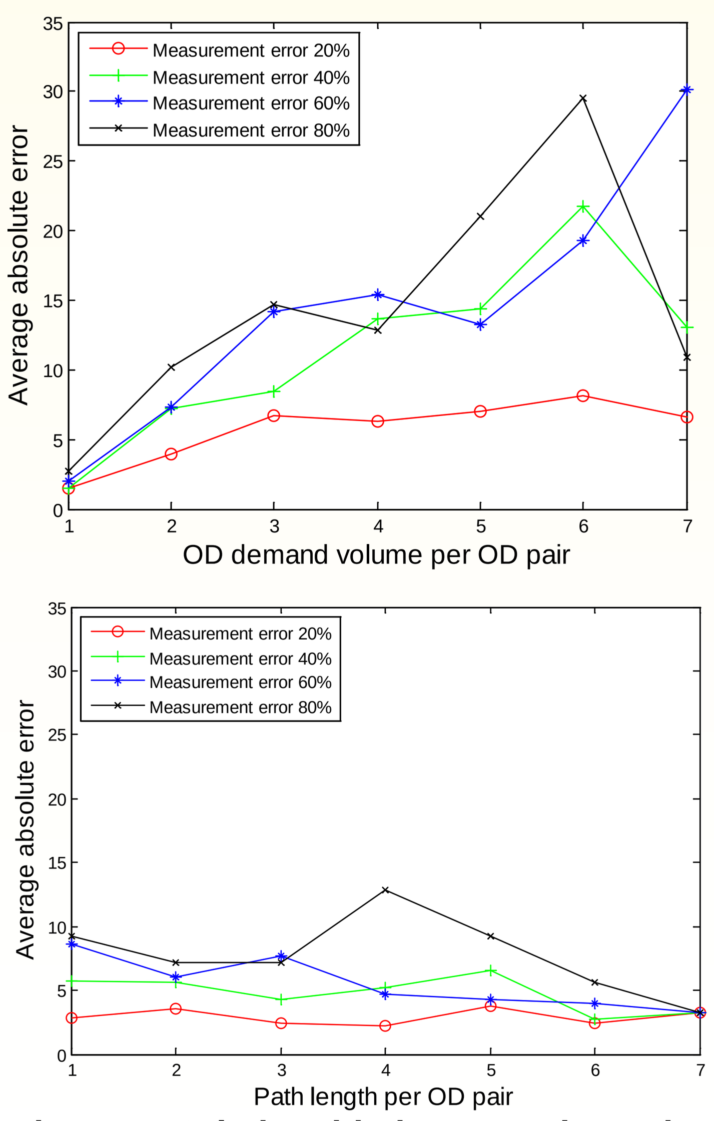


Figure 3. Relationship between the estimation error and properties of the network topology

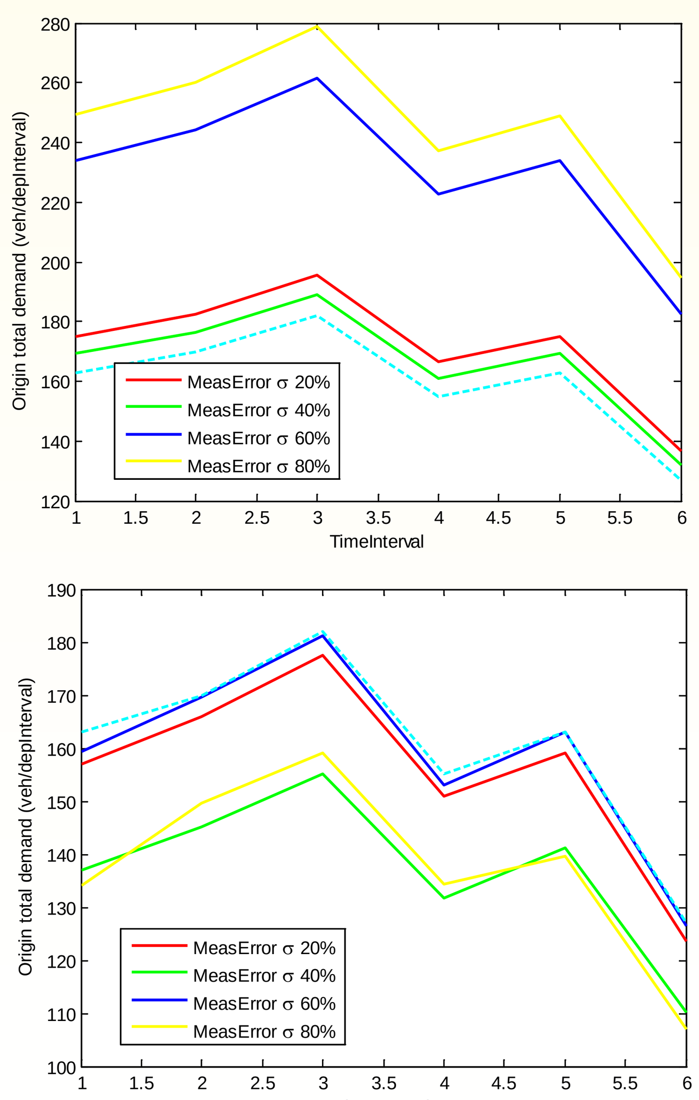


Figure 4. Total demand estimates per origin with 100% and 60% covered links with detector

In real case study based on benchmark framework the sensitivity of entropy maximization (EM) method is demonstrated under different scenarios related to the quality of prior OD matrix and measurements, and detector layout as well. The presented results provide following insights into the sensitivity of entropy maximization estimation method:

- The errors in link measurements lead to the larger range of errors resulting in underestimation and overestimation of total demand and per total origin demand as well;
- The presence of errors in measurements can dominate the accuracy of entropy method especially when the link flow measurements availability is limited;
- The accuracy of OD demand estimates differ among OD pairs;
- EM method is more sensitive to the magnitude of the OD demand than to path lengths between origin and destination for an OD pair.

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