# Calibration of behavioral parameters in an agent-based transport simulation

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## Extended Abstract

**Introduction** Use of dynamic traffic assignment (DTA) models for the planning purpose of transportation network is gaining popularity. In contrast to the analytical DTA models, the simulation based DTA models are used for large urban transportation networks [1]. However, application of such models in the microscopic context is data and resource intensive. In practice, the latter issue is managed by using a fast network loading algorithm [e.g., 2]. For the requirement of intensive data, in contrast to the traditional way of using data from household trip diary surveys, alternative approaches are explored. For instance: (i) trip diaries are generated using traffic counts by integrating Cadyts [3, 4] and MATSim [5]; [e.g., 6, 7] (ii) all-day trip chains are generated using mobile phone data (e.g., see [8]). In this direction, this study addresses the issue of scenario calibration to establish the behavioral parameters which are necessary for the realistic scenario and policy decision making. In past, several studies obtain these parameters by calibrate the scenario manually which is a rigorous and error-prone process [e.g., 7]. This paper proposes an optimization-based automatic calibration to obtain the unavailable behavioral parameters based on the given constrains.

**Methodology** For this, an optimization approach developed by [9] is used which has been integrated in MATSim as Opdyts ("Optimization of dynamic traffic simulations"). The relative efficiency of Opdyts as a general-purpose optimization tool for iterated DTA simulations is its implicit approach of evaluating more decision variables than it actually simulates. Essentially, the method is able to estimate the performance of a decision variable long before the corresponding simulation run has converged, allowing for the early termination of simulation runs for inferior decision variables.

The travel simulator MATSim, is chosen due to its computationally efficient queue model for homogeneous as well as heterogeneous traffic conditions [10].

**Scenario set up** Initially, a toy scenario with two simulation setups is considered with a sole difference of travel modes. They are:

- homogeneous traffic: car as network mode and PT as teleported mode
- heterogeneous traffic: car and bicycle as network modes.

Afterwards, a real-world scenario of Patna, India is considered [11], in which, car, motorbike and bicycle are simulated on the network. The objective function for all simulation experiments is taken as:

$$O = \frac{1}{\left(\sum_{i=1}^{N}\sum_{j=1}^{M} R_i\right)^2} \cdot \sum_{i=1}^{N}\sum_{j=1}^{M}(R_{i,j} - S_{i,j})^2 \tag{1}$$

where $R_{i,j}$ and $S_{i,j}$ are real and simulation trip counts for $i^{th}$ mode and $j^{th}$ distance bin. For simplicity, initially, only alternative specific constants (ASCs) are calibrated against the given modal share and rest of the behavioral are taken from previous studies [7]. However, later, it is planned to calibrate the scenario using a more complex distance-based modal share.

**Preliminary results** For the toy scenario, following ASCs are obtained to reach the desired modal share. (a) +3.09 for PT (homogeneous traffic) and (b) +3.1 for bicycle (heterogeneous traffic). The ASC for PT is not realistic, however, it comes from the initial design of the utility function, where marginal utility of traveling by car or by PT is same and the network is not enough congested. In the second case, the positive ASC for bike indicates the convenience of parking the bicycle directly to the door step (see [12] for details about scoring function in MATSim).

For Patna scenario, the desired modal share is compared with before and after calibration in Figure 1. With this, it can be observed that the calibration results into a modal share which is a good fit to the desired modal share. Comparing the modal share before and after calibration (see Figure 1), it can be observed that in order to achieve the desired modal split, car should be least attractive and bicycle should be most attractive. The calibrated ASCs for bicycle, car and motorbike modes are +0.93, 0.0, +0.28 i.e., as expected, car is least attractive whereas bicycle is most attractive in the scenario. Comparing these values from the ASCs obtained from the manual calibration in [11], the values appears to be realistic.

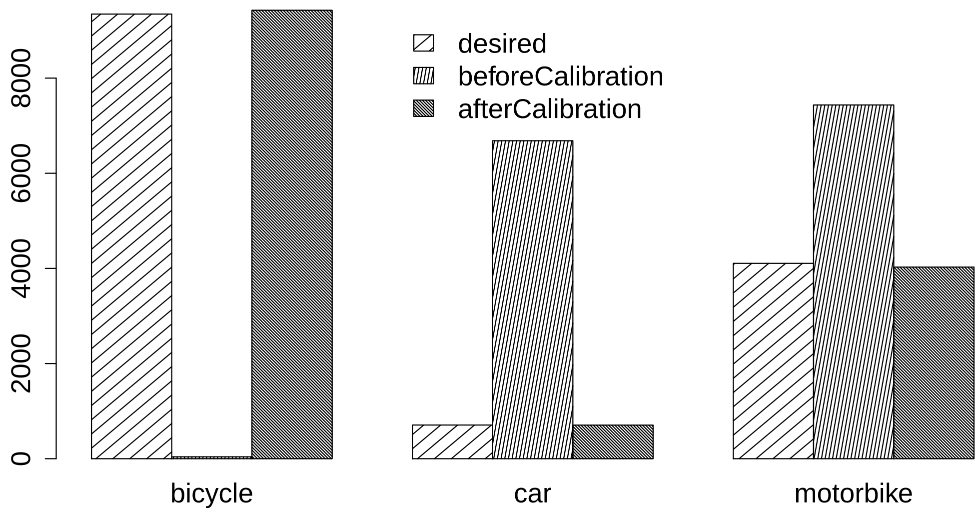


Figure 1: A comparison of modal share

Clearly, with these results, it can be summarized that the integration of Opdyts with MATSim is an useful approach to estimate the unknown behavioral utility parameters mainly if the given distribution is non-linear.

**Keywords:** MATSim, Opdyts, agent-based simulation, calibration, optimization, utility parameters

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