Origin-Destination Matrix Estimation Based on Microsimulation and Optimization

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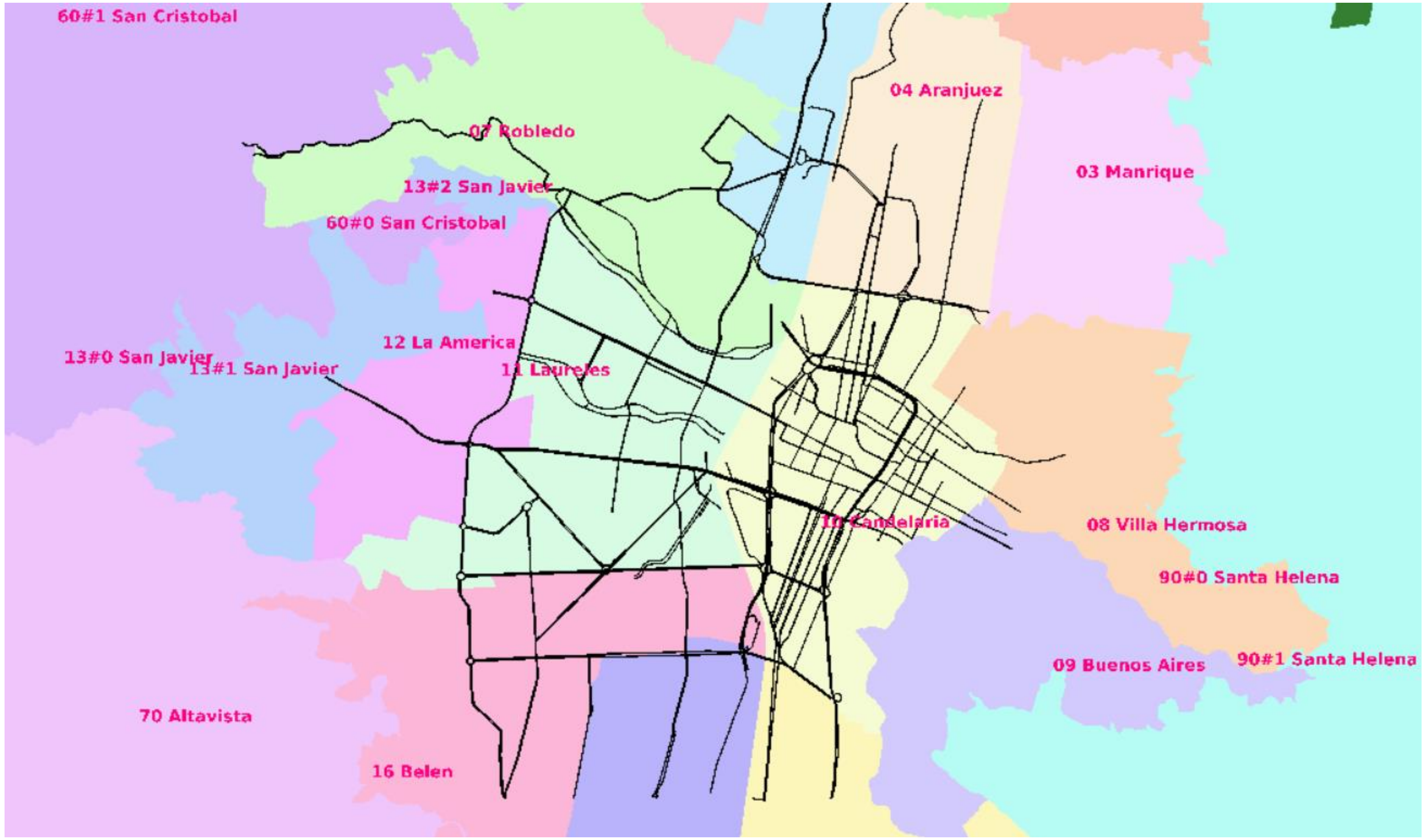
Calibration of traffic scenarios



Assignment and estimation

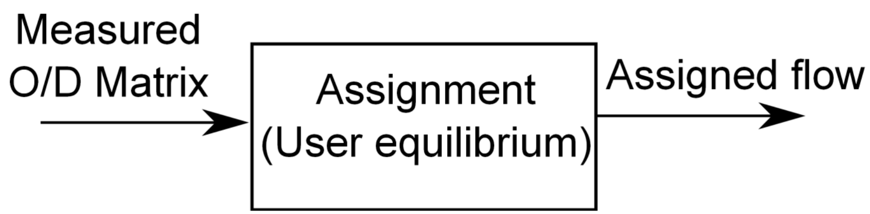


Fig. 1. Assignment and estimation process

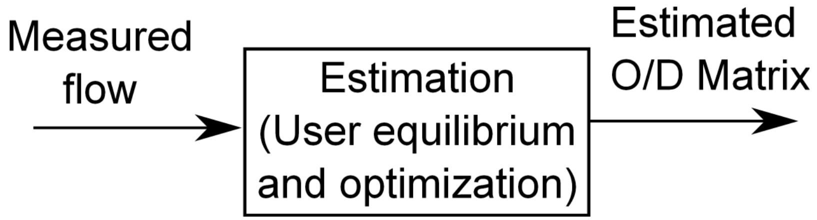


Fig. 2. Assignment and estimation process

Outline

1. User equilibrium
2. O/D matrix estimation
3. Results and discussion
4. Conclusions

1. User equilibrium

Every driver chooses a route for which the cost (usually the travel time) is minimal

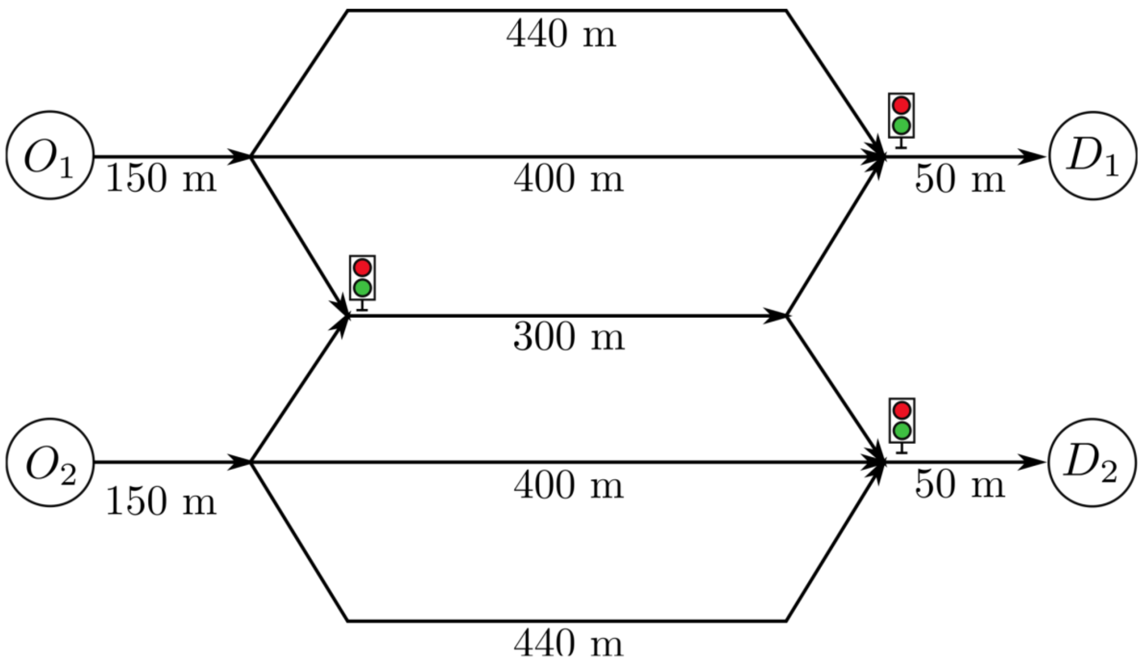


Fig. 3. Simple traffic network

$$M_{(O_i,D_j)} = \begin{bmatrix} V_{(O_1,D_1)} & V_{(O_1,D_2)} \\ V_{(O_2,D_1)} & V_{(O_2,D_2)} \end{bmatrix}, \tag{1}$$

$$M_{(O_i/D_j)} = \begin{bmatrix} 1\,500 & 0 \\ 0 & 1\,500 \end{bmatrix} \tag{2}$$

1. User equilibrium

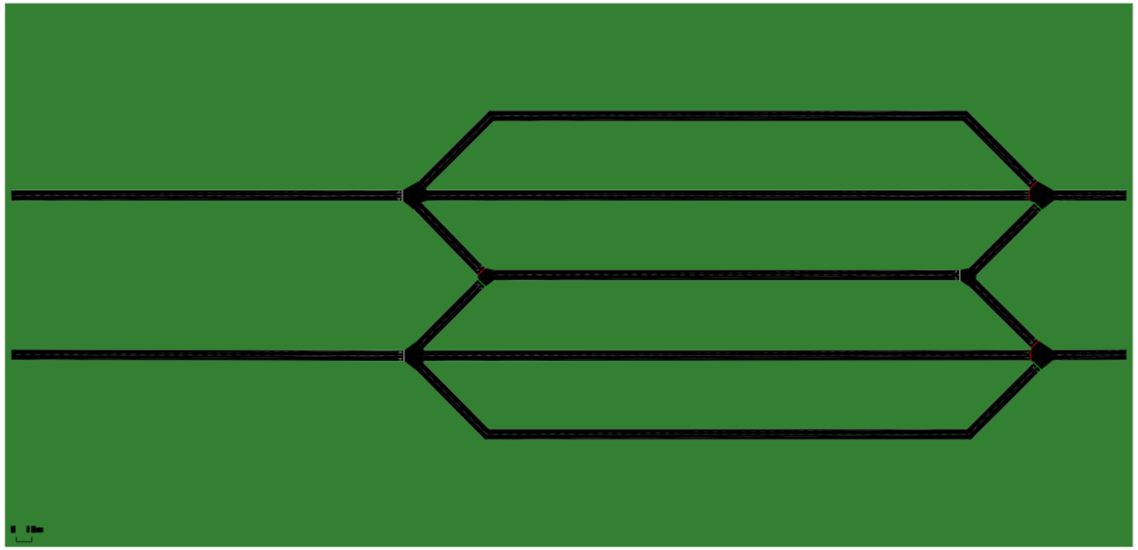


Fig. 4. Urban traffic network in SUMO

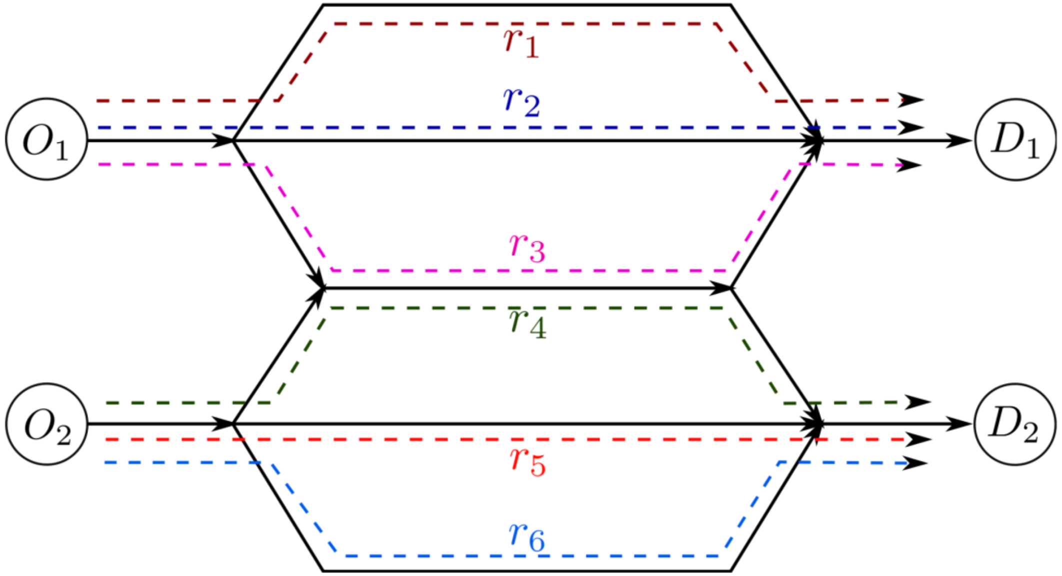


Fig. 5. Possible routes in the case of study

$$R_{(O_1,D_1)} = \{r_1, r_2, r_3\} \quad (3)$$

$$R_{(O_2,D_2)} = \{r_4, r_5, r_6\}. \quad (4)$$

1. User equilibrium

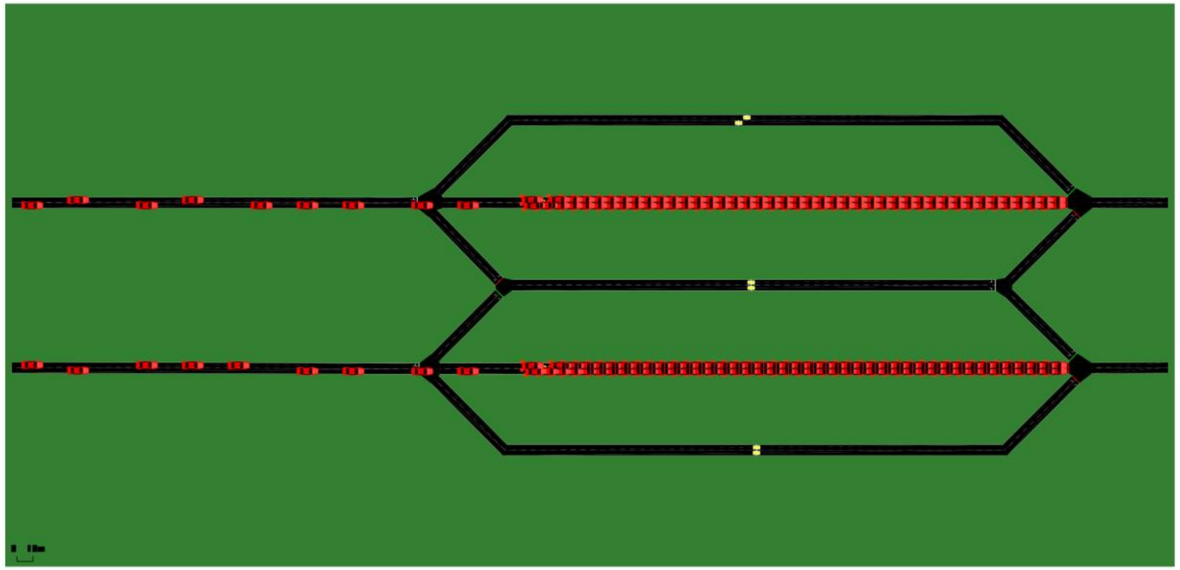


Fig. 6. Assignment using the shortest path

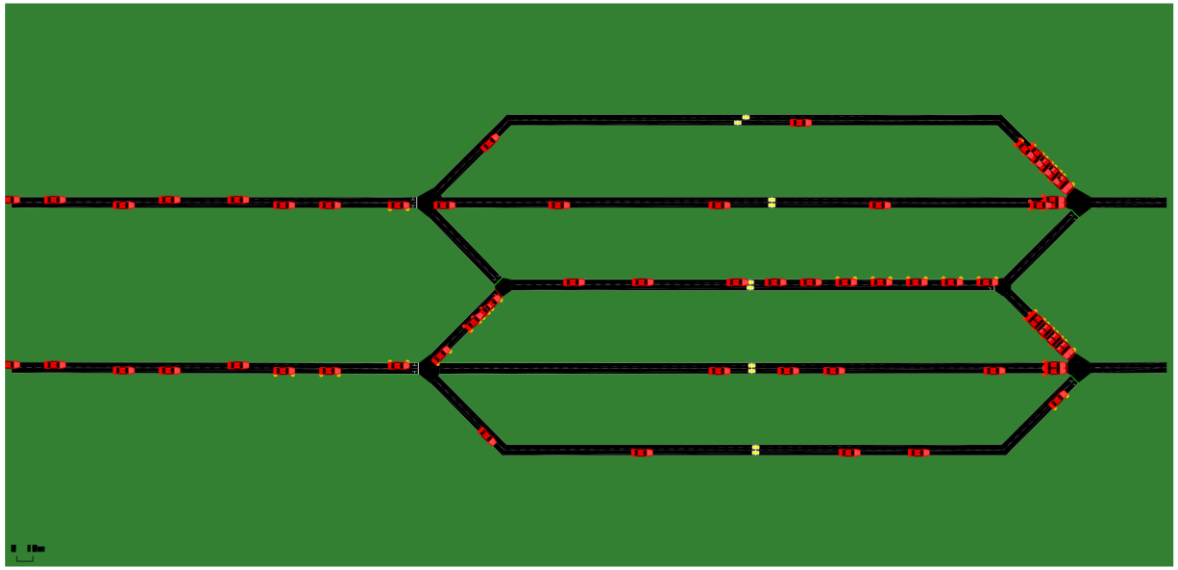
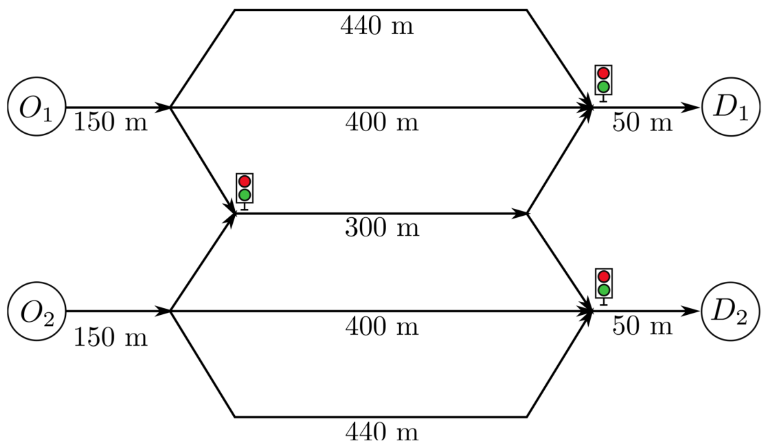
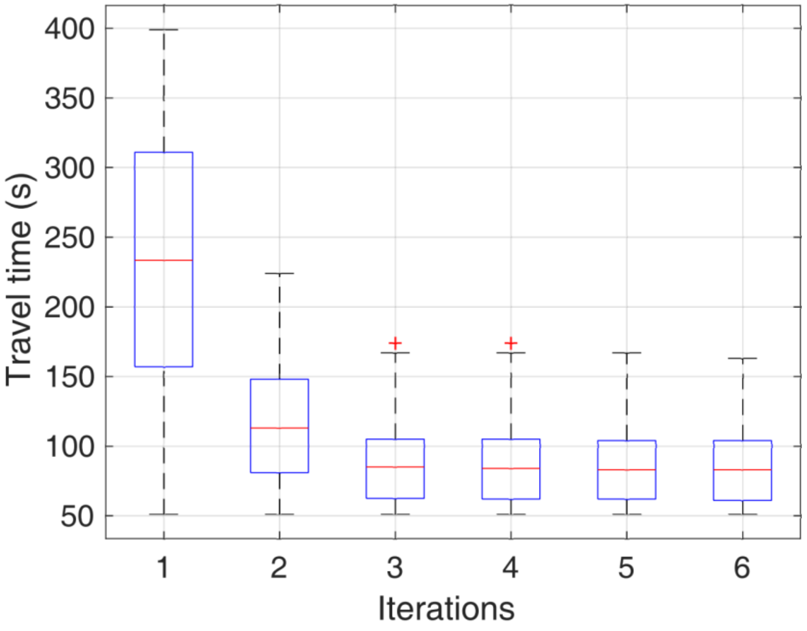


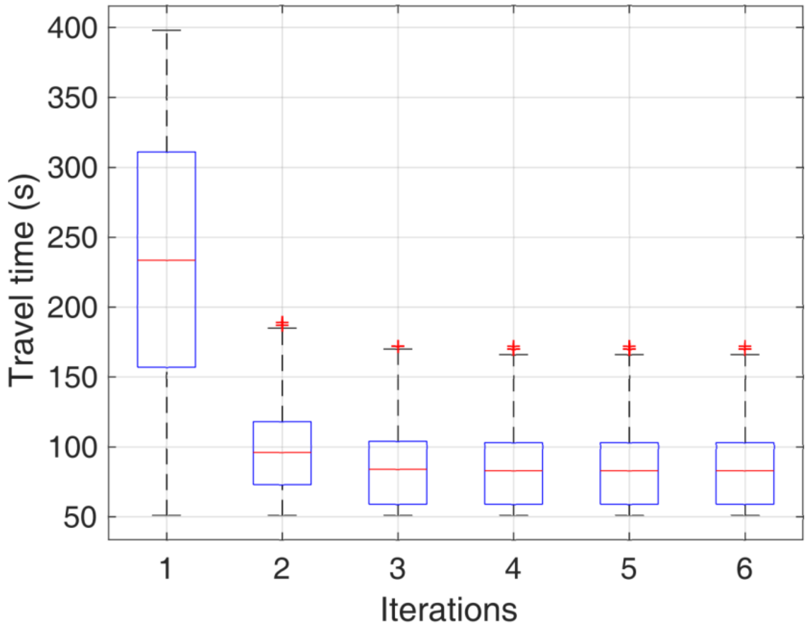
Fig. 7. User equilibrium representation

1. User equilibrium





(a) Travel time for different iterations for $V_{(O_1,D_1)}$



(b) Travel time for different iterations for $V_{(O_2,D_2)}$

Fig. 8. Dynamic User Equilibrium for a simple urban traffic network

2. O/D matrix estimation

$$\dot{\boldsymbol{q}} = f(\boldsymbol{u}) \tag{5}$$

$$\boldsymbol{u} = [V_{(O_1,D_1)}, V_{(O_1,D_2)}, V_{(O_2,D_1)}, V_{(O_2,D_2)}]^\mathsf{T}$$

$$\min_{\boldsymbol{u}} J(\mathbf{u}, \boldsymbol{q}, \hat{\boldsymbol{q}}) = \|q - \hat{q}\|_2$$

subject to:

$$\begin{aligned} &\dot{\boldsymbol{q}} = f(\boldsymbol{u}), \\ &\boldsymbol{u}_{\min} \le \boldsymbol{u} \le \boldsymbol{u}_{\max}, \end{aligned} \tag{6}$$

measured flow $\boldsymbol{q} = [q_{r_1}, q_{r_2}, q_{r_3} + q_{r_4}, q_{r_5}, q_{r_6}]^\mathsf{T}$

estimated flow $\hat{\boldsymbol{q}} = [\hat{q}_{r_1}, \hat{q}_{r_2}, \hat{q}_{r_3} + \hat{q}_{r_4}, \hat{q}_{r_5}, \hat{q}_{r_6}]^\mathsf{T}$

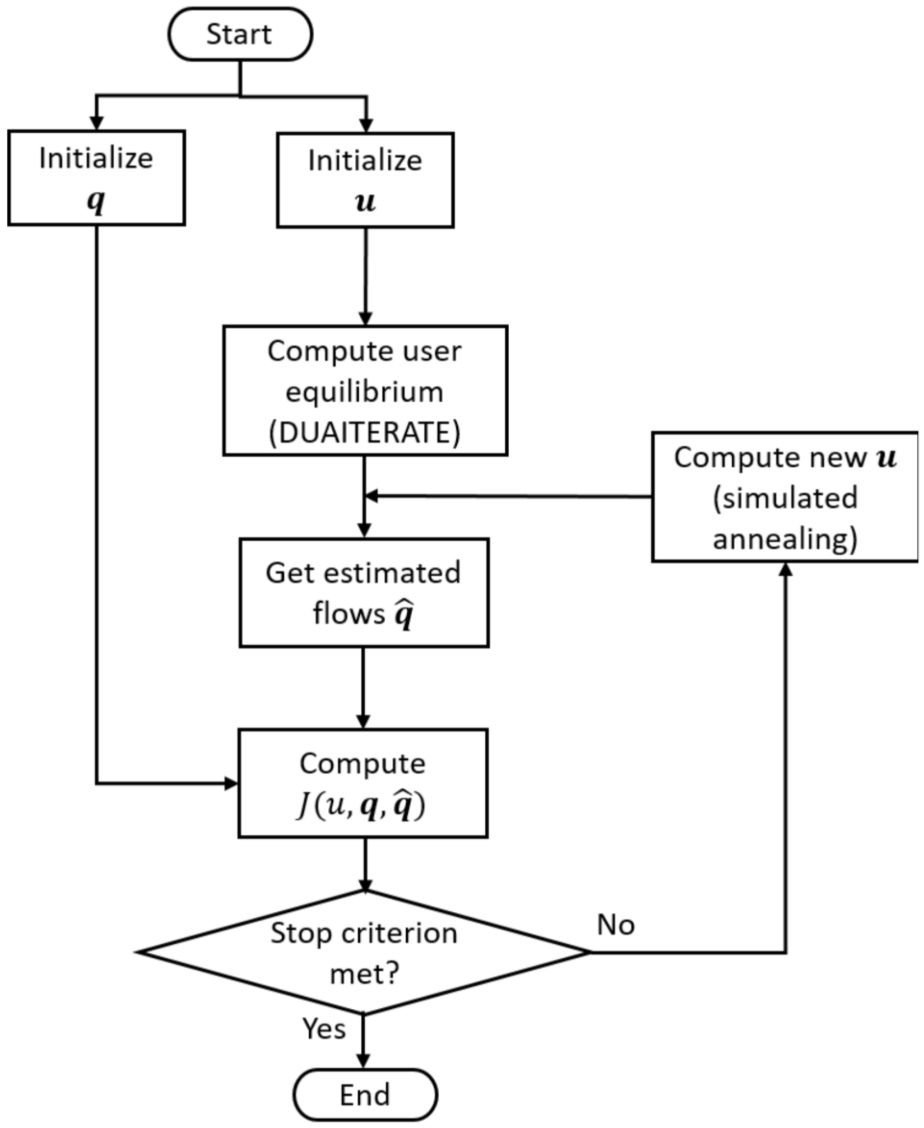
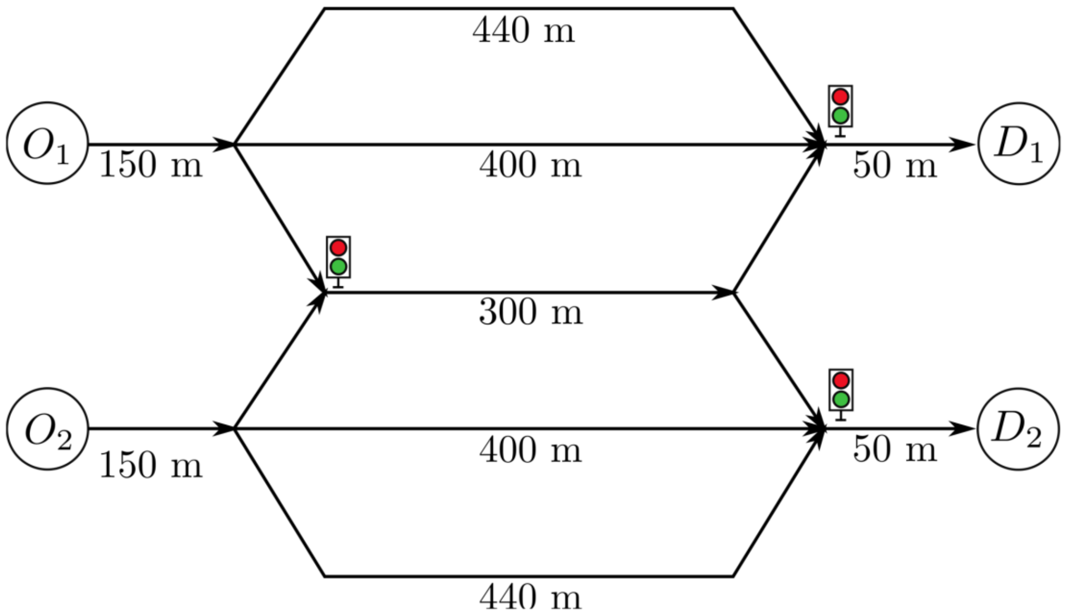


Fig. 9. Flow chart of the O/D estimation process

2. O/D matrix estimation



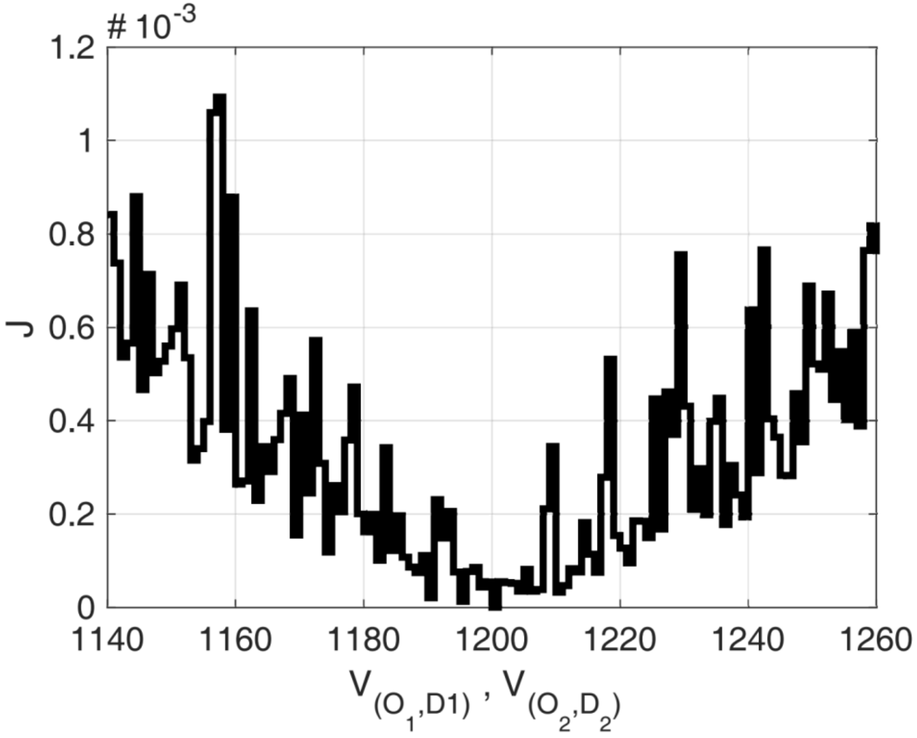


Fig. 10. Cost function obtained by varying $V_{(O_1,D_1)}$ and $V_{(O_2,D_2)}$, and keeping the other values of the O/D matrix as $V_{(O_1,D_2)} = V_{(O_2,D_1)} = 1000$

3. Results and discussion

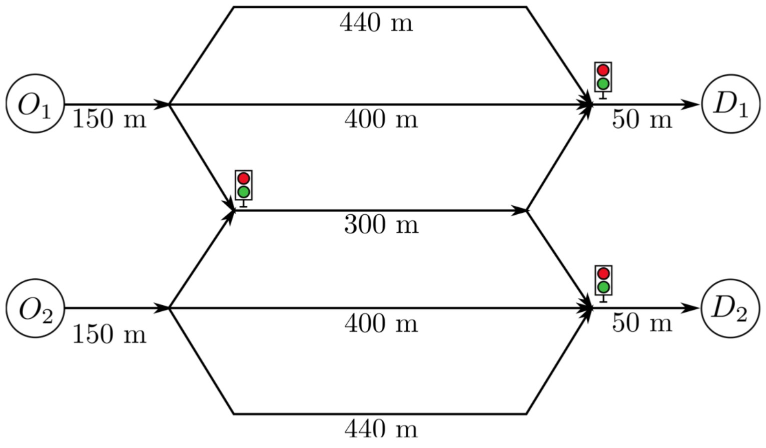


TABLE I
REAL AND MEASURED TRIPS AND FLOWS FOR THE TEST CASE SCENARIO.

Variable	Real value	Measured value	Error (%)
$V_{(O_1,D_1)}$	1 200	1 158,9	3,42
$V_{(O_1,D_2)}$	1 000	1 045,7	4,57
$V_{(O_2,D_1)}$	1 000	998,5	-0,15
$V_{(O_2,D_2)}$	1 200	1 256,5	4,7
q_{r_1}	612	612	0
q_{r_2}	580	580	0
$q_{r_3} + q_{r_4}$	2 000	2 000	0
q_{r_5}	609	609	0
q_{r_6}	591	591	0

3. Results and discussion

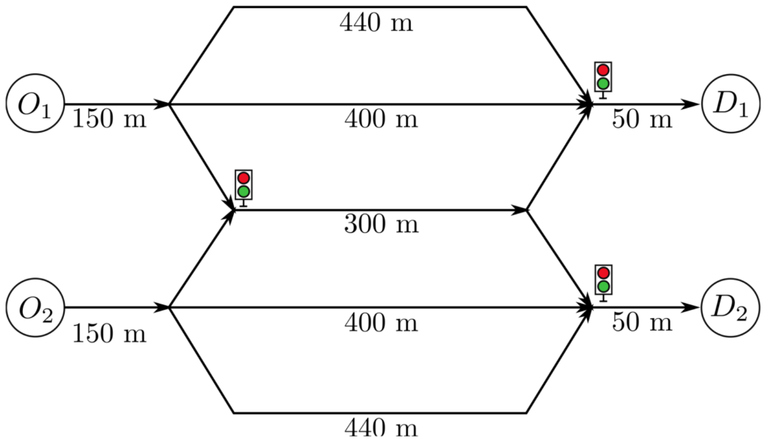


TABLE II
INITIAL FLOWS OBTAINED WITH THE MEASURED O/D MATRIX

Variable	Real value	Initial conditions	Error (%)
$V_{(O_1,D_1)}$	1 200	1 158,9	3,42
$V_{(O_1,D_2)}$	1 000	1 045,7	4,57
$V_{(O_2,D_1)}$	1 000	998,5	-0,15
$V_{(O_2,D_2)}$	1 200	1 256,5	4,7
q_{r_1}	612	567	-7,4
q_{r_2}	580	582	0,3
$q_{r_3} + q_{r_4}$	2 000	2 041	2,1
q_{r_5}	609	609	0
q_{r_6}	591	648	9,6

3. Results and discussion

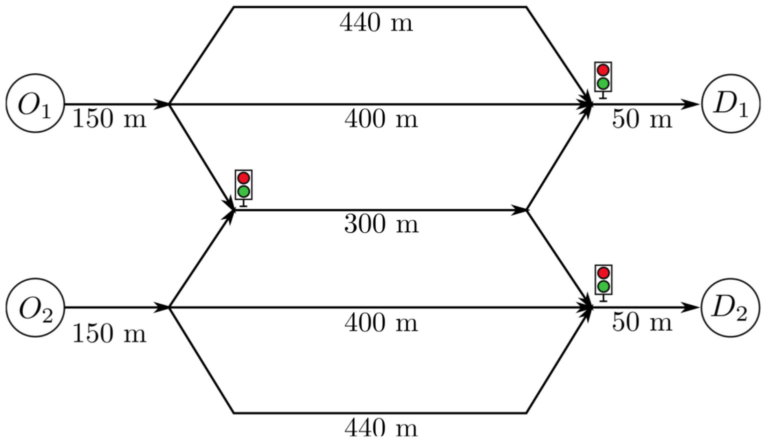


TABLE III

SOLUTION OBTAINED WITH THE ESTIMATION METHOD

Variable	Real value	Estimated value	Error (%)
$V_{(O_1,D_1)}$	1 200	1 198,3	0,1
$V_{(O_1,D_2)}$	1 000	1 042,0	4,2
$V_{(O_2,D_1)}$	1 000	958,6	4,2
$V_{(O_2,D_2)}$	1 200	1 208,9	0,7
q_{r_1}	612	608	0,6
q_{r_2}	580	583	0,5
$q_{r_3} + q_{r_4}$	2 000	2 000	0
q_{r_5}	609	609	0
q_{r_6}	591	600	1,5

4. Conclusions

- In this presentation, a method for estimating an O/D matrix based on microscopic simulation was described. This method consists in an optimization problem where the decision variables correspond to the trips comprising the O/D matrix, which is assumed to have a measurement error.
- This optimization iteratively runs a dynamic user equilibrium using the DUAITERATE tool found in the SUMO simulator, which implements the Gawron's Dynamic Traffic Assignment Model.
- The objective function tries to minimize the error between the flows obtained with the measured O/D matrix, and those obtained with the corrected O/D matrix.
- Simulation results showed the validity of the proposed method. Due to the dependence between the O/D matrix and the resulting traffic flows, it was difficult to consider measurement errors in the latter. Future improvements will evaluate these errors directly in the SUMO simulator.

ACKNOWLEDGMENT

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Thank you.

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