Assigning user class link and route flows uniquely

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ABSTRACT

The standard method for predicting traffic flows on urban road networks, static user-equilibrium traffic assignment, is based on the principle that drivers seek their own least cost routes from their origins to their destinations. This principle corresponds to a user-equilibrium state in which all used routes have equal costs and no unused route has a lower cost for every origin-destination pair. This problem can be formulated as a convex optimization problem with linear constraints, and solved with an iterative algorithm. Although the total flows on links of the urban road network are uniquely determined by this formulation, multi-class link flows, as well as route flows, are not. An additional assumption, called the condition of proportionality, namely that the proportion of travelers on each of the two alternative, equal-cost segments (sequences of links) should be the same regardless of their origin or their destination, may be imposed to determine these flows uniquely.

Two multi-class assignments to the Chicago regional network are performed in which the order of the trip matrices are specified as car followed by truck, and truck followed by car; each is iterated towards a user-equilibrium with a relative gap less than 1E-8 with the travel forecasting software system, VISUM. The total link flows for the two assignments are effectively equal; however, substantial differences exist between the class link flows determined by the arbitrary ordering of the matrices in the two assignments. Post-processing to impose the condition of proportionality on the class O-D flows removes about 90% of these differences. Analyses of class link flows of cars and trucks before and after imposing the condition of proportionality for one of the assignments, car followed by truck, reveal that about half of all links experience differences in user class flows, ranging up to +/–300 vph. The largest differences in class link flows occur on links with class flows less than 2,000 vph. These findings offer insights into the magnitude of the differences arising from the non-uniqueness of class link flows, which links are subject to such differences, and the importance of imposing the condition of proportionality in multi-class traffic assignments at the link and segment level for travel forecasting practice.

The effects of imposing the condition of proportionality on car and truck link flows from two assignments on a large-scale road network of the Chicago region are compared in this paper at three levels:

1. class link flows over the entire network, as shown in Fig. 1;
2. class flows over a pair of alternative segments (not shown here);
3. O-D class flows over a selected link (not shown here).

The effects of the ordering of the trip matrices in the assignment on the resulting class link flows and class O-D flows are emphasized in the conclusions together with the overall effects of imposing the condition of proportionality on a traffic assignment.

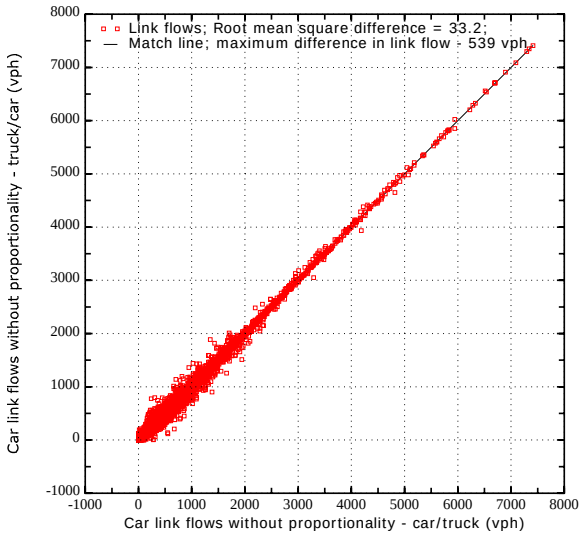

Fig. 1a. Car link flows without proportionality: truck/car versus car/truck.

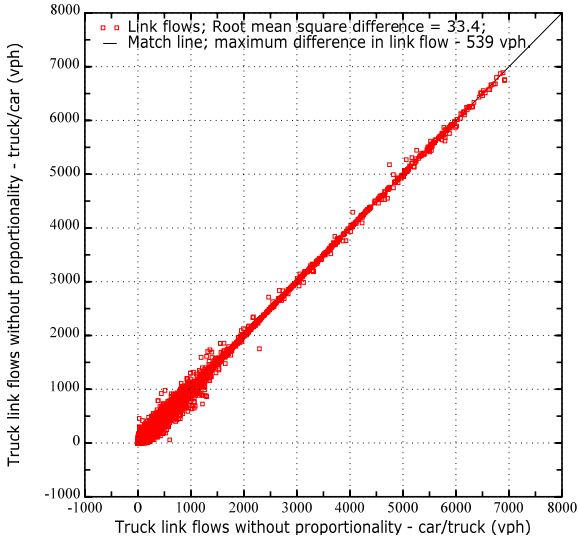

Fig. 1b. Truck link flows without proportionality: truck/car versus car/truck.

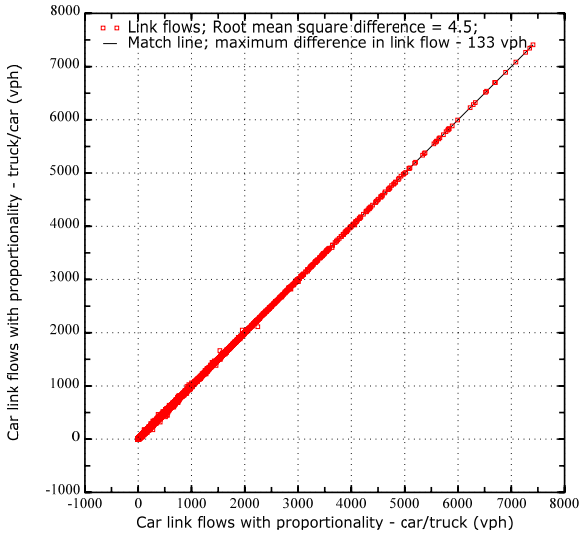

Fig. 1c. Car link flows with proportionality: truck/car versus car/truck.

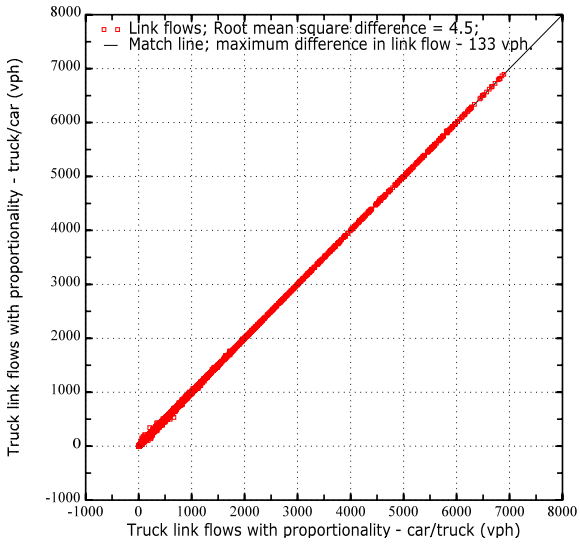

Fig. 1d. Truck link flows with proportionality: truck/car versus car/truck