Identify and Visualize Differences in Traffic Data

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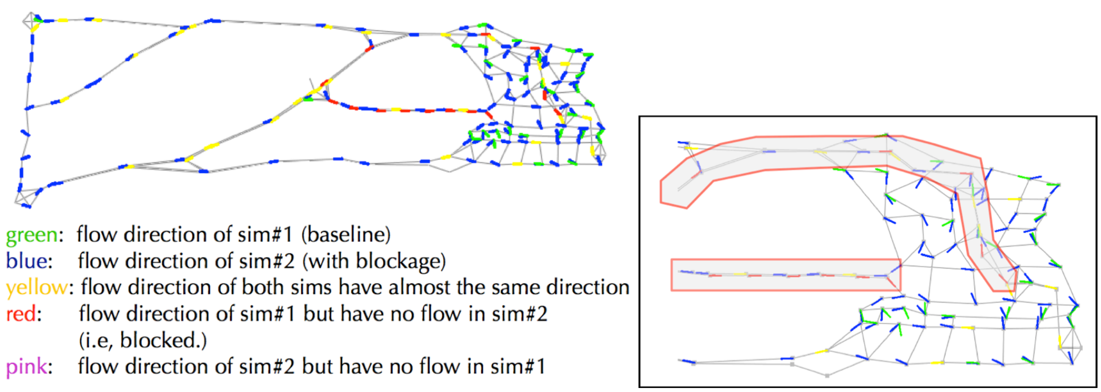
Given the massive amounts of historical traffic data collected by government agencies and the traffic monitoring sensors that are currently deployed and traffic data generated by advancing simulation capability, traffic engineers and policy makers nowadays study large traffic datasets in order to improve the efficiency, safety, and other related qualities of their road networks. However, the overwhelming size and detail of these datasets prevent domain experts from making high level conclusions effectively, such as identifying how flows change during heavy traffic. Thus, in order to assist these users effectively, traffic visualization is developed to automatically search for events of interest using quantitative metrics, while also simplifying the presentation of these complex traffic properties and comparisons.

Many visualization techniques on traffic data are designed for road users for tasks such as route planning by displaying data at each time instance or data aggregated over time. An example is the congestion information visualization in Google Maps and INRIX Traffic. Visualization for traffic engineers and decision and policy makers usually relies on *traffic analysis*. Traffic analysis can be approached as a problem of searching for trends and outliers. However, these analysis techniques have only been applied to *local traffic data* that is usually focused on a single route, thus provide only limited information about the changes of the underlying road network. For example, searching traffic data for outliers and anomalies is an effective approach for detecting traffic incidents, this has very limited use to visualize and understand the ripple effect of an incident to the regional traffic. More recently, traffic visualization approaches have also made progress in graphical presentation of complex data sets; however, much less attention has been given to using these visualizations for comparing related data sets.

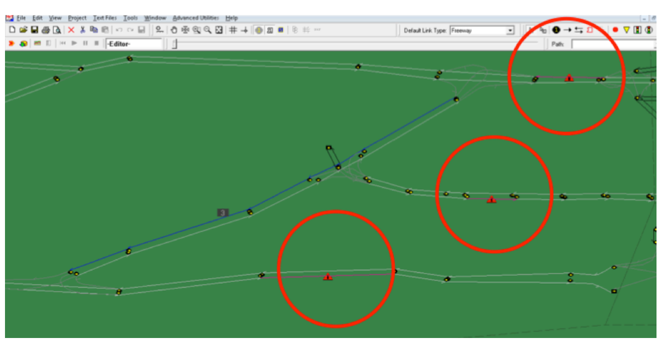
Motivated by the limitations of existing work, the objective of this work is to provide alternative methods that highlight the differences among traffic data beyond the local traffic. More specially, examples in this paper will focus on analyzing properties of this traffic relevant to its throughput efficiency, and then graphically display these results for the user. Although we will use only simulated data in this paper, our technique is also suitable for historical data. Due to recent advances, traffic simulation has become a necessary tool in traffic optimization, which generally involves modifying the parameters and structure of the road network until some desired traffic pattern emerged. The time scale in these simulations can range from minutes to decades. Use the proposed visualization tool, traffic experts can see the changes in traffic flow decades apart after a bridge is built, see the divergence of highway traffic into the regional network minutes after an accident, and see the effect of a short-term road closure (such as the 10-mile closure of the 405 Freeway in Los Angeles in 2012, which triggered the fear of Carmageddon).

In this work, we propose visualization methods that are suitable for understanding, comparing and highlighting the differences between traffic recorded before and after certain events. For example, the developed tool will allow users to study the impact of a road or bridge closure by highlighting the changes in optimal routes through the network, as well as changes in the actual routes taken by drivers.

To show the power of our visualization tools, we use a small network consisting of 174 nodes, 374 edges and 4,624 vehicles with over 160 simulation steps. In Fig. 1(a), we show a screen shot of our visualization tool that highlights the differences in traffic flow of two simulation outputs. These two simulations (called sim#1 and sim#2) are created using DynusT with and without road blockages shown in Fig. 1(b). The visualization shown in Fig. 1(a) is created by analyzing the traffic volume and flow direction. Notice the red segments in the figure. These red segments represent the flows that are present in the first simulation (sim#1) but not in the second simulation (sim#1) and accurately correspond to the locations of road blockages shown in Fig. 1(b). Furthermore, if we group the red segments in Fig. 1(a), we can also see where the vehicles in sim#2 start to diverge from those in the sim#1 due to the blockage.



(a)



(b)

Figure 1. (a) Identified blockage (shown in red) by finding the differences in the simulated traffic obtained before and after the blockage. (b) These identified blockages were confirmed by the ground truth. The bottom blockage is not identified due to missing traffic volume in both simulations.