High-Performance Spatial Visualization of Traffic Data

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Why This Research is Needed

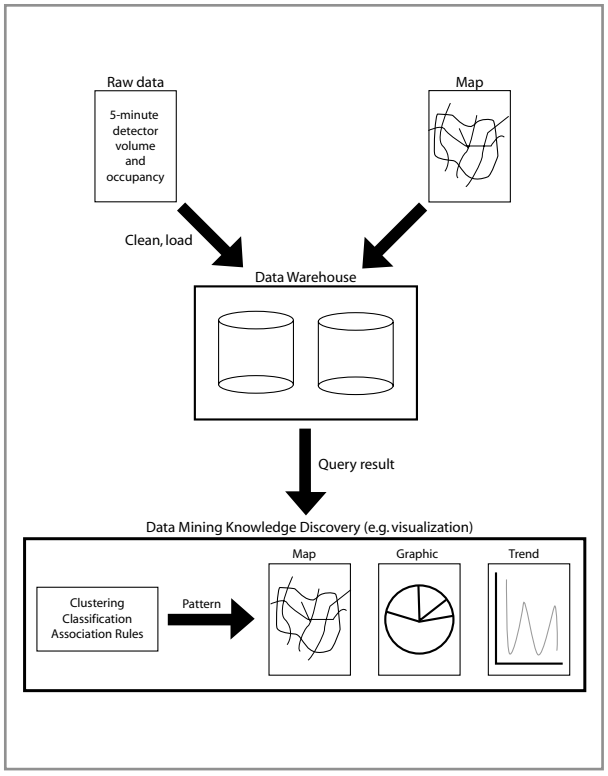
High-performance visualization techniques are becoming crucial for traffic planners, because the wealth of traffic data collected by an ever-expanding sensor network is growing much faster than it can possibly be analyzed manually. For example, producing a three-dimensional visualization of speed as a function of time and highway network space for a single day's traffic data can take up to a week using current tools. This performance bottleneck makes it hard for traffic researchers to perform interactive visualization for asking "what-if" questions.

Research Objectives

First, to develop high performance spatial tools and techniques to generate critical visualizations of traffic patterns, based on data collected by roadway-embedded sensors. Second, to develop new spatial data structures and algorithms to speed up the process of producing and revising interactive visualizations.

Methodology

The researchers have constructed a data warehousing framework to hold the immense amount of data gathered so that it is accessible by the visualization tools under development. The framework will integrate different multi-dimensional views of traffic data, and support on-line analytical processing (OLAP).



Schematic representation of information flow in a high-performance data visualization system

Research Results

The research team has developed new visualization algorithms for spatially indexed data, operating within a lattice framework where each node corresponds to a subspace of the multidimensional concept space. This lattice framework is conducive to "what-if" scenario analysis and provides for integration with other high-performance visual kernels.

Applying data mining techniques within the data warehousing framework has revealed clusters of monitoring stations that exhibit similar traffic patterns. Stations exhibiting relatively unusual traffic patterns have also been identified for further analysis.

Research Impacts

Prototype software applications have been developed that allow users to visualize traffic data.

The traffic video applet is a tool for viewing the dynamic traffic flow at a specific date for the Twin Cities major highways. It displays average volume, total volume, or occupancy for each station. Users can choose the start and end times, and can view all the stations in the freeway network or just a chosen highway.

The traffic volume map displays the traffic flow for a particular highway on a chosen date by plotting the volume on a graph of time (X axis) and location (Y axis). Complementing the traffic video display, the volume map provides a summary view of a whole day's traffic flow.

Traffic Management Center researchers are using these tools to rapidly get summary information on traffic behavior during the period covered by currently available data.

What's Next

The researchers plan to improve both the data mining framework and the prototype software applications. Software improvements will enable users to visually compare representations of traffic flow for different dates. Advances in data mining techniques will aim to discover implicit patterns and relationships embedded in the data, using methods such as clustering, classification, outlier detection, sequential pattern discovery, and association rules discovery.