Interactive Visual Interfaces for Evacuation Planning

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ABSTRACT

To support planning of massive transportations under time-critical conditions, in particular, evacuation of people from a disaster-affected area, we have developed a software module for automated generation of transportation schedules and a suite of visual analytics tools that enable the verification of a schedule by a human expert. We combine computational, visual, and interactive techniques to help the user to deal with large and complex data involving geographical space, time, and heterogeneous objects.

Categories and Subject Descriptors

H.1.2 [User/Machine Systems]: Human information processing – Visual Analytics; I.6.9 [Visualization]: information visualization.

Keywords

Visual Analytics, geovisualization, transportation planning, task-centered visualization design, coordinated multiple views.

1. INTRODUCTION

In time critical situations, software tools automating some of people's activities or suggesting solutions to problems are of great benefit. However, machine-generated solutions can generally be used only after a verification and validation by a human expert, who takes the responsibility for the decisions made. Hence, the expert needs tools that enable effective reviewing of these solutions in the shortest possible time. Although visualization plays a great role here, large amounts of information cannot be efficiently examined without the involvement of computational techniques for analysis and summarization.

We have developed a software system to support civil protection services in planning evacuation of people from disaster-affected areas. The system includes a module that automatically builds transportation schedules and a suite of techniques enabling the inspection of the schedules by a human planner. To handle large amounts of data, we integrate interactive visual displays with computational techniques for data transformation, according to the paradigm of visual analytics (Thomas and Cook 2005, Keim 2005). This distinguishes our approach from the usual tools (e.g. ILOG 2007, TurboRouter 2007, Fagerholt 2004).

In (Andrienko et al. 2007), we described the main features of the automated schedule builder and presented our task-centered design of the tools for schedule examination. We also demonstrated the appropriateness of the tools for the task by an example of schedule analysis. In this presentation, we focus on the display manipulation techniques, coordination between different views, and dynamic transformations of the data.

2. VISUAL ANALYTICS TOOLS

2.1 The data to be examined

In an emergency evacuation, it is necessary to schedule the transportation of many people from multiple sources (original locations) to multiple destinations (shelters). There may be diverse categories of people such as general public, disabled people, and critically sick or injured persons. These categories need to be handled differently, which includes the selection of proper destinations and proper types of vehicles as well as proper timing of the transportation.

The input data for the evacuation planning include (1) the sources of the endangered people, (2) the numbers and categories of these people, (3) the latest allowed departure times per place and category; (4) possible destinations and their capacities, by people categories; (5) types of vehicles and their capacities for the people categories they are suitable for; (6) available vehicles and their initial locations. The automated schedule generator produces a collection of *transportation orders* assigned to the vehicles, where each order specifies one trip of a vehicle: source and destination locations, start and end times, and the category and number of the people to be delivered. One schedule may consist of hundreds of orders. A human planner cannot examine each order individually, especially under time-critical conditions. Hence, the information needs to be presented to the planner in a summarized form adequate to the purpose of detecting possible problems (e.g. people remaining in the sources, time limits exceeded, etc.) and understanding their reasons.

2.2 Dynamic aggregation

To provide a summarized representation of the data while enabling the planner to focus on various subsets, we combine interactive filtering of the data with dynamic aggregation. The user may set one or more data filters of different types: by people category, by time interval, by source, and/or by destination. The aggregation is applied to the portion of the data that have passed through the filters and immediately re-applied when the filters change. For this purpose, several types of *dynamic aggregators* are created. A dynamic aggregator is a special object linked to a number of data records and able to derive certain statistical summaries from those records which satisfy current filters. These summaries are presented on visual displays, and the aggregators are responsible for updating the displays when the filters change. Different types of aggregators are attached to individual locations (e.g. counters of remaining people in the source locations and counters of used and free capacities in the destinations), to pairs of locations (trip aggregators), or to the entire territory (e.g. aggregator of people by states and calculator of the vehicle use).

2.3 Visualization and user interaction

A transportation schedule is a complex construct involving geographical space, time, and heterogeneous objects (people and vehicles) with states and positions varying in time. All this information cannot be appropriately presented in a single display. Our toolkit includes several coordinated views presenting different aspects: (1) a summary view of the transportation progress over time (Figure 1), which also serves as a direct manipulation interface to the time filter; (2) a map display showing the situation on a user-selected time interval (Figures 2, 3); (3) a source-destination matrix presenting summarized data for pairs of locations, which serves as a direct manipulation interface of the filter by source and/or destination; (4) a Gantt chart providing a detailed view of the distribution of the trips over time. All the views are dynamically updated when the user changes current filters: selects an item category, a time interval, a source, and/or a destination. In our presentation, we are going to demonstrate how the tools enable detection of possible problems and investigation into their reasons.

3. CONCLUSION

To support efficient examination of large transportation schedules involving multiple geographical locations and diverse categories of transported items and types of vehicles, we combine interactive visual displays with dynamic aggregation and summarization of the data. This research is conducted within the integrated EU-funded project OASIS – Open Advanced System for Improved Crisis Management (IST-2003-004677, 2004-2008; http://www.oasis-fp6.org/). We have presented out tools to potential users, professionals in civil protection and crisis management, who expressed their high interest and wish to have such tools at their service. Next year, the users will test and evaluate the tools in the course of the trials of the entire OASIS system, which will take place in two European countries.

4. REFERENCES

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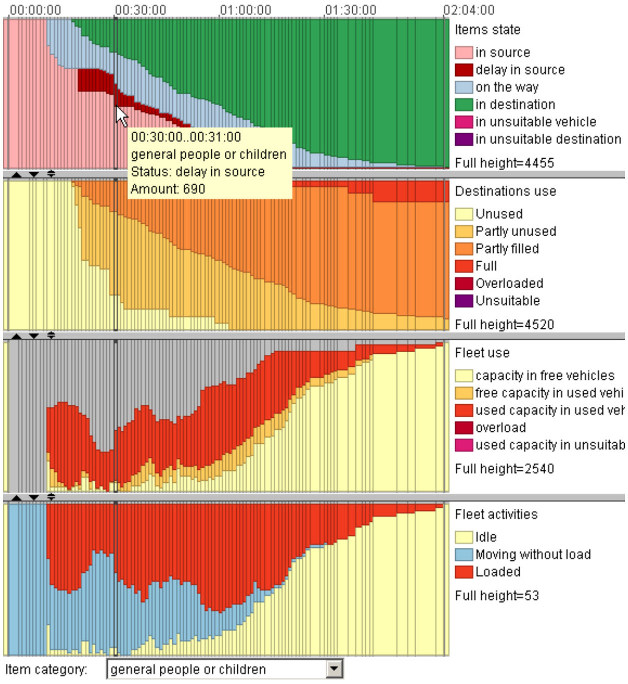

Figure 1. The summary view of the transportation progress.

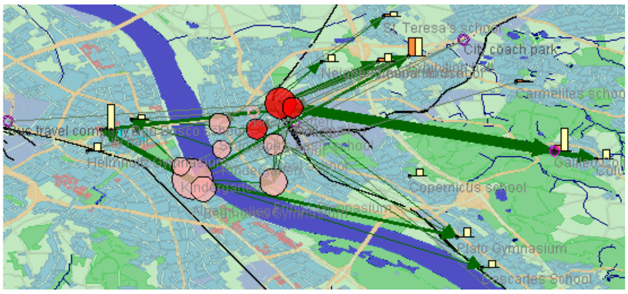

Figure 2. A fragment of the map view.

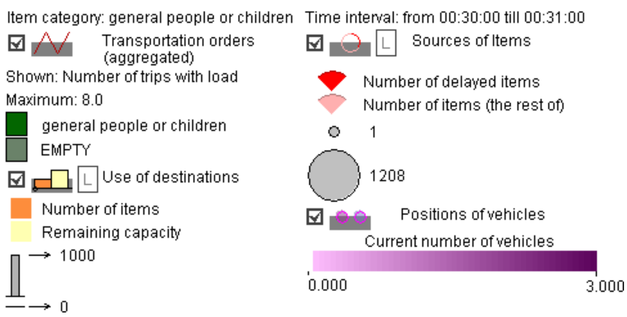

Figure 3. The legend of the map shown in Figure 2.