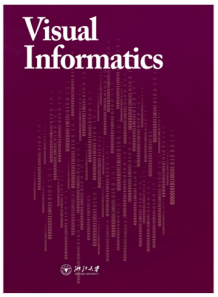

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Visual Exploration of Movement and Event Data with Interactive Time Masks

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Abstract

We introduce the concept of time mask, which is a type of temporal filter suitable for selection of multiple disjoint time intervals in which some query conditions fulfill. Such a filter can be applied to time-referenced objects, such as events and trajectories, for selecting those objects or segments of trajectories that fit in one of the selected time intervals. The selected subsets of objects or segments are dynamically summarized in various ways, and the summaries are represented visually on maps and/or other displays to enable exploration. The time mask filtering can be especially helpful in analysis of disparate data (e.g., event records, positions of moving objects, and time series of measurements), which may come from different sources. To detect relationships between such data, the analyst may set query conditions on the basis of one dataset and investigate the subsets of objects and values in the other datasets that co-occurred in time with these conditions. We describe the desired features of an interactive tool for time mask filtering and present a possible implementation of such a tool. By example of analyzing two real world data collections related to aviation and maritime traffic, we show the way of using time masks in combination with other types of filters and demonstrate the utility of the time mask filtering.

Keywords:
Data Visualization, Interactive Visualization, Interaction Technique

1. Introduction

In interactive exploration of spatiotemporal data, such as data describing spatial events or trajectories of moving objects, it is often necessary to filter the data [Shneiderman, 1996], i.e., select subsets of events, trajectories, or segments of trajectories based on the spatial locations, time references, values of attributes, and/or other conditions [Andrienko et al., 2013a]. There are two common approaches to temporal filtering. First, it can be done by selecting a continuous time interval within the time range of the data. This kind of filter adheres to the linear view of time, in which time is treated as a continuous linearly ordered sequence of time instants. Another possible view of time is cyclic, in which time is considered as repetition of cycles, particularly, diurnal, weekly, and annual (seasonal). Time-related data can be filtered according to the positions of the time references within a time cycle. These two types of filtering can be called linear and cyclic, respectively.

We introduce one more type of temporal filtering, in which time intervals are selected based on satisfaction of query conditions formulated in terms of time-variant attributes. We call this type of filtering time mask as it hides (i.e., removes from the consideration) the time intervals in which the query conditions do not hold. The remaining active (selected) time intervals may thus be separated by temporal gaps. A time mask filter allows an analyst to see when certain conditions are fulfilled and what else happened during those times. Hence, it provides additional opportunities for analysis with regard to the commonly used types of temporal filtering. In particular, it may be very useful in joint analysis of several time-referenced datasets for

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