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Visualizing Hierarchical Time Series with a Focus+Context Approach

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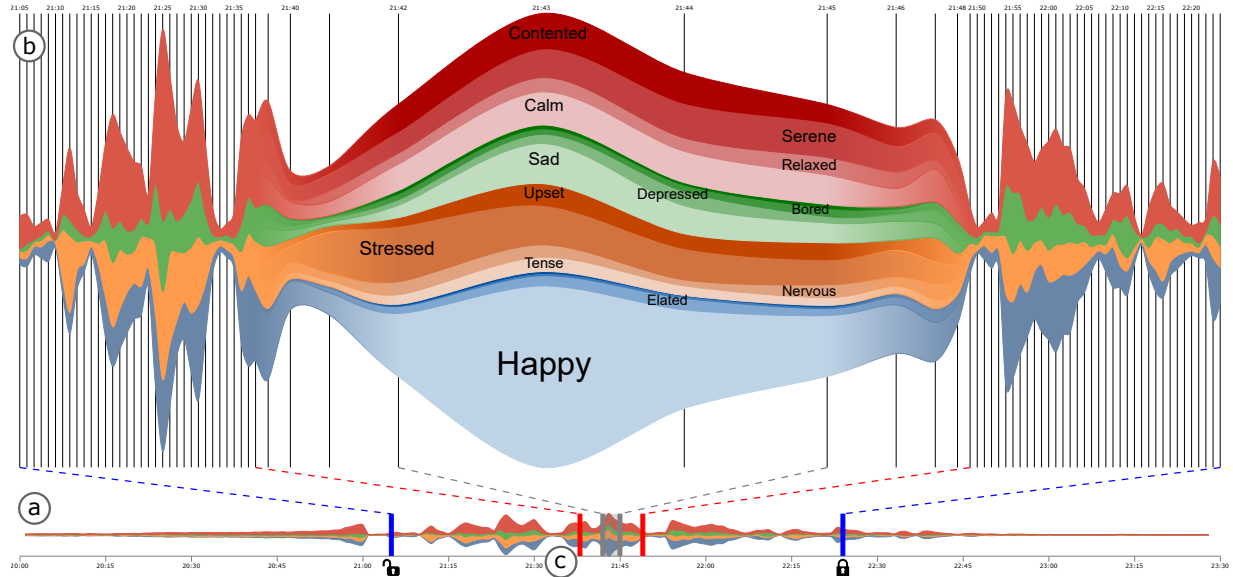


Figure 1: (a) An overview depicts time series in a high level of abstraction. (b) Multiresolution view depicts time series in different levels of abstraction. (c) Controller links the overview and the multiresolution view.

ABSTRACT

Multiple time series are present in many domains such as medicine, finance, and manufacturing for analytical purposes. When dealing with several time series scalability problem overcome. To solve this problem, multiple time series can be organized into a hierarchical structure. In this work, we introduce a Streamgraph-based approach to convey this hierarchical structure. Based on a focus+context technique, our visualization allows time series exploration at different granularities (e.g., from overview to details). A demo is available at <http://advanse.lirmm.fr/hierarchical/>.

Index Terms: Streamgraph, Hierarchical Time Series.

1 INTRODUCTION

A widely followed approach to represent temporal variation in multiple time series is using Streamgraph [1]. However, this visualization suffer from scalability problems when the number of time series increase. To overcome this problem, multiple time series can be aggregated into a hierarchical structure to depict the information in different levels of abstraction. Interaction techniques are used to enhance the effectiveness of a visualization. For instance, distortion techniques [2, 4, 5] extend focus+context approach [3] in order to show details in a magnifying area, and the context in a gradually

smaller area. Our work aims to combine different interaction techniques to expand the advantages of a Streamgraph representation and explore different levels of abstraction in the hierarchical structure of time series.

2 VISUAL MAPPINGS AND INTERACTIVE FUNCTIONALITY

This section describes our visualization as well as the interactivity techniques. We propose a new visual approach to facilitate the analysis of hierarchical time series. It is based on two interactive views: overview and multiresolution view.

2.1 Overview

We adopt a Streamgraph approach to show more readable time series using a river flow metaphor (Fig. 1a). We represent multiple time series as colored layers in a 2D Cartesian coordinates system, where the time dimension is encoded in a discrete scale along the horizontal axis and quantitative dimension is encoded on the vertical axis. Fig. 1a shows a Streamgraph of the entire multiple time series in a high level of abstraction. The highest level represents the top in the hierarchy and the thickness of a layer at this level conveys the sum of time series in the group at each given time step.

2.2 Multiresolution View

The multiresolution view is based on a focus+context approach to show a part of the data in detail. This view depicts time series on different levels of granularity. Our goal is to show the top and the lowest level of the hierarchy in one view. Fig. 2 shows the multiresolution view representing an example of the evolution of musical genres. We defined three types of areas: context-area, detailed-area, and transition-area. The *context-area* (Fig. 2a) is the interval of time where time series are displayed at a high level

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of abstraction. In this case, metal and jazz categories are plotted using two different hues. The *detailed-area* (Fig. 2c) represents the interval of time to display the lowest level of the hierarchy. In this case, the sub-genres of metal and jazz category (e. g., black metal, doom metal, classic jazz, contemporary jazz, and so forth). In the detailed-area, the time series related to a group are colored with the same category family hue but with a different level of saturation. Finally, the *transition-area* (Fig. 2b) represents the time segment dedicated to the transition between these two levels of abstraction. In this area, a color interpolation is applied to preserve the context of this transition.

The time intervals in the multiresolution view are distorted to depict different levels of details over time (see horizontal axis in Fig. 2). This distortion is related to the focus+context approach where details are shown in a magnifying area and the context in a smaller area. Thus, the length of the time steps in the detailed-area (Fig. 2c) are larger than the length of the time steps in the context-area (Fig. 2a) and the transition-area (Fig. 2b).

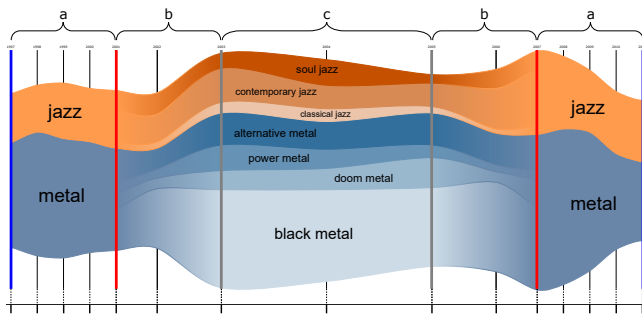


Figure 2: Multiresolution view. (a) context-areas depict the top level of the hierarchy, (c) detailed-area depicts the lowest level of the hierarchy, and (b) transition-areas depict the transition between the context-area to detailed-area, and vice versa.

In order to handle the intervals of time of the detailed-area, context-areas, and transition-areas, we designed a *controller* that allows customizing them according to user requirements.

2.3 Controller

Since multiple time series datasets are often large, filtering out irrelevant data helps users to focus on interesting data. We designed a *controller* to interact with the overview along the horizontal axis (i. e., time dimension) and focusing on interesting data according to users requirements. This movable tool is designed over the overview to handle the intervals of time used by areas in the multiresolution view (i.e., detailed-area, context-areas, and transition-areas).

Fig. 3 shows the design of the controller. Vertical interactive lines control the position and extension of the areas. Context-areas are handled by the blue lines (Fig. 3a). Transition-areas are handled by the red lines (Fig. 3b). Finally, the grey lines handle the detailed-area (Fig. 3c). All of the lines in the controller can be expanded and collapsed interactively at regular intervals of time.

As the lines guide the position of the areas, we manage the interactivity between them. When dragging the mouse over the detailed-area, all other areas dynamically update, keeping their same length. For instance, Fig. 4a shows the detailed-area dragged to the left, and the other areas updated in their new position after moving left. In Fig. 4b the detailed-area is expanded to the right by dragging the right grey vertical line. It updates the length of the adjacent areas (transition and context areas) in the same direction. When a transition-area or a context-area is expanded or collapsed, only the length of that area is updated. Fig. 4c shows a transition-area expanded to the right. Note that all other areas remain static. The position of context-areas can be locked by clicking on the padlock

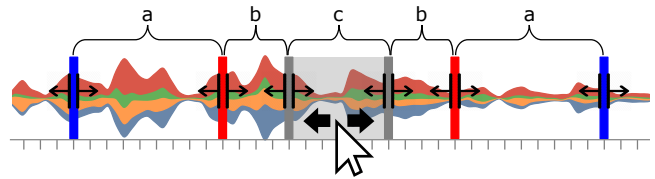


Figure 3: Controller. (a) context-areas, (b) transition-areas, and (c) detailed-area are handled by colored lines that can be expanded and collapsed interactively. Detailed-area remains colored in grey reminding the viewer the focus point.

icon below the context lines. Fig. 4d shows the two context-areas locked, and detailed-area dragged to the right. Notice that when the detailed-area is dragged, the length of transition-areas are updated, but not the length of the context-areas. Dragging any area of the controller updates the multiresolution view. This animation helps the user to conserve a mental map of the views (i. e., overview and multiresolution view).

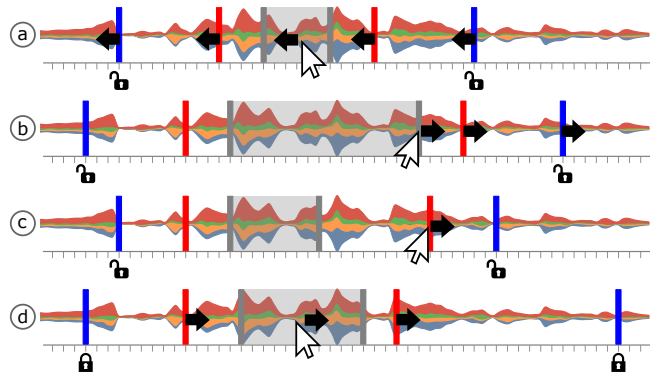


Figure 4: Using the controller. (a) Detailed-area is dragged to the left. (b) Detailed-area is expanded to the right. (c) Right transition-area is expanded to the right. (d) The position of the context-areas are locked by clicking the padlock icon.

3 CONCLUSION

In this work, we presented a new approach for visualizing large, multiple time series. It is based on two interactive views: an overview showing the main trends of a dataset, and a multiresolution view showing details on a subset of the dataset. The approach uses a hierarchical structure on the series to display different granularities on the multiresolution view. Following the Shneiderman mantra “overview first, zoom and filter, then details on demand”, the flexible interactive feature covers a wide range of possibilities, from overview + detail to classical fisheye. A demo video of our work is available at: <https://youtu.be/xxTSJR90pQA>.

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