Towards Combining Attribute-based and Time Series-based Visual Querying

David Sessler[1], Martin Spott[2], Detlef Nauck[3], William Harmer[3], Jörn Kohlhammer[1] and Jürgen Bernard[4]

[1]Fraunhofer IGD, Germany, [2]HTW Berlin, Germany, [3]BT, United Kingdom, [4]TU Darmstadt, Germany

Motivation

Complex data often comprise multivariate and time series data. Our targeted users, analysts of British Telecommunications (BT) want to gain access to this type of multi-modal data in an effective way.

In this work, we present a concept for the visual-interactive definition of meaningful subsets in data sets combining multivariate attributes and time series data.

Approach

Based on a generalization of requirements, we propose a three-stage approach, combining visual-interactive querying, query filter analysis, and result exploration.

Visual-Interactive Querying
We combine the faceted search concept with bar-chart visualizations for selecting multivariate attributes [1]. Inspired by the VisInfo digital library system, we apply querying time series patterns by example on the basis of the Self-Organising-Mapalgorithm [2].

Query Filter Analysis
The combination of queries refers to as the intersection of subsets of a data set. Inspired by set visualizations [3], we propose a visual interface based on a contingency table for the analysis of query filters.

Result Exploration
We propose a similarity-preserving layout for the visualization of query results. The interface addresses both scalability for large result sets and highlighting of interesting data characteristics. We apply visual data aggregation (clustering) represent frequent patterns. In addition, a similarity-preserving layout enables the visualization of outliers in combination with the clusters [4].

Future Work

The next step of this design study is the iterative design of the proposed concept together with the targeted user group.

A long-term goal is the generalization of the approach and the adaptation to other application domains.

References

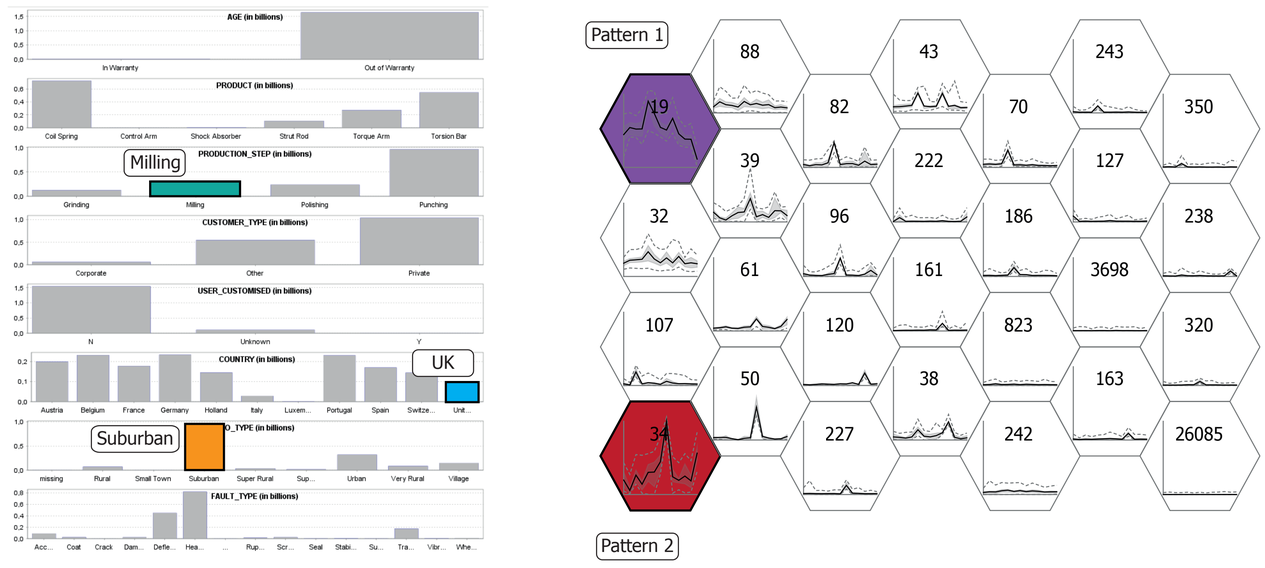
[1] BERNARD J., SPOTT M., STEIGER M., SESSLER D., KOHLHAMMER J.: Visual-Interactive Exploration of Relations Between Time-Oriented Data and Multivariate Data . In EuroVis Workshop on Visual Analytics (EuroVA) (2016)

[2] BERNARD J., DABERKOW D., FELLNER D., FISCHER K., KOEPLER O., KOHLHAMMER J., RUNNWERTH M., RUPPERT T., SCHRECK T., SENS I.: VisInfo: a digital library system for time series research data based on exploratory search - a user-centered design approach. International Journal on Digital Libraries 16, 1 (2015), 37–59.

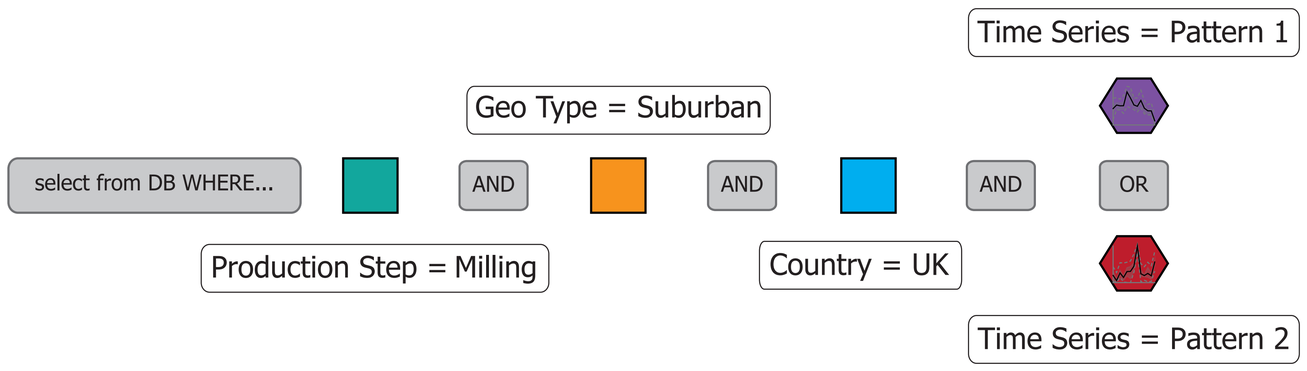
[3] ALSALLAKH B., MICALLEF L., AIGNER W., HAUSER H., MIKSCH S., RODGERS P.: Visualizing Sets and Set-typed Data: Stateof-the-Art and Future Challenges. In EuroVis - STARs (2014)

[4] STEIGER M., BERNARD J., MITTELSTÄDT S., LÜCKETIEKE H., KEIM D., MAY T., KOHLHAMMER J.: Visual analysis of time-series similarities for anomaly detection in sensor networks. Comput. Graph. Forum 33, 3 (June 2014), 401–410.

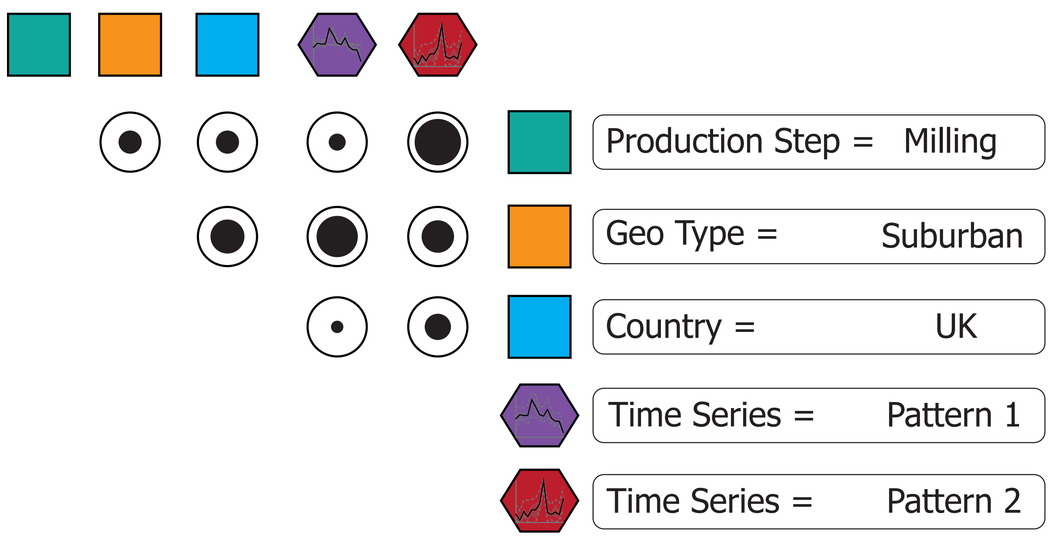
Visual-Interactive Querying



Interfaces combining faceted search in multivariate attributes with query-by-example support in time series data. The two visual interfaces at the top are the result of a recent design study [1], here applied to visual-interactive querying. The interface at the bottom illustrates the visual representation of a query, enabling the adjustment of query concatenations (AND and OR operations).

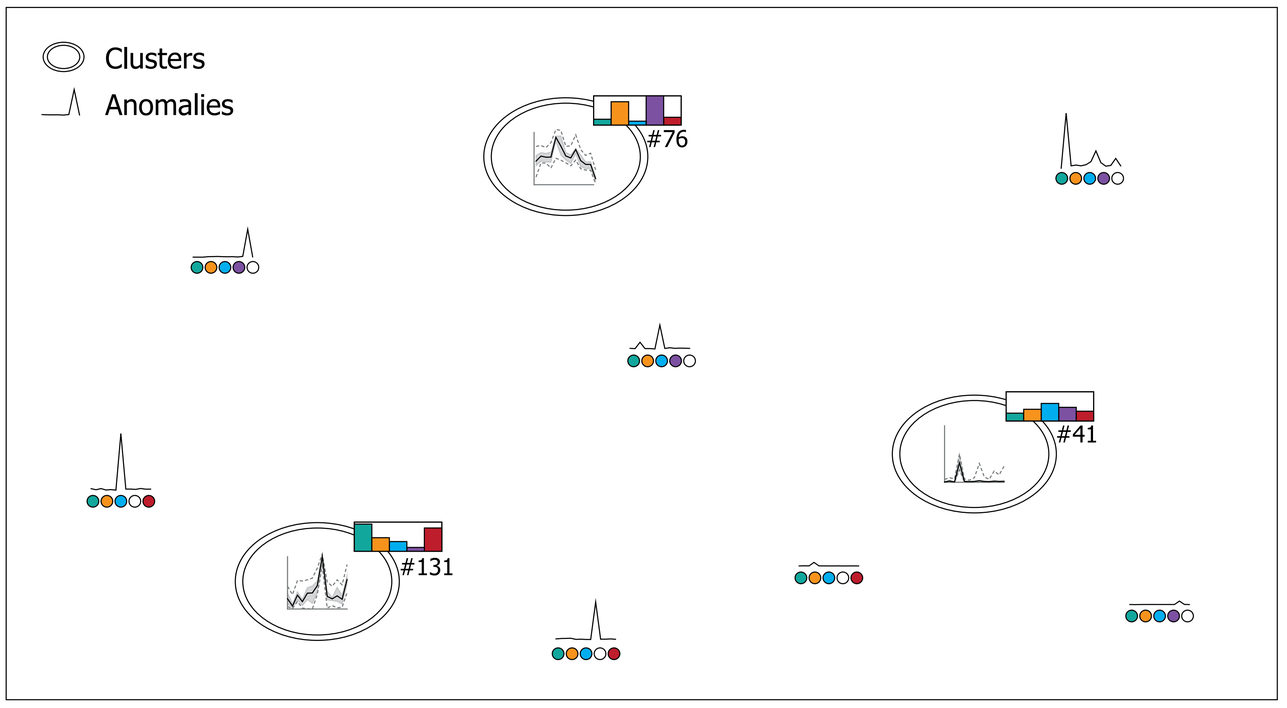


Query Filter Analysis



Visual Interface revealing intersections between pairs subsets defined by different queries. Individual queries can be based on both attribute filters and time series patterns.

Result Exploration



Similarity-preserving layout of retrieved subsets. A clustering algorithm reveals frequently occurring time series patterns, outlier patterns are visualized separately.