Visual Comparison of Multivariate Data Ensembles

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Motivation

Today's advancements in industry are largely driven by the improvement of materials. To ensure qualitiy-critical propreties of materials and components, material experts need to inspect their inner structure, consisting of features such as fibers or pores, and their attributes, e.g., length, volume etc. The main goal in the analysis of these materials is to investigate the properties of various specimens. Therefore, comparing the inner structure according to these features is of greatest importance. At the moment the use of juxtaposed visualizations such as simple 3D renderings or basic charts, e.g., scatterplots, are common practice. This work aims to support domain experts in their daily tasks of analyzing large ensembles of material data.

Contribution & Research Questions

We propose an interactive framework for material scientists that provides a comparative visualization of multidimensional material data through the development and implementation of an overview visualization technique and three visual metaphors for detailed visualizations. The design of our framework is based on following research questions:
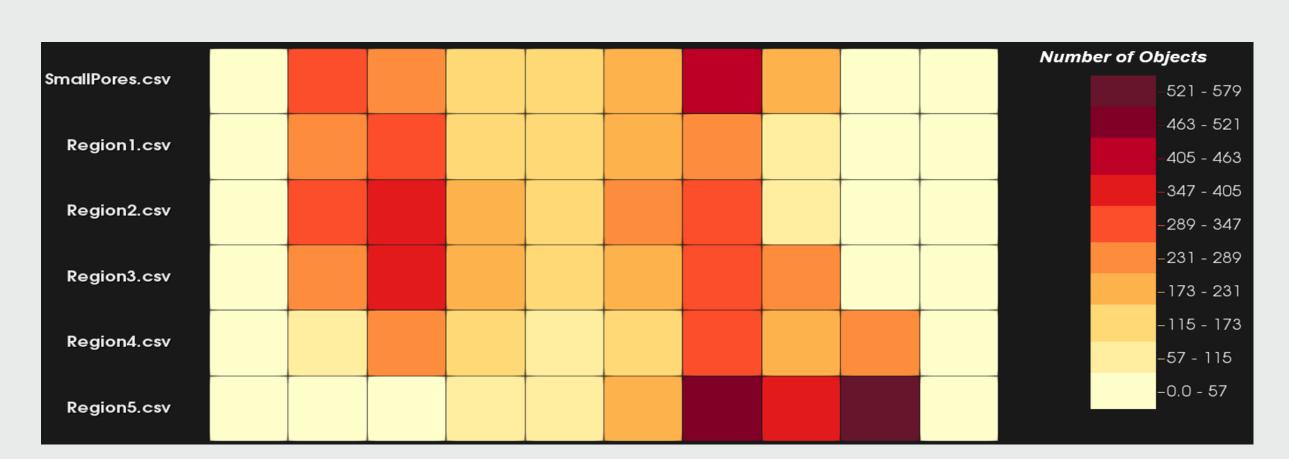
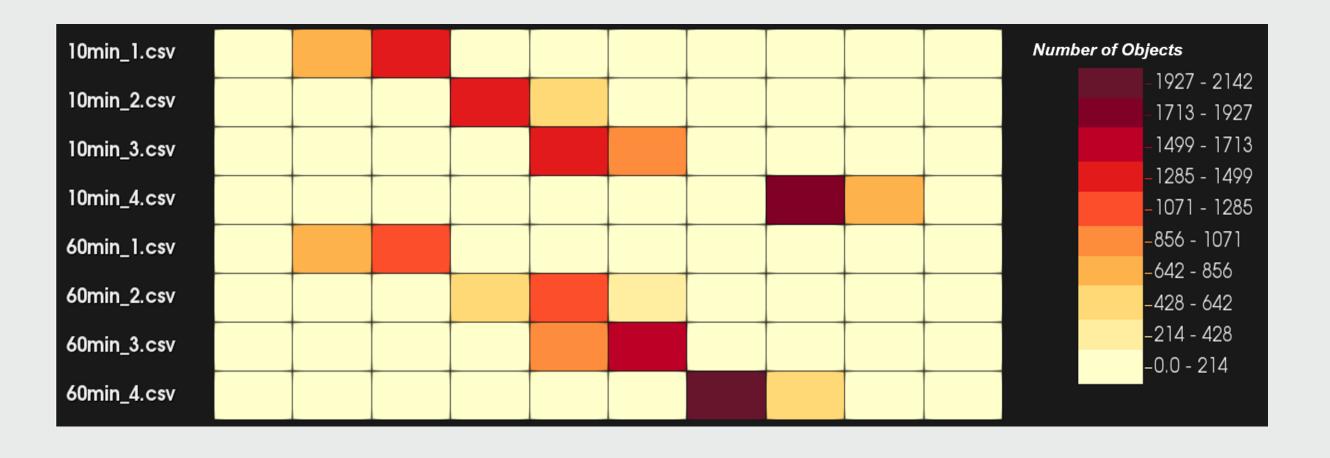Which datasets are similar/different?

In which attributes are the datasets similar/different?

Is there a correlation between certain attributes?

Approach

From nD to 1D through Multidimensional Scaling

Overview Visualization

Histogram-Table

The **histogram-table** provides an overview of the similarity of the different datasets. Through multidimensional scaling (MDS) each object is projected to a position on its respective number line. To avoid visual clutter, the number lines are binned and the bins are colored according to the number of objects they contain. The closer the bins are positioned to each other, the more similar they are. The more distant they are from each other, the more dissimilar they are.

The **correlation map** reveals the linear correlation between the attributes. The vertices represent the attributes. Attributes with a high correlation are drawn closer together. The color of the edges represents the type of correlation.

The **bar chart** shows the attributes according to their similarity. The similarity of the values inside one attribute are calculated using the coefficient of variation.

Correlation Map

Bar Chart

Box Plot

The **box plot** displays the distribution of the attributes' values.

Detailed Visualizations

Results

We present the usability of our framework by means of three different usage scenarios. In the first scenario two different material specimens are compared based on their pore properties (left). The second scenario describes a fiber material on which a force has been applied for 10 and 60 minutes (right). To test the applicability of our framework we conducted a qualitative user study with 12 material experts.