Interactive Poster: Exploring OLAP Aggregates with Hierarchical Visualization Techniques

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Abstract

Analysts interact with data cubes in a predominantly "drill-down" fashion, i.e. from coarse grained aggregates towards the desired level of detail. Hierarchical visualization techniques offer an adequate structure for mapping the logic of the exploration due to preserving the overview of the entire interaction and providing the details of every drill-down step. We present a novel user interface for exploring complex multidimensional data in an OLAP (online analytical processing) environment. Users navigate in dimensional hierarchies via a schema-based data browser. Query results are presented in form of *enhanced decomposition trees*. We propose multiple tree layouts and embedded visualization techniques optimized to satisfy various criteria.

Keywords: hierarchical visualization, OLAP, explorative interface.

Index Terms: E.1 [Data]: Data Structures—; H.5.2 [Information Interfaces and Presentation]: User Interfaces—Graphical user interfaces (GUI)

1 Introduction

OLAP systems employ the multidimensional data model to structure "raw" data into cubes in which analytical values, referred to as *measures*, are uniquely determined by descriptive values drawn from a set of *dimensions*. The desired view of the data for further analysis and exploration is retrieved via a visual interface. Typically, users proceed from a high level overview towards finer granularity via stepwise decomposition of aggregates along dimensions of interest. Insights obtained at one stage of exploration often influence the subsequent interaction.

Hierarchical visualization techniques are an adequate form of presenting the results of iterative decomposition due to preserving the overview of the entire interaction and providing the details of every drill-down step. A *decomposition tree* is obtained by placing an aggregate value in the root node and recursively splitting the values along selected dimensions to show the constituent sub-aggregates as the aggregate's child nodes.

ProClarity was the first to incorporate a *Decomposition Tree* [3] visualization into an OLAP interface. An OLAP web client Report Portal 2.1 [4], recently released by XMLA Consulting, enhances visual decomposition by introducing BarChart Tree and PieChart Tree. Rather than displaying plain numbers in the nodes, these techniques arrange the child sub-aggregates of a value into a chart, as illustrated in Figure1 (top). The existing decomposition techniques expand a single value per interaction, have rather poorly formatted results and are wasteful in terms of display utilization.

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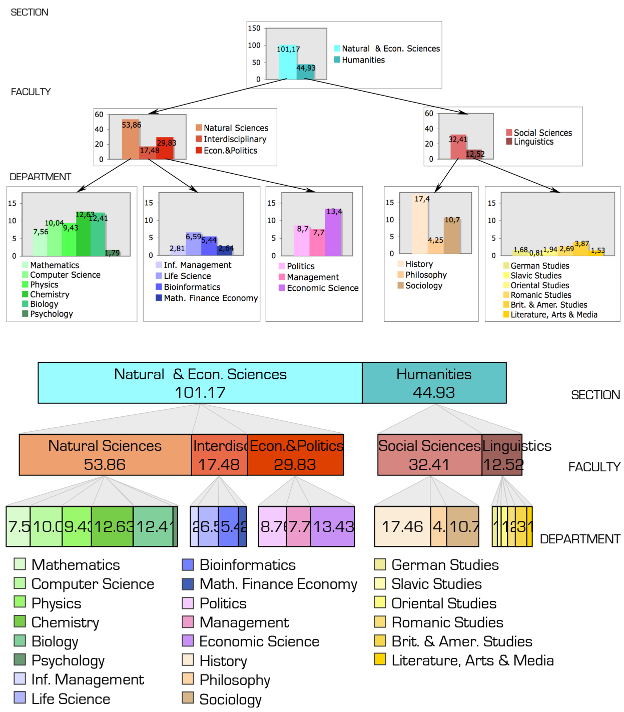
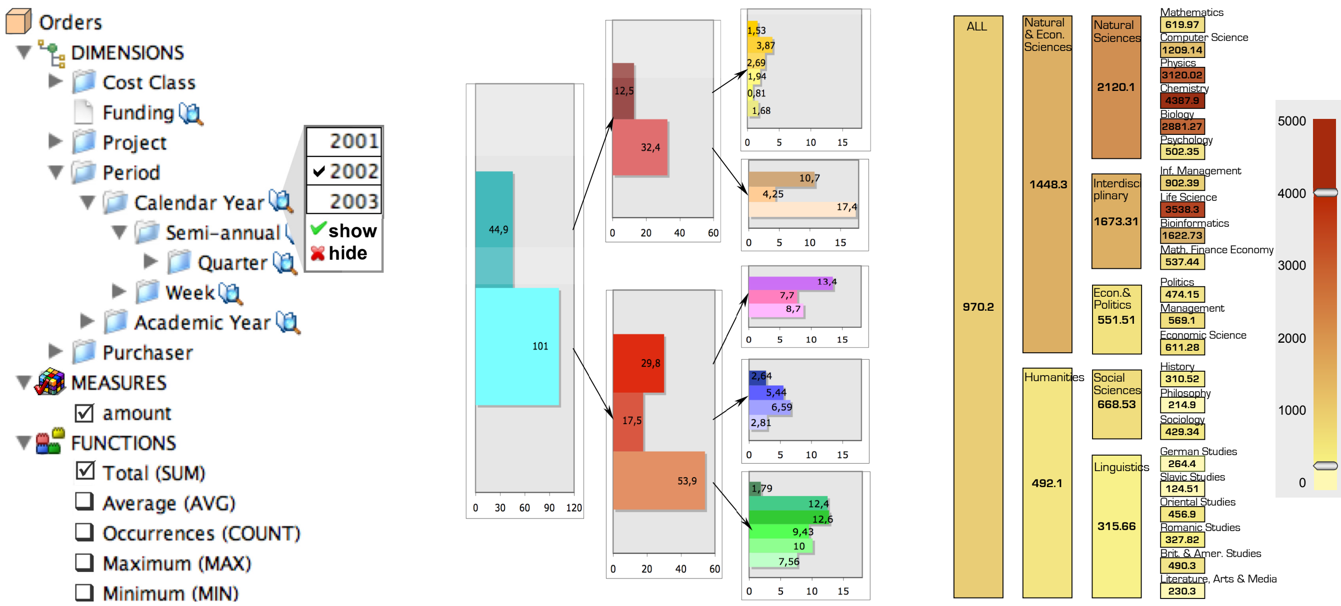


Figure 1: Hierarchical decomposition techniques allow analysts to interactively "drill down" in OLAP data and explore the aggregates at various granularity levels. Both visualizations show the university's expenditures disaggregated along *section*, *faculty*, and *department*. Top: A *bar-chart tree* with uniform scaling within each level is especially helpful for visually comparing the values of the same granularity. Bottom: *Space-filling bar-chart tree* is more compact; aggregates are mapped to bars of equal height providing correct visual comparison of values throughout the entire hierarchy.

In a previous work [6] we described a framework for generating user-defined visual hierarchies from OLAP cubes using schema-based navigation. An approach to navigating in complex and irregular dimensional hierarchies is provided in [2].

2 Hierarchical Decomposition

Our contribution is twofold: 1) we have designed a framework for efficient and intuitive exploration of OLAP data using visual hierarchical decomposition, and 2) we propose multiple visualization techniques and interaction features optimized along various criteria (e.g., visual scalability, interpretability, outlier recognition). Special effort was put into simplifying the process of generating a user-defined hierarchy by properly interfacing the data via an enhanced OLAP browser. Data cube's schema is used for specifying the decomposition axes while dimensional data is accessed for filtering the subset to display.



(a) Schema-based navigation hierarchy (b) Area-preserving bar-chart tree (c) Multiscale HeatMap with average values

Figure 2: Data browser for querying OLAP cubes and visualization of query results as core elements of the explorative framework

The query is specified interactively by selecting a measure to aggregate upon and an aggregation function to apply, by choosing the dimensions to "drill down" and the values to set as filters. We pursue a schema-based navigation metaphor by representing an OLAP cube as a container of dimensions and measures, with each hierarchical dimension as a recursive nesting of its granularities in ascending order of detail. Figure 2(a) shows the navigational tree of a cube with an expanded dimensional hierarchy of Period and on-demand data display for level Calendar Year. Having selected the measure and the aggregate function, the user simply drags any dimension folder into the visualization area to render a new level in the decomposition tree.

Since standard visualization metaphors are poorly scalable on large data sets, we experimented with more compact layouts for both the trees and the nodes. Usefulness of any particular technique depends on various factors, such as user's preference, available display area, chosen aggregate function, data volume etc.

Classical bar-chart tree from Figure1 (left) uses aesthetic tree layout and applies the same direction to the chart bars (e.g., vertical bars in a vertical tree). In such trees, all nodes are nicely aligned for visual comparability along the sibling as well as along the ancestor axis. However, different scaling at each level, unavoidable for saving display area, may be misleading for interpreting the visualization. A possible solution are "area-aware" bars, as demonstrated in Figure 2(b): the area of any value's bar equals the total area of the bars of its child subtotals. Therefore, all values throughout the tree are comparable via the area of their bars.

Figure 2(c) demonstrates a hierarchical HeatMap for decomposing the measure's average value. The bottom-level nodes are represented as cells in an array; higher level nodes are shaped as rectangles spanning the width of of their subtrees, similarly to the multiscale matrix pattern for pivot table visualization presented in [5]. A linear colormap (from light yellow to dark red) with gradually increasing color intensity helps to see the overall behavior of the average and to immediate identify outliers. Sliders at the poles of the scale can be used to dynamically adjust the value range of the colormap. We also experimented with radial tree and chart layouts and found interesting scenarios for their application.

3 Conclusion

Our proposed visual framework empowers analysts to explore OLAP aggregates along arbitrary dimensional paths using hierarchical visualization techniques. Decomposition trees are generated with a few mouse clicks and support "speed-of-thought" analysis by revealing a multiscale view of the data. By implementing various hierarchical layouts, visual metaphors, and interaction options we account for a variety of tasks, data patterns and user preferences. We plan to further improve the scalability of hierarchical decomposition by applying pixel based techniques such as proposed in [1].

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