SCALABLE INTERACTIVE VISUALIZATION OF HIERARCHICAL KNOWLEDGE REPOSITORIES

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SYNOPSIS

Spatial tesselations based on Voronoi diagrams have been extensively used in Information Visualization and Visual Analytics to represent hierarchical knowledge repositories. This paper introduces a visualization framework which combines Voronoi diagrams and level of detail techniques to address precision, performance and usability issues identified in existing systems. The framework facilitates the interactive visualization of very large repositories organized into a hierarchy of unlimited depth using two or three visual dimensions.

INTRODUCTION

The visualization of large, hierarchically structured document repositories has been a recognized challenge in the fields of Information Visualization and Visual Analytics for the last two decades. A common approach to this challenge is the use of tree map algorithms (e.g. Bederson et al., 2002). A tree map displays hierarchical data as a set of nested rectangles and assigns leaf rectangles an area proportional to specified properties of the underlying data. Voronoi tree maps (e.g. Balzer et al., 2005) extend this concept by displaying a set of nested polygons constructed using voronoi subdivision with varying distance functions.

The InfoSky visual explorer (Granitzer et al., 2004) is an exemplary repository visualization system based on Voronoi tree maps. Analogous to a real-world telescope, InfoSky employs a planar graphical representation with variable magnification. Documents of similar content are placed close to each other and displayed as stars Collections of documents at a particular level in the hierarchy are visualised as polygonal areas (compare Fig.1). Technical analysis has identified performance problems for very large repositories and precision issues for deep hierarchies. User studies have found that the representation of individual documents is not beneficial for many application scenarios. This paper introduces a visualization framework specifically designed to address these issues.

RESULTS

The performance and precision issues present in the InfoSky system have been addressed by executing all geometrical operations (i.e. inscription, subdivision) in a local space assigned to each collection in the hierarchy. Collection visibility is computed at runtime by using a viewport, which is specified in coordinates of arbitrary precision, to query hierarchical spatial data structures forming an index of all available collections. A level-of-detail algorithm eliminates collections which do not contribute to the visual representation for a given viewport magnification. These methods have obviated identified precision issues and enable the interactive visualizations of hierarchies of unlimited depth.

The usability issues present in the InfoSky system have been addressed by introducing a level-of-detail algorithm which combines relevant properties of documents coinciding for a

given viewport magnification. The local space assigned to a collection is subdivided into cells using a fixed size grid and each grid cell is assigned a visual representation of all documents coinciding in its area. At runtime, the grid cells of visible collections are merged to create a uniform visualization, similar to the MIP map approach (Williams, 1983). The type of visual used to represent each cell can be adapted to match arbitrary application scenarios. For example, the star metaphor used in InfoSky displayed multiple coinciding documents as "brighter stars", effectively encoding document density as brightness.

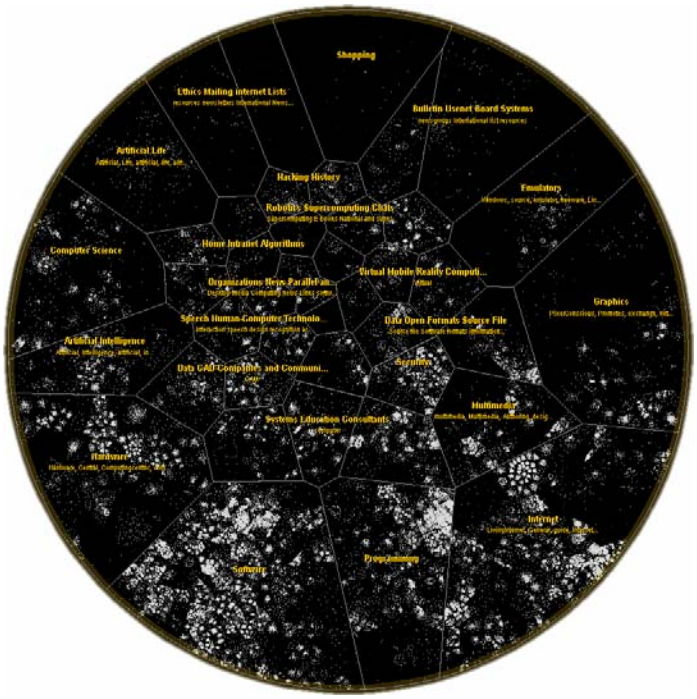

Fig. 1 The InfoSky Visual Explorer displaying a large document repository using a nightsky metaphor which reflects inter-document similarity and collection structure.

CONCLUSIONS

We have presented a visualization framework for hierarchical knowledge repositories which eliminates several issues identified in existing systems and enables the interactive visualization of unlimited depth hierarchies. In the light of the continuing exponential growth of available information, we envision plenty of applications for such a framework.

REFERENCES

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