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petra.isenberg@inria.fr



A BRIEF HISTORY OF IEEE VIS

1990



IEEE CONFERENCE ON VISUALIZATION (VIS)

1991

1992

1993

1994

1995

Proceedings

Information Visualization

Edited by

Nahum Gershon

Steve Eick

(published as part of the IEEE Visualization proceedings)

1996

Proceedings

IEEE Symposium on Information Visualization'96

October 28 — 29, 1996
San Francisco, California

Sponsored by

IEEE Computer Society Technical Committee on Computer Graphics

Edited by

Stuart Card

Stephen G. Eick

Nahum Gershon

1997

1998

1999

2000

2001

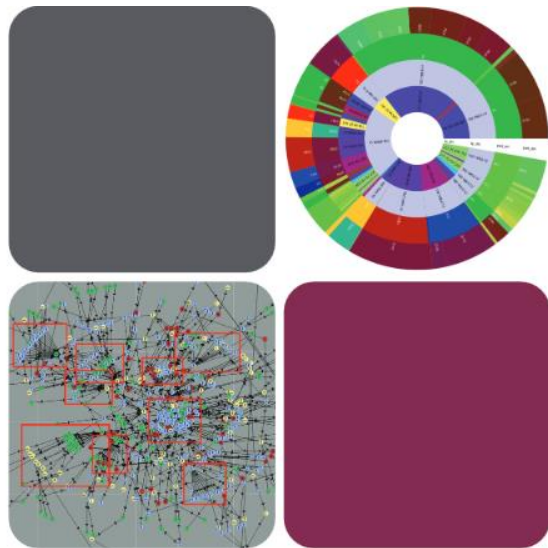
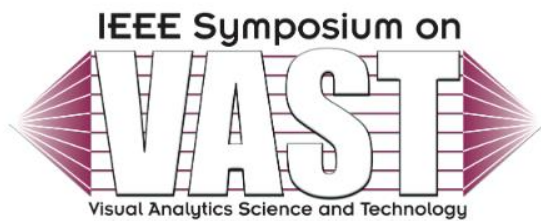
2002

2003

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2006



IEEE Symposium on VAST 2006

IEEE TRANSACTIONS ON VISUALIZATION AND COMPUTER GRAPHICS

A publication of the IEEE Computer Society

SEPTEMBER/OCTOBER 2006 VOLUME 12 NUMBER 5 ITVGEA (ISSN 1077-2626)

VAST
2006

PROCEEDINGS

Edited by
Eduard Gröller
Alex Pang
Claudio T. Silva
John Stasko
Jarke van Wijk

BALTIMORE • MARYLAND • USA
October 29 - November 3, 2006

INFOVIS
2006

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60th anniversary



IEEE Symposium on VAST 2006

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IEEE INFORMATION VISUALIZATION CONFERENCE

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2008



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OCTOBER

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>> Week-at-a-Glance

>> VisWeek Sessions

>> Exhibition

>> Registration

>> Student Volunteers

>> Call for Participation

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VisWeek 2008 is the premier forum for data visualization in academia, government, and industry. This event, with a shared interest in tools, techniques, and applications, will include an exciting and informative collection of presentations, demonstrations, posters, and exhibitions. We are pleased to host the **Visualization Conference (IEEE Vis)**, the **IEEE Symposium on Information Visualization (IEEE InfoVis)** and the **IEEE Symposium on Visual Analytics Science and Technology (IEEE VAST)**.

2009

2010



IEEE **Conference** on Visual Analytics Science
and Technology 2010

Salt Lake City, Utah, USA

24 - 29 October, 2010

2011

2012

IEEE Transactions on Visualization and Computer Graphics

IEEE SCIENTIFIC VISUALIZATION CONFERENCE,

IEEE INFORMATION VISUALIZATION CONFERENCE, AND

IEEE VISUAL ANALYTICS SCIENCE & TECHNOLOGY CONFERENCE

PROCEEDINGS 2012

SOME BUT NOT ALL VAST PAPERS

Seattle, Washington, USA

14 - 19 October 2012

2013

ALL PAPERS

*IEEE Transactions on Visualization and
Computer Graphics*

IEEE VISUAL ANALYTICS SCIENCE & TECHNOLOGY CONFERENCE,
IEEE INFORMATION VISUALIZATION CONFERENCE, AND
IEEE SCIENTIFIC VISUALIZATION CONFERENCE,
PROCEEDINGS 2013

Atlanta, Georgia, USA
13 - 18 October 2013



2014

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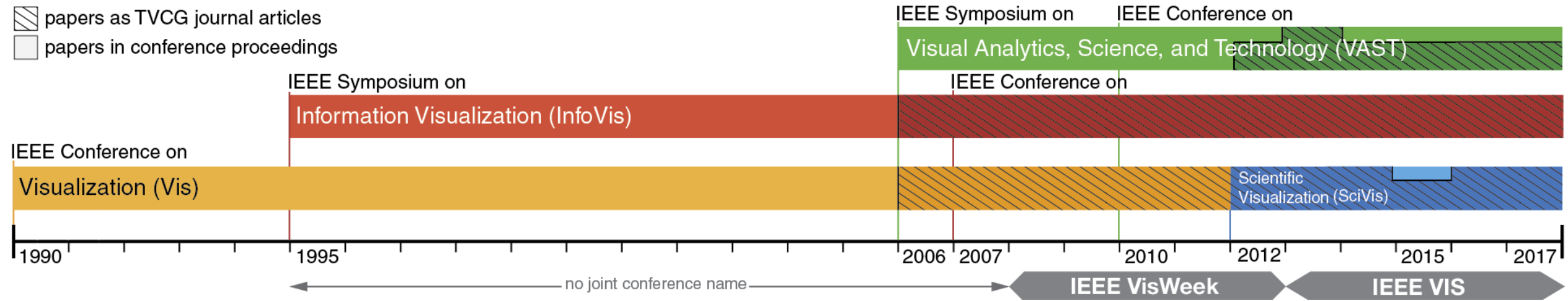
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- 2011 2011 IEEE Conference on Visual Analytics Science and Technology (VAST)
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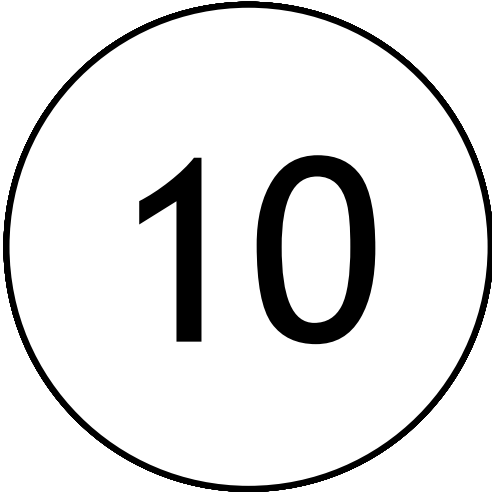
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- Daniel Weiskopf (3)
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Vis	1990	Surface representations of two- and three-dimensional fluid	10.1109/VISUAL.1990.146359	http://dx.doi.org/10.1109/VISUAL.1990.146359	6	13, 460	C	The use of critical po	James Helman; Lambertus Hessel	Stanford Univ., CA, USA c ;
Vis	1990	FAST: a multi-processed environment for visualization of co	10.1109/VISUAL.1990.146360	http://dx.doi.org/10.1109/VISUAL.1990.146360	14	27, 461	C	The authors discuss	Gordon V. Bancroft; Fergus Merrit	Sterling Federal Syst. Inc., Palo Alto, CA, USA c ; ; ; ;
Vis	1990	The VIS-5D system for easy interactive visualization	10.1109/VISUAL.1990.146361	http://dx.doi.org/10.1109/VISUAL.1990.146361	28	35, 462	C	The VIS-5D system	William L. Hibbard; David A. Sante	Space Sci. & Eng. Center, Wisconsin Univ., Madison, WI, USA c ;
Vis	1990	A procedural interface for volume rendering	10.1109/VISUAL.1990.146362	http://dx.doi.org/10.1109/VISUAL.1990.146362	36	44, 462	C	The author presents	James L. Montine	Alliant Comput. Syst., Littleton, MA, USA c
Vis	1990	Techniques for the interactive visualization of volumetric da	10.1109/VISUAL.1990.146363	http://dx.doi.org/10.1109/VISUAL.1990.146363	45	50, 462	C	Some ideas and tech	Gregory M. Nielson; Bernd Hamar	Dept. of Comput. Sci., 10.1109/VISUAL.1990.146388
Vis	1990	Displaying voxel-based objects according to their qualitativ	10.1109/VISUAL.1990.146364	http://dx.doi.org/10.1109/VISUAL.1990.146364	51	58, 463	C	The use of qualitative	Yaser Yacoob	Dept. of Comput. Sci., Maryland Univ., College Park, MD, USA c
Vis	1990	Interpreting a 3D object from a rough 2D line drawing	10.1109/VISUAL.1990.146365	http://dx.doi.org/10.1109/VISUAL.1990.146365	59	66	C	Visualizing the third	Del Lamb; Amit Bandopadhyay	Dept. of Comput. Sci., State Univ. of New York, Stony Brook, NY, USA c ;
Vis	1990	Animation techniques for chain-coded objects	10.1109/VISUAL.1990.146366	http://dx.doi.org/10.1109/VISUAL.1990.146366	67	73	C	The animation of two	Anthony J. Maeder	Dept. of Comput. Sci., Monash Univ., Clayton, Vic., Australia c
Vis	1990	Extracting geometric models through constraint minimizati	10.1109/VISUAL.1990.146367	http://dx.doi.org/10.1109/VISUAL.1990.146367	74	82, 464	C	The authors propose	James V. Miller; David E. Breen; Mi	Rensselaer Design. Res. Center, Rensselaer Polytech Inst., Troy, NY, USA c ;
Vis	1990	Wide-band relativistic Doppler effect visualization	10.1109/VISUAL.1990.146368	http://dx.doi.org/10.1109/VISUAL.1990.146368	83	92, 465	C	The authors present	Ping-Kang Hsiung; Robert H. Thiba	Carnegie Mellon Univ., Pittsburgh, PA, USA c ; ; ; ;
Vis	1990	Dynamic graphics for network visualization	10.1109/VISUAL.1990.146369	http://dx.doi.org/10.1109/VISUAL.1990.146369	93	96, 467	C	The authors describe	Richard A. Becker; Stephen G. Eick	AT&T Bell Lab., Murray Hill, NJ, USA c ; ; ;
Vis	1990	Techniques for visualizing Fermat's last theorem: a c	10.1109/VISUAL.1990.146370	http://dx.doi.org/10.1109/VISUAL.1990.146370	97	106, 46	C	The authors describe	Andrew J. Hanson; Pheng-Ann Hei	Indiana Univ., Bloomington, IN, USA c ;
Vis	1990	Visualizing computer memory architectures	10.1109/VISUAL.1990.146371	http://dx.doi.org/10.1109/VISUAL.1990.146371	107	113	C	The authors describe	Bowen Alpern; Larry Carter; Ted Se	IBM Thomas J. Watson Res. Center, Yorktown Heights, NY, USA c ;
Vis	1990	A methodology for scientific data visualisation: choosing re	10.1109/VISUAL.1990.146372	http://dx.doi.org/10.1109/VISUAL.1990.146372	114	123	C	A methodology for gu	Philip K. Robertson	CSIRO, Canberra, ACT, Australia c
Vis	1990	Moving iconic objects in scientific visualization	10.1109/VISUAL.1990.146373	http://dx.doi.org/10.1109/VISUAL.1990.146373	124	130, 46	C	The idea of independ	G. David Kerlick	Tektronix Labs., Beaverton, OR, USA c
Vis	1990	Classifying visual knowledge representations: a foundation	10.1109/VISUAL.1990.146374	http://dx.doi.org/10.1109/VISUAL.1990.146374	131	138	C	An exploratory effort	Gerald L. Lohse; Henry H. Rueter;	Cognitive Sci. & Machine Intelligence Lab., Michigan Univ., Ann Arbor, MI, USA c ; ; ;
Vis	1990	A problem-oriented classification of visualization technique	10.1109/VISUAL.1990.146375	http://dx.doi.org/10.1109/VISUAL.1990.146375	139	143, 46	C	Progress in scientific	Stephen Wehrend; Clayton Lewis	Colorado Univ., Boulder, CO, USA c ;
Vis	1990	Visualization and three-dimensional image processing of p	10.1109/VISUAL.1990.146376	http://dx.doi.org/10.1109/VISUAL.1990.146376	144	149, 46	C	The author applied in	Nahum D. Gershon	MITRE Corp., McLean, VA, USA c
Vis	1990	Applying space subdivision techniques to volume rendering	10.1109/VISUAL.1990.146377	http://dx.doi.org/10.1109/VISUAL.1990.146377	150	159, 47	C	We present a new ra	Kalpathi R. Subramanian; Donald S	
Vis	1990	Volume visualization in cell biology	10.1109/VISUAL.1990.146378	http://dx.doi.org/10.1109/VISUAL.1990.146378	160	168, 47	C	The authors discuss	Arie E. Kaufman; Roni Yagel; Reuve	Dept. of Comput. Sci., State Univ. of New York, Stony Brook, NY, USA c ; ; ;
Vis	1990	Hierarchical triangulation using terrain features	10.1109/VISUAL.1990.146379	http://dx.doi.org/10.1109/VISUAL.1990.146379	168	175	C	A hierarchical triang	Lori L. Scarlatos; Theodosios Pavli	Grumman Data Syst., Woodbury, NY, USA c ;
Vis	1990	Rendering and managing spherical data with sphere quadtr	10.1109/VISUAL.1990.146380	http://dx.doi.org/10.1109/VISUAL.1990.146380	176	186	C	The sphere quadtree	Gyorgy Fekete	NASA, Goddard Space Flight Center, Greenbelt, MD c
Vis	1990	Methods for surface interrogation	10.1109/VISUAL.1990.146381	http://dx.doi.org/10.1109/VISUAL.1990.146381	187	193, 47	C	The authors discuss	Hans Hagen; Thomas Schreiber; Er	Kaiserslautern Univ., Germany c ; ;
Vis	1990	A three-dimensional/steroscopic display and model contr	10.1109/VISUAL.1990.146382	http://dx.doi.org/10.1109/VISUAL.1990.146382	194	201, 47	C	A forecasting system	Chieh-Cheng Yen; Keith W. Bedford	Dept. of Civil Eng., Ohio State Univ., OH, USA c ; ; ;
Vis	1990	Spline-based color sequences for univariate, bivariate and	10.1109/VISUAL.1990.146383	http://dx.doi.org/10.1109/VISUAL.1990.146383	202	208, 47	C	Alternative models th	Binh Pham	Dept. of Comput. Sci., Monash Univ., Melbourne, Vic., Australia c
Vis	1990	Interactive visualization of quaternion Julia sets	10.1109/VISUAL.1990.146384	http://dx.doi.org/10.1109/VISUAL.1990.146384	209	218, 47	C	The first half of a two	John C. Hart; Louis H. Kauffman; D	Electron. Visualization Lab., Illinois Univ., Chicago, IL, USA c ; ;
Vis	1990	A journey into the fourth dimension	10.1109/VISUAL.1990.146385	http://dx.doi.org/10.1109/VISUAL.1990.146385	219	229, 47	C	It is shown that by a	Yan Ke; E. S. Panduranga	Dept. of Comput. Sci., Saskatchewan Univ., Saskatoon, Sask., Canada c ;
Vis	1990	Exploring N-dimensional databases	10.1109/VISUAL.1990.146386	http://dx.doi.org/10.1109/VISUAL.1990.146386	230	237	C	The ability of researc	Jeffrey LeBlanc; Matthew O. Ward	Worcester Polytech. Inst., MA, USA c ;

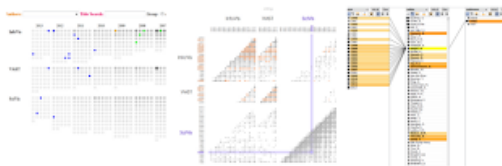
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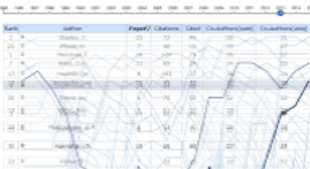
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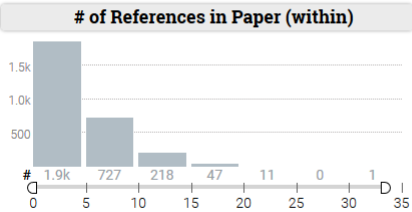
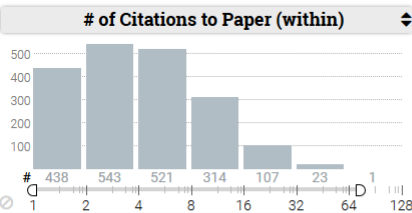
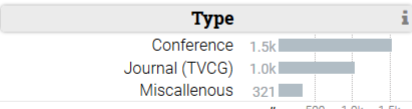
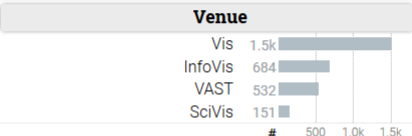
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2008 ²¹



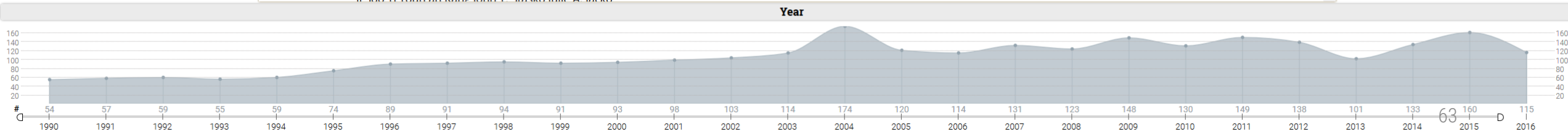
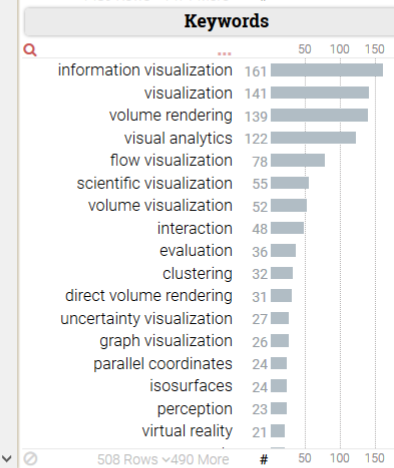
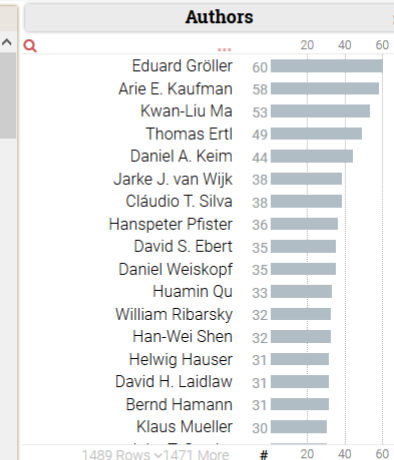
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63	Tree-maps: a space-filling approach to the visualization of hierarchical information structures	Conference Vis	Tue Jan 01 1991 01:00:00 GMT+0100 (W. Europe Daylight Time)	Brian Johnson, Ben Shneiderman
56	Jigsaw: Supporting Investigative Analysis through Interactive Visualization	Conference VAST	Mon Jan 01 2007 01:00:00 GMT+0100 (W. Europe Daylight Time)	John T. Stasko, Carsten Görg, Zhicheng Liu, Kanupriya Singhal
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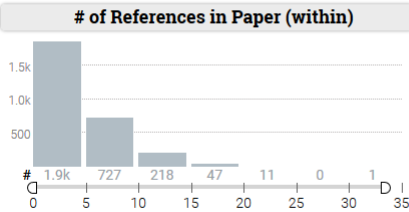
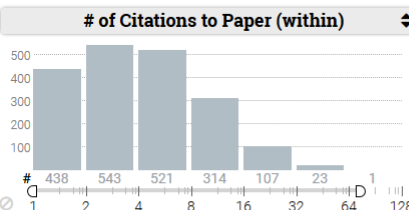
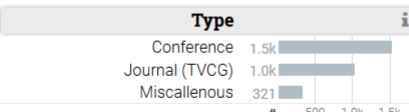
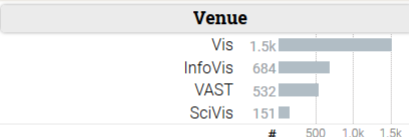




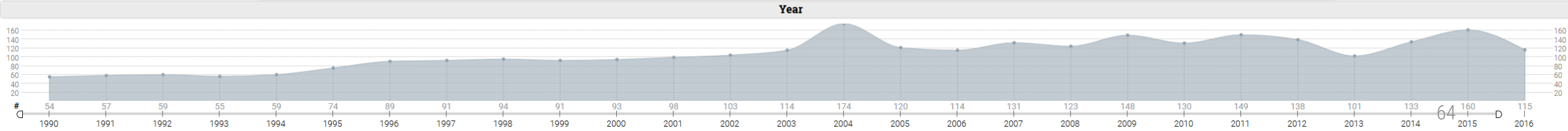
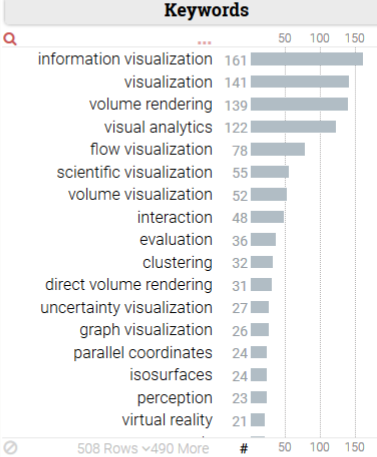
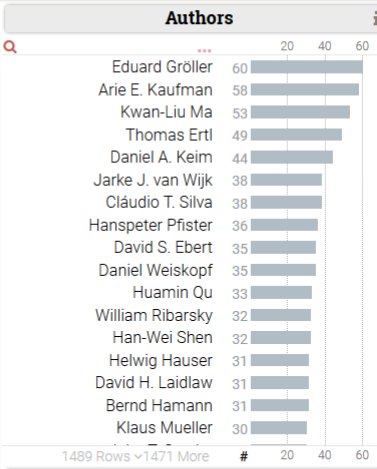
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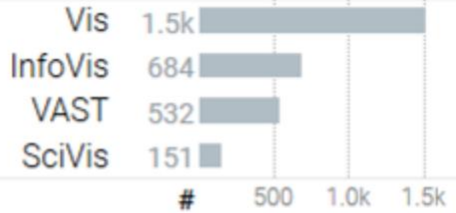


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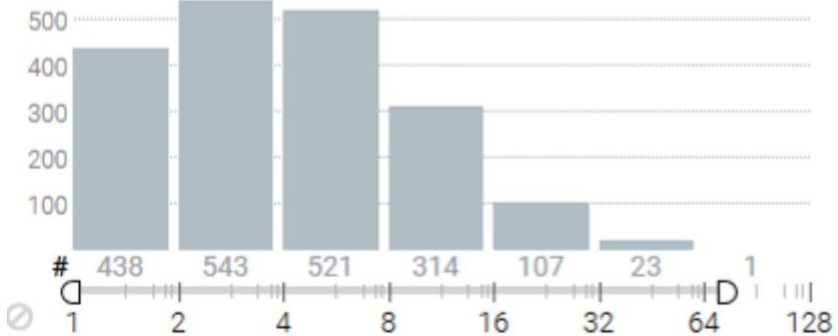
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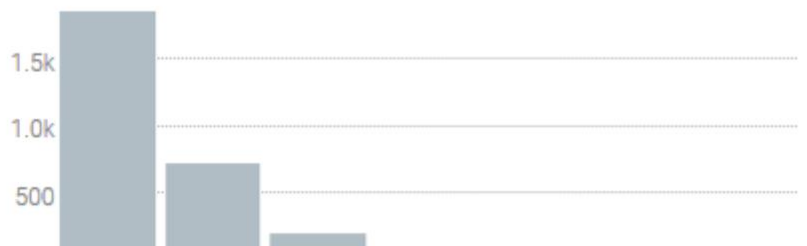
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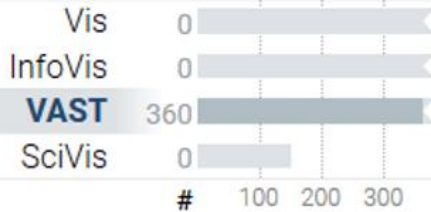
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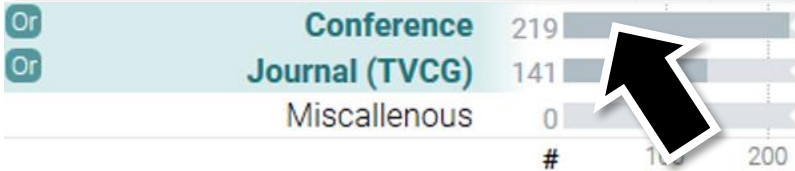
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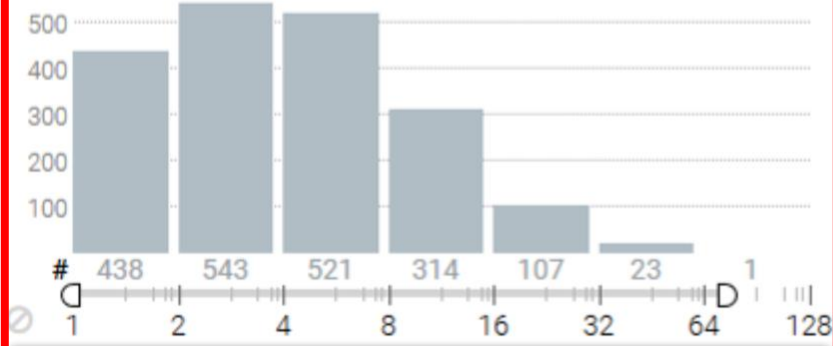
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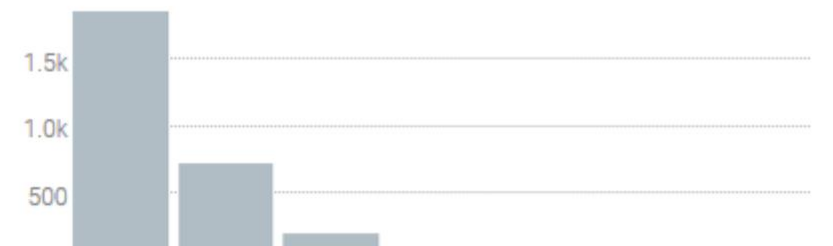
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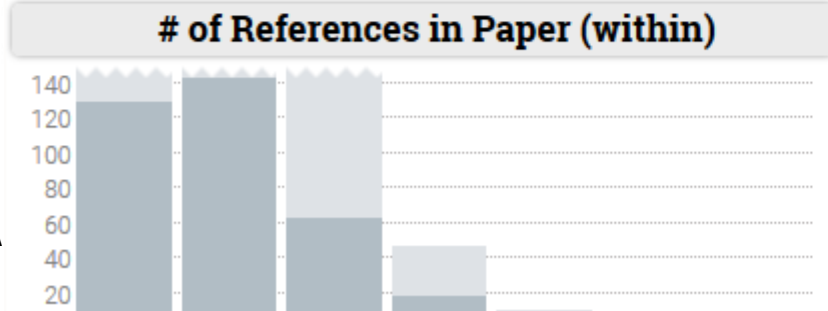
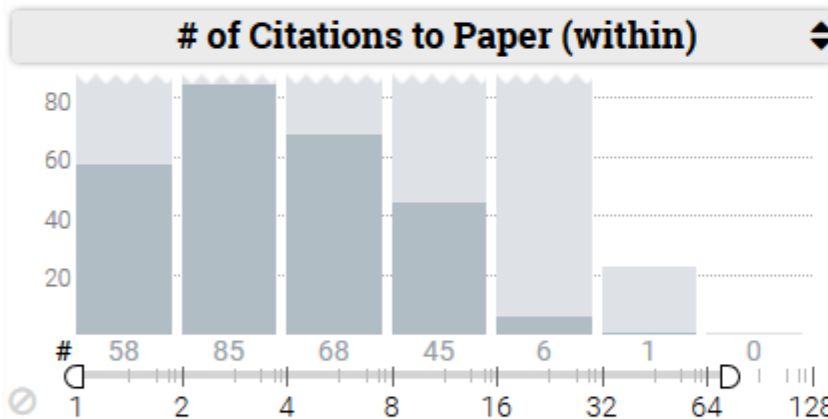
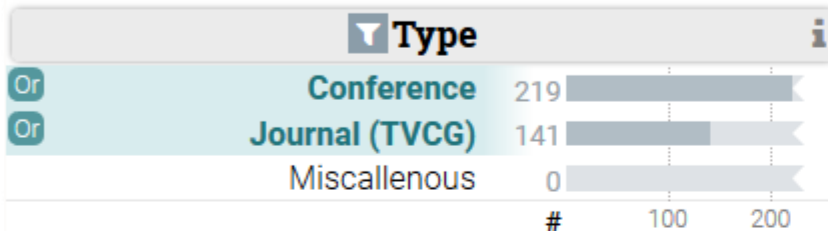
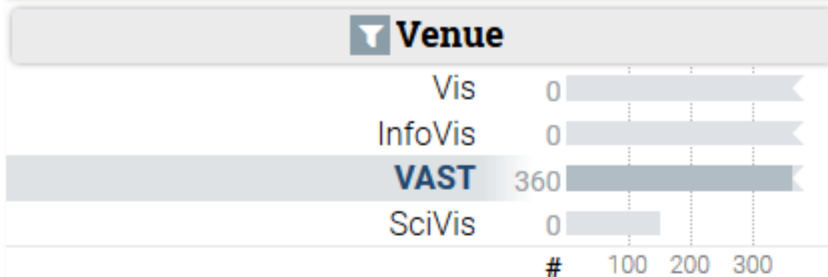
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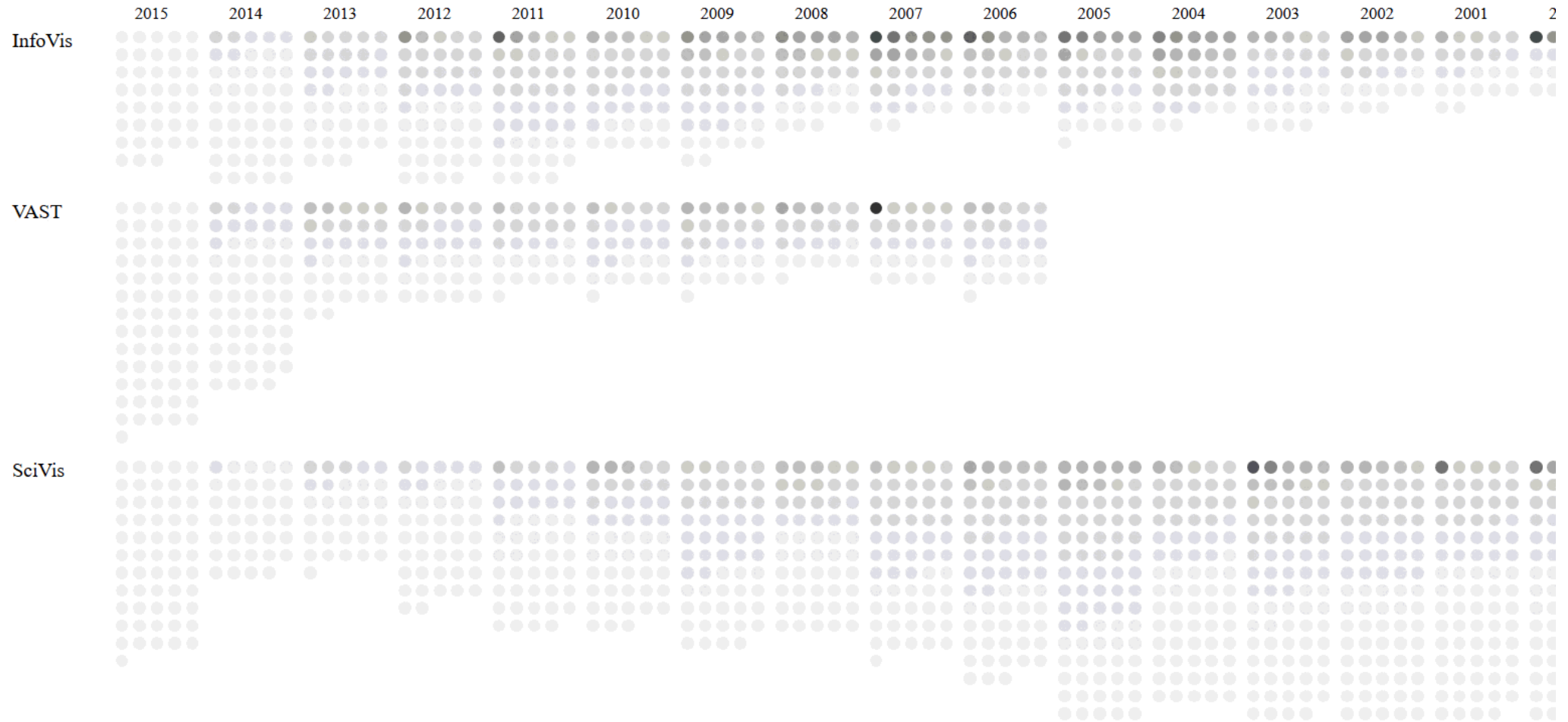
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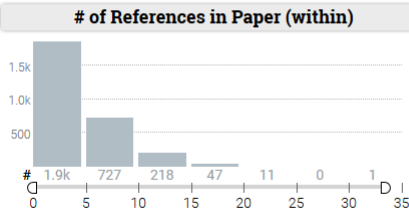
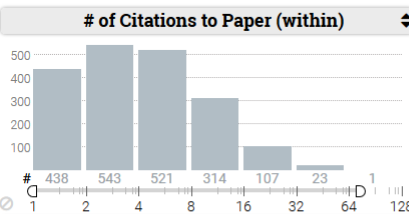
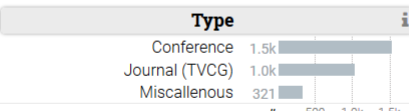
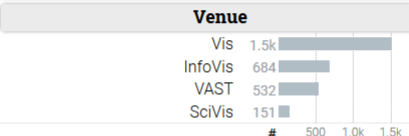




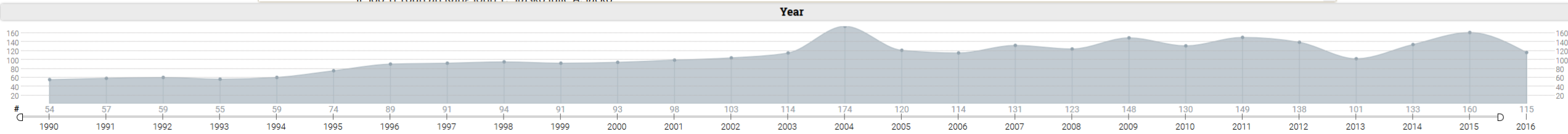
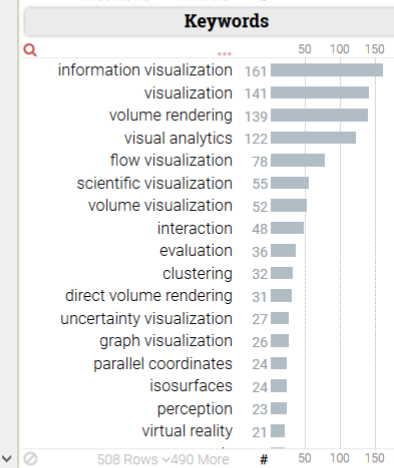
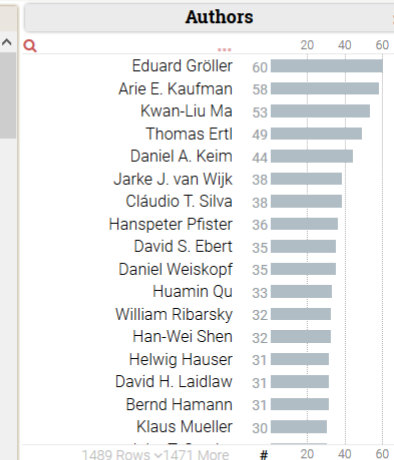
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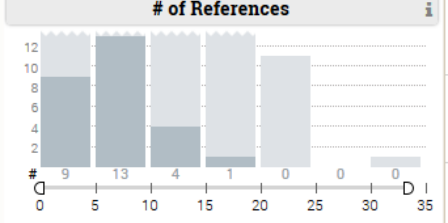
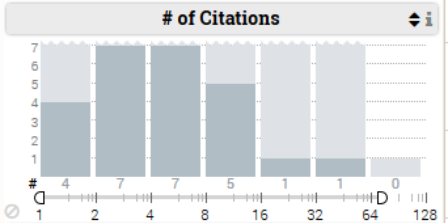
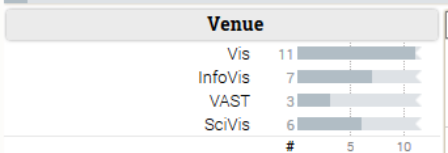
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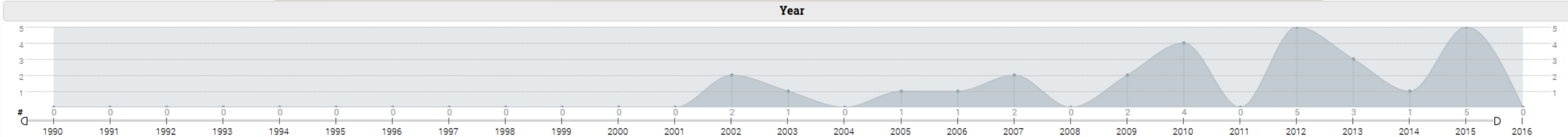
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visualization	0
volume rendering	2
visual analytics	0
flow visualization	1
scientific visualization	0
volume visualization	0
interaction	1
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ABSTRACTS

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Supporting Communication and Coordination in Collaborative Sensemaking

Narges Mahyar and Melanie Tory

Abstract—When people work together to analyze a data set, they need to organize their findings, hypotheses, and evidence, share that information with their collaborators, and coordinate activities amongst team members. Sharing externalizations (recorded information such as notes) could increase awareness and assist with team communication and coordination. However, we currently know little about how to provide tool support for this sort of sharing. We explore how linked common work (LCW) can be employed within a ‘collaborative thinking space’, to facilitate synchronous collaborative sensemaking activities in Visual Analytics (VA). Collaborative thinking spaces provide an environment for analysts to record, organize, share and connect externalizations. Our tool, CLIP, extends earlier thinking spaces by integrating LCW features that reveal relationships between collaborators’ findings. We conducted a use study comparing CLIP to a baseline version without LCW. Results demonstrated that LCW significantly improved analytic outcome at a collaborative intelligence task. Groups using CLIP were also able to more effectively coordinate their work, and held more discussion of their findings and hypotheses. LCW enabled them to maintain awareness of each other’s activities and findings and link those findings to their own work, preventing disruptive oral awareness notifications.

Index Terms—Sensemaking; Collaboration; Externalization; Linked common work; Collaborative thinking space

1 INTRODUCTION

Supporting collaborative sensemaking has been identified as an important challenge in collaborative visualization [20]. Sensemaking in collaborative VA is a very time consuming and demanding process, requiring the analysts to iteratively exchange and discuss results to form and evaluate hypotheses, derive conclusions, and publish findings. Team members also need to maintain *awareness* of each other’s work, including both activities that people are working on and results and evidence that they have found. Tools that provide *externalization* support (i.e., ability to record insights, questions, and findings, e.g., as text notes) can help teams to organize and share their results [6, 18, 22, 41], and those that provide awareness channels should enhance collaboration, communication and coordination [12]. However, to date, we have a very limited understanding of how to provide externalization and awareness support for collocated collaborative teams. How should such tool support look and behave within VA tools?

We investigate the use of *Linked Common Work (LCW)* to facilitate synchronous collaborative sensemaking. With LCW, common work elements such as similar findings are automatically discovered, linked, and visually shared among the group. We built this technique within a ‘collaborative thinking space’ that enables analysts to record, organize and schematize their externalizations. Linked common work reveals similarities in people’s externalizations, enabling analysts to acquire awareness of each other’s findings, hypotheses, and evidence. Moreover, each individual analyst can review and merge others’ work from within his/her workspace. Our results demonstrate that applying LCW to externalizations, and providing the ability to integrate collaborators’ findings together within one view, noticeably improve team awareness, coordination, communication, and analytic outcomes.

Our work focuses on supporting teams of investigative analysts, for example in the domain of intelligence analysis. Intelligence analysts need to sift through large document collections, determine which pieces of data are relevant, and gradually build up an explanation supported by evidence. Field studies have revealed that professional analysts need to share sources and data, view each other’s work, and combine findings together in order to build common ground, resolve

conflicts, and validate each other’s findings and hypotheses [8, 25].

The *sensemaking* process of intelligence analysts has been studied in some depth, and has been described as involving two iterative loops: the information foraging loop and the sensemaking loop [34]. The information foraging loop involves searching for relevant data and reading, filtering, and extracting information, whereas the sensemaking loop involves iteratively developing a mental model, forming and evaluating hypotheses, and publishing the results. We focus primarily on supporting later stages of the sensemaking process (i.e., the sensemaking loop), when teams are more likely to work together in a synchronous, collocated fashion [25]. This synthesis phase is reported to be the most difficult and time-consuming phase of analysis [25].

We are exploring the design of visual thinking spaces that support the sensemaking loop in collaborative VA. A collaborative thinking space should enable analysts to record and organize findings, evidence, and hypotheses; moreover, it should facilitate the process of sharing findings amongst collaborators, to minimize redundant work and help investigators identify relationships and build a shared understanding. In this paper, we examine the value of employing LCW to relate and integrate team members’ visual thinking spaces. The notion of LCW closely resembles *collaborative brushing and linking* [21] in which certain actions of each investigator are visible to collaborators through their own views. However, collaborative brushing and linking was only applied to search queries and retrieved documents and did not cover externalizations. It also focused on supporting only information foraging activities. In contrast, our work facilitates later stages of the collaborative sensemaking process (i.e., the sensemaking loop), by applying the linking concept to people’s externalizations (i.e., recorded findings and notes). We anticipate that enabling analysts to see how their findings relate to each other should make it easier to maintain awareness of each others’ work, build common ground, and solve analytic problems. We address the following research questions (RQs):

- RQ1: Does linking collaborators’ externalizations lead to better analytic outcomes?
- RQ2: Does linking collaborators’ externalizations improve communication?
- RQ3: Does linking collaborators’ externalizations help collaborators to coordinate their work more effectively?
- RQ4: Does linking collaborators’ externalizations increase collaborators’ awareness of each others’ findings and activities?

To answer these questions, we designed and implemented CLIP, a visual thinking space to support collaborative sensemaking. CLIP allows analysts to record their findings in the form of a node-link graph and

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For information on obtaining reprints of this article, please send e-mail to: tvcg@computer.org.

Digital Object Identifier 10.1109/TVCG.2014.2346573

USE CASES

RESEARCH

DATASET AS A USE CASE

Using Phylogenetic Trees to Generate Semantic Meaningful Edge Bundles

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Fig. 1. Graph of citations in a subset of the 2014 IEEE InfVis Content dataset, comprising papers published on the IEEE InfVis Conference between 2000 and 2014. An edge linking two papers means that one paper cites or is cited by the other one (10). The vertices are placed in the visual space using a radial layout algorithm (middle). The Neighbor Joining algorithm was used to produce a graph with cluster reduction and grouped edges (right).

Abstract—Graphs have been successfully applied in a range of problem and applications. It is the subject of study of different areas, from modeling and analysis to the construction of visual representations. Different approaches exist for graph visualization, however, most of them suffer from the severe clutter when the number of nodes or edges is large. Amongst the techniques of graph visualization that handle such problem, Edge-bundling techniques attained relative success on improving the quality of the visual representations by bundling and aggregating edges in order to reduce overlapping. Despite this success, most of them just perform the bundle based only on the visual space information, that is, there is no explicit connection between the produced bundled visual representation and the data. Some of them look upon edge information as a complement to the visual information, but it is just an additional measure, not their main goal. In this paper, we present a novel edge-bundling technique, called Neighbor Joining Bundling (NJB), for graph visualization that tackles this problem by considering the similarity between the nodes when performing the edges bundling.

Keywords—edge bundling; graph visualization.

1. INTRODUCTION
Graphs are used in a range of problems, being useful to model different kinds of relationships between elements. The visual representation of data sets modeled as graphs is frequently used in data analytics, being the node-link diagram the most common visual representation. However, graph visualization presents several challenges [1], [2]. Specifically, when the number of vertices and edges is large, the

visualization suffers from the visual-clutter problem, reducing the power of data analysis. The clutter reduction is a frequent thread in different areas of study in data visualization [3] and aims at reorganizing or transforming the visual elements so that the attained representation can reveal patterns that are hidden on the original representation.

Among the graph visualization techniques, Edge-Bundling [4] has obtained great success reducing the visual-clutter on node-link diagrams. The main goal of this technique is to transform a straight node-link representation by bundling and aggregating the edges using a set of control points. Edges that share control points are grouped, reducing overlapping lines the visual clutter. The smoothness provided by the curves also helps improving the data analysis in the visual representation.

After Holten [4], many other edge-bundling based techniques have been published, proposing different ways to execute the bundling and grouping the edges. Some examples include: strategies based on force-directed [5], proximity processing [6], [7], clustering [8] and image processing [9], [10], [11]. However, these techniques mainly use the visual space information to perform the edge bundling, ignoring the underlying data, thereby creating aggregations that do not explicitly reflect the data. In some techniques, the underlying data may be used as a complement to the visual information. However, this is not used as their main goal.

Visualization Methods and Evaluation

CHI 2016, San Jose, CA, USA

Egocentric Analysis of Dynamic Networks with EgoLines

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Figure 1. EgoLines supports the investigation of temporal patterns in dynamic ego-networks. Here, a 3-level ego-network of academic collaboration is shown for the author P. Dragicevic (PD). Collaborations between the author, his co-authors, and their co-authors are displayed, indicating how PD interacts with the other authors during the academic career. Using a subway map metaphor, authors are shown as actor lines across time steps (years); data shown for 2009. Colors indicate clusters of co-authors who collaborated most frequently with one another. Actor lines are tightly packed to create blocks of line segments at each time step while its adjacency matrices. Authors directly connected to PD are indicated using a light gray curve, similar to how actor lines in a subway map. For 2013, the shortest path between the hovered author (MA) and PD is traced using curved arrows, resulting that VW is the connection between them.

ABSTRACT
The egocentric analysis of dynamic networks focuses on discovering the temporal patterns of a subnetwork around a specific central actor (i.e., an ego-network). These types of analyses are useful in many application domains, such as social science and business intelligence, providing insights about how the central actor interacts with the outside world. We present EgoLines, an interactive visualization to support the egocentric analysis of dynamic networks. Using a “subway map” metaphor, a user can trace an individual actor over the evolution of the ego-network. The design of EgoLines is grounded in a set of key analytical questions pertinent to egocentric analysis, derived from our interviews with three domain experts and general network analysis tasks. We demonstrate the effectiveness of EgoLines in egocentric analysis tasks through a controlled experiment with 18 participants and a use-case developed with a domain expert.

Author Keywords
Dynamic network; egocentric network; graph visualization.

ACM Classification Keywords
H.5.2. Information Interfaces and Presentation (e.g. HCI); User Interfaces.

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INTRODUCTION

A network is a ubiquitous data structure found in a range of application domains that can be used to describe concepts such as social networks, mobile device connections, and neural pathways. Many of these networks are dynamic, i.e., the topology of a network and/or the attributes of its nodes and links vary over time, revealing relationship dynamics in real-world systems. Information visualization techniques have been shown effective in many scenarios, helping people understand how these networks change over time [1]. One key method of dynamic network analysis uses an egocentric approach. In contrast to whole-network analysis, egocentric analysis focuses on the local subnetwork around a particular node, the ego, and its surrounding neighbors, the alters [29]. The ego is the central actor of interest in a particular domain analysis (e.g., an individual, a device, or a system). This subnetwork is called an ego-network and its boundary is defined in terms of levels. For example, a 1-level ego-network includes only alters directly connected to the ego, while a 2-level ego-network includes all alters within a path distance of two, and all connections between them. In practice, only 1-level and 2-level ego-networks are typically considered [29].

The temporal dynamics of ego-networks can provide insight into how an ego affects, or is affected by, alters over time. For example, medical experts have shown that an individual’s health is strongly associated with many social factors (e.g., number of friends) [27], analysis in management and business intelligence have made informed decisions about marketing strategies by identifying and observing the most influential people in social networks [15], and computer



Article

Visual Analysis of Relationships between Heterogeneous Networks and Texts: An Application on the IEEE VIS Publication Dataset

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Abstract: The visual exploration of large and complex network structures remains a challenge for many application fields. Moreover, a growing number of real-world networks is multivariate and often interconnected with each other. Entities in a network may have relationships with elements of other related datasets, which do not necessarily have to be networks themselves, and these relationships may be defined by attributes that can vary greatly. In this work, we propose a comprehensive visual analytics approach that supports researchers to specify and subsequently explore attribute-based relationships across networks, text documents and derived secondary data. Our approach provides an individual search functionality based on keywords and semantically similar terms over the entire text corpus to find related network nodes. For examining these nodes in the interconnected network views, we introduce a new interaction technique, called Hui2Go, which facilitates the navigation by guiding the user to the information of interest. To showcase our system, we use a large text corpus collected from research papers listed in the visualization publication dataset that consists of 2752 documents over a period of 25 years. Here, we analyze relationships between various heterogeneous networks, a bag-of-words index and a word similarity matrix, all derived from the initial corpus and metadata.

Keywords: heterogeneous networks; interaction; graph drawing; multivariate datasets; NLP; text analysis; visualization; visual analytics

1. Introduction

The combination of different heterogeneous networks and related textual data is crucial for various application domains. Libraries, for example, are nowadays interested in analyzing (known or hidden) relationships among various collections of books, which might be related to each other even though they do not share the same author or topic. Based on an initial book search, analysts want to find out what terms were used in a specific book, find related ones that might use the same or similar terms and also visualize the direct neighborhood network of those books, which could, for instance, consist of other books written by the same authors.

Similar text corpora may be derived from conference proceeding publications, such as the IEEE Visualization Conference [1] proceedings, which we use as an application example and use case in this paper. Here, a researcher could be interested in finding out more about a specific topic and therefore wants to explore publications that use a number of specific keywords or terms. However, related publications might use different terms, but still talk about the same idea; or those publications mention certain terms that do not appear in the title or their keyword list. For less experienced researchers, it

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B. Korthorst, T. Schreck, and T. Wischgold (Editors)

Short Paper

PubViz: Lightweight Visual Presentation of Publication Data

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Abstract

Publications play a central role in presenting the outcome of scientific research but are typically presented as textual lists, whereas related work visualization focuses on exploration – not presentation. To bridge this gap, we conducted a design study of an interactive visual representation of publication data in a BibTeX file. This paper reports our domain and problem characterization as well as our visualization design decisions in light of our user-centered design process including interviews, non-user studies with a paper prototype and a usability prototype, and practical application in our group’s website. Categories and Subject Descriptors according to ACM CCS: Information Interfaces and Presentation [H.5.2]: User Interfaces—Graphical user interfaces

1. Introduction

One’s publications are probably the most vital assets for early stage and senior researchers alike. Despite their central role as scientific track record, publication lists of a single researcher or research group are still commonly represented as textual lists. These can, for example, be grouped by the type of publication or sorted by year of publication. However, the representation itself as well as the level of interactivity for online versions are rather limited.

This paper is a design study [SMM11] that presents the domain and problem characterization, conceptual design, and implementation of an interactive visual representation of publication data called PubViz. The designed representations are interactive and co-ordinated, focusing on different aspects such as development over time, publication type distribution, co-authors, and keywords. Input data is given in the established BibTeX format [Pat00] and the interactive views are implemented based on standard web technologies such as HTML5 [H09/011] in order to be easily embeddable into webpages. PubViz is available as free and open source software on GitHub [HC17].

The main contributions of the paper at hand are: 1) a systematic domain and problem characterization manifested in concrete personas and scenarios that may be used for further work in the area, 2) a specific visualization and interaction design along with 3) empirical evidence collected in the course of a user-centered design process and 4) an open and reusable implementation in JavaScript.

2. Design Method and Evaluation

For the design of PubViz, we used a four-level user-centered design process [BS13], iteratively involving persons from the target audience throughout the process.

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www.mdpi.com/journal/informatics

RESEARCH

DATASET AS OBJECT OF STUDY

Visualization as Seen Through its Research Paper Keywords

Petra Isenberg, *Member, IEEE*, Tobias Isenberg, *Senior Member, IEEE*, Michael Sedlmair, *Member, IEEE*, Jian Chen, *Member, IEEE*, and Torsten Möller, *Senior Member, IEEE*

Abstract—We present the results of a comprehensive multi-pass analysis of visualization paper keywords supplied by authors for their papers published in the IEEE Visualization conference series (now called IEEE VIS) between 1990–2015. From this analysis we derived a set of visualization topics that we discuss in the context of the current taxonomy that is used to categorize papers and assign reviewers in the IEEE VIS reviewing process. We point out missing and overemphasized topics in the current taxonomy and start a discussion on the importance of establishing common visualization terminology. Our analysis of research topics in visualization can, thus, serve as a starting point to (a) help create a common vocabulary to improve communication among different visualization sub-groups, (b) facilitate the process of understanding differences and commonalities of the various research sub-fields in visualization, (c) provide an understanding of emerging new research trends, (d) facilitate the crucial step of finding the right reviewers for research submissions, and (e) it can eventually lead to a comprehensive taxonomy of visualization research. One additional tangible outcome of our work is an online query tool (<http://keyvis.org/>) that allows visualization researchers to easily browse the 3 952 keywords used for IEEE VIS papers since 1990 to find related work or make informed keyword choices.

Index Terms—Keywords, data analysis, research themes, research topics, taxonomy, visualization history, theory.

1 MOTIVATION

One of the main reasons why visualization is such a fascinating field of research is its diversity. There is not only a diversity of applications but also a diversity of research methods being employed, a diversity of research contributions being made, as well as the diversity of its roots.

Diversity of roots: The term *visualization* can be understood very broadly, expressing a long history of its use in common language. Therefore, it is not surprising that concepts of visual thinking have penetrated many areas of science, engineering, and philosophy. The field of modern (computer-based) visualization has been greatly influenced by research methods from the fields of numerics and computer graphics, which have given it its birth in 1990. The impact of human-computer interaction affected the birth of the InfoVis community in 1995 and the influence of applied statistics (such as data mining) and cognition has led to the establishment of VAST in 2006.

Diversity of research methods: Given its diverse roots, visualizations remains a highly inter-disciplinary field that borrows and extends research methods from other fields. Methods come from fields as diverse as the broader computer science, mathematics, statistics, machine learning, psychology, cognitive science, semiotics, design, or art.

Diversity of contributions and applications: Based on these diverse influences, the results of visualization research can be manifold: from engineering solutions to dealing with large data sources (such as real-time rendering solutions, distributed and parallel computing technologies, novel display devices, and visualization toolkits) to understanding design processes (as in perceptual guidelines for proper visual encodings and interaction or facilitating collaboration between different users through visual tools) to scientific inquiries (such as improved understanding of perceptual and cognitive processes).

While all these diverse influences make the field of visualization

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research an exciting field to be part of, they also create enormous challenges. There are different levels of appreciation for all aspects of visualization research, communication challenges between visualization researchers, and the challenge of communicating visualization as an independent field of research to the outside. These issues lead, in particular, to the frequently asked question “what is visualization?”—among funding agencies or even between colleagues. Given our field’s broad nature, we need to ask how we can comprehensively describe and summarize all on-going visualization research. These are not just theoretical and philosophical questions, but the answer to these questions has many real-world (e.g., career-deciding) impacts—from finding the right reviewers during peer-review to administrative strategic decisions on conference and journal structures and foci.

So while “what is visualization?” is a fundamental question, it has not been discussed to a large extent within our community. In fact, thus far the approaches have mostly focused on understanding some sub-field of visualization (e.g., [17, 38, 42]) but the question for the broader community has rarely been tackled beyond general textbook definitions (e.g., [6, 34, 46]). Those who have approached the problem, did so in a top-down approach based on the opinion and experiences of the authors. For example, several taxonomies were suggested by experts based on tasks, techniques, or data models (e.g., [7, 38, 43]). Another way of splitting visualization into more focused areas has been through specific application foci (e.g., VisSec, BioVis, SoftVis, etc.).

What is missing in this picture is a bottom-up analysis: What types of visualization research are actually happening as expressed by single research contributions in the visualization conferences and journals. Our paper is one of the first steps in this direction. We analyze one type of data that can shed light on the diversity of visualization research: author-assigned keywords as well as author-selected taxonomy entries in the submission system for the three IEEE VisWeek/VIS conferences. Based on this analysis, we make the following contributions:

Mapping visualization research: In Sect. 4, through the vehicle of keyword analysis, we build a conceptual map of all visualization work as indexed by individual authors. Our main assumption here is that, while each single keyword might be understood in a slightly different way by different researchers, their co-occurrence with other keywords clarifies their meaning, especially when aggregated over many different usages (i.e., many research papers in a major publication venue). This co-occurrence analysis is the basis for deriving clusters and, therefore, research sub-fields. The use of keywords seen over the past years also allows us to understand historical trends and we report on the most prominent declining and rising keywords within all of visualization.

Taxonomy and Terminology Discussion: Visualization research is influenced by a diverse set of application domains. The vocabulary of

RESEARCH

DATASET TO HELP RESEARCH

RELATED WORK

REVIEWERS

...

The screenshot shows the KEYVIS website interface. At the top, there is a navigation bar with links for 'Getting started', 'Search', 'Topics', and 'About'. The main heading is 'Search for VIS paper keywords'. Below this, a red link says 'Explore all topic clusters:'. The main content area displays a topic cluster for 'Acoustics, Sound, Sonification'. It lists 15 keywords: auralization 2x, acoustic imaging 1x, acoustic metric 1x, acoustic propagation 1x, acoustic simulation 1x, acoustics 1x, midi 1x, musicology 1x, phonon map 1x, phonon tracing 1x, room acoustics 1x, sonar technology 1x, sonification 1x, sound analytics 1x, and sound propagation 1x. Below the keywords, there is a table of papers that include at least one of these keywords. The table has columns for 'Conf.', 'Year', and 'Title'. The papers listed are: VAST 2015 'Interactive Visual Profiling of Musicians', Vis 2008 'AD-Frustum: Adaptive Frustum Tracing for Interactive Sound Propagation', Vis 2007 'Interactive sound rendering in complex and dynamic scenes using frustum tracing', Vis 2007 'Listener-based Analysis of Surface Importance for Acoustic Metrics', Vis 2006 'Comparative Visualization for Wave-based and Geometric Acoustics', Vis 2005 'Phonon tracing for auralization and visualization of sound', Vis 2000 'Real-time visualization of the clear-up of a former US naval base', Vis 2000 'Case study: a methodology for plume visualization with application to real-time acquisition and navigation', and Vis 1996 'LISTEN: sounding uncertainty visualization'. Below the table, there are several topic clusters listed: 'Adaptive Processing and Refinement', 'Algorithmic pattern/feature detection/tracking', 'Ambient Visualization', 'Analysis Process - General', and 'Animation and Motion'.

Getting started Search Topics About

Search for VIS paper keywords

Explore all topic clusters:

Abstraction, Simplification, Approximation

Acoustics, Sound, Sonification

Topic cluster containing **15** keywords :

auralization 2x acoustic imaging 1x acoustic metric 1x acoustic propagation 1x acoustic simulation 1x acoustics 1x midi 1x
musicology 1x phonon map 1x phonon tracing 1x room acoustics 1x sonar technology 1x sonification 1x sound analytics 1x
sound propagation 1x

All papers that include at least one of these keywords:

Conf.	Year	Title
VAST	2015	Interactive Visual Profiling of Musicians
Vis	2008	AD-Frustum: Adaptive Frustum Tracing for Interactive Sound Propagation
Vis	2007	Interactive sound rendering in complex and dynamic scenes using frustum tracing
Vis	2007	Listener-based Analysis of Surface Importance for Acoustic Metrics
Vis	2006	Comparative Visualization for Wave-based and Geometric Acoustics
Vis	2005	Phonon tracing for auralization and visualization of sound
Vis	2000	Real-time visualization of the clear-up of a former US naval base
Vis	2000	Case study: a methodology for plume visualization with application to real-time acquisition and navigation
Vis	1996	LISTEN: sounding uncertainty visualization

Adaptive Processing and Refinement

Algorithmic pattern/feature detection/tracking

Ambient Visualization

Analysis Process - General

Animation and Motion

<http://keyvis.org>

keywords, papers, topics

TEACHING

TEACHING

- CLEANING
- TRANSFORMING
- JOINING

- DEVELOPING OF RESEARCH QUESTION

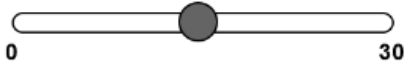
- DEVELOPING APPS

MEMBER HUNTER --- FIND THE NEXT COMMITTEE BOARD

by ranking past experience and publications

Vis	VAST	InfoVis	SciVis
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Recommended Authors for Next Committe



North, C. 9 papers

Ribarsky, W.

Huamin Qu

Maciejewski, R.

Koch, S.

Xiaoyu Wang

Silva, C.T.

Shixia Liu

Schreck, T.

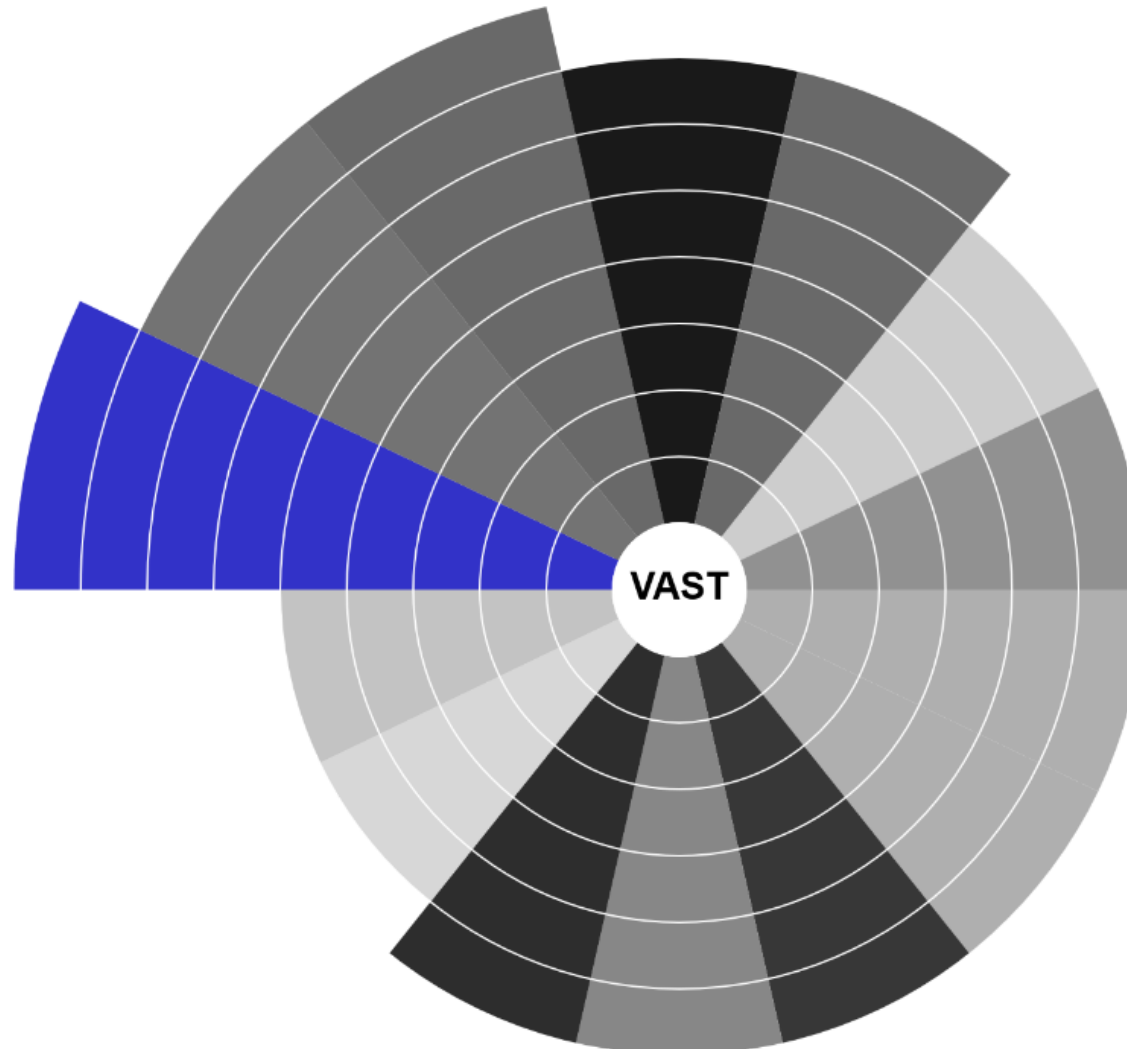
Ertl, T.

Endert, A.

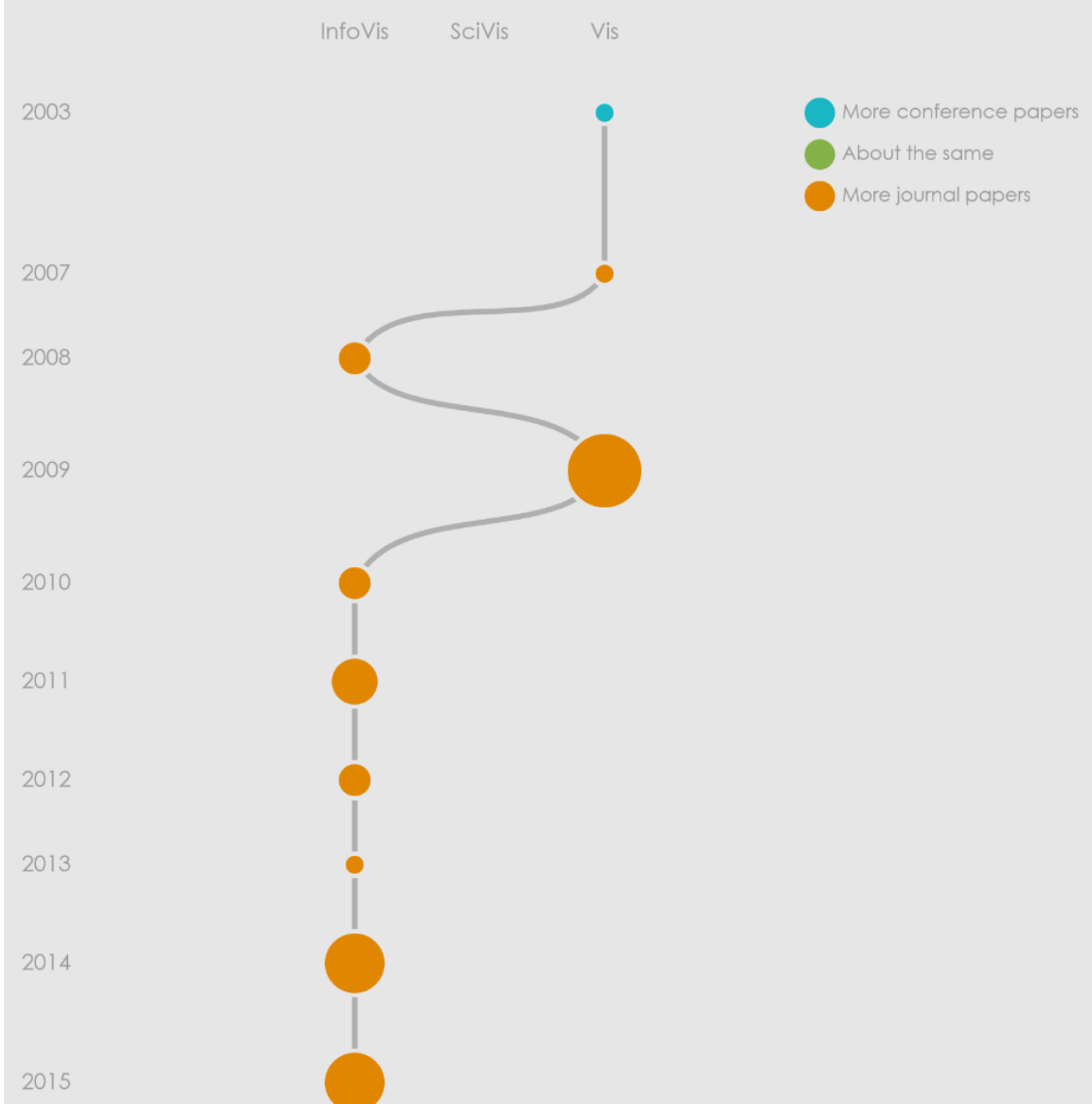
Ebert, D.S.

Wenwen Dou

Perer, A.



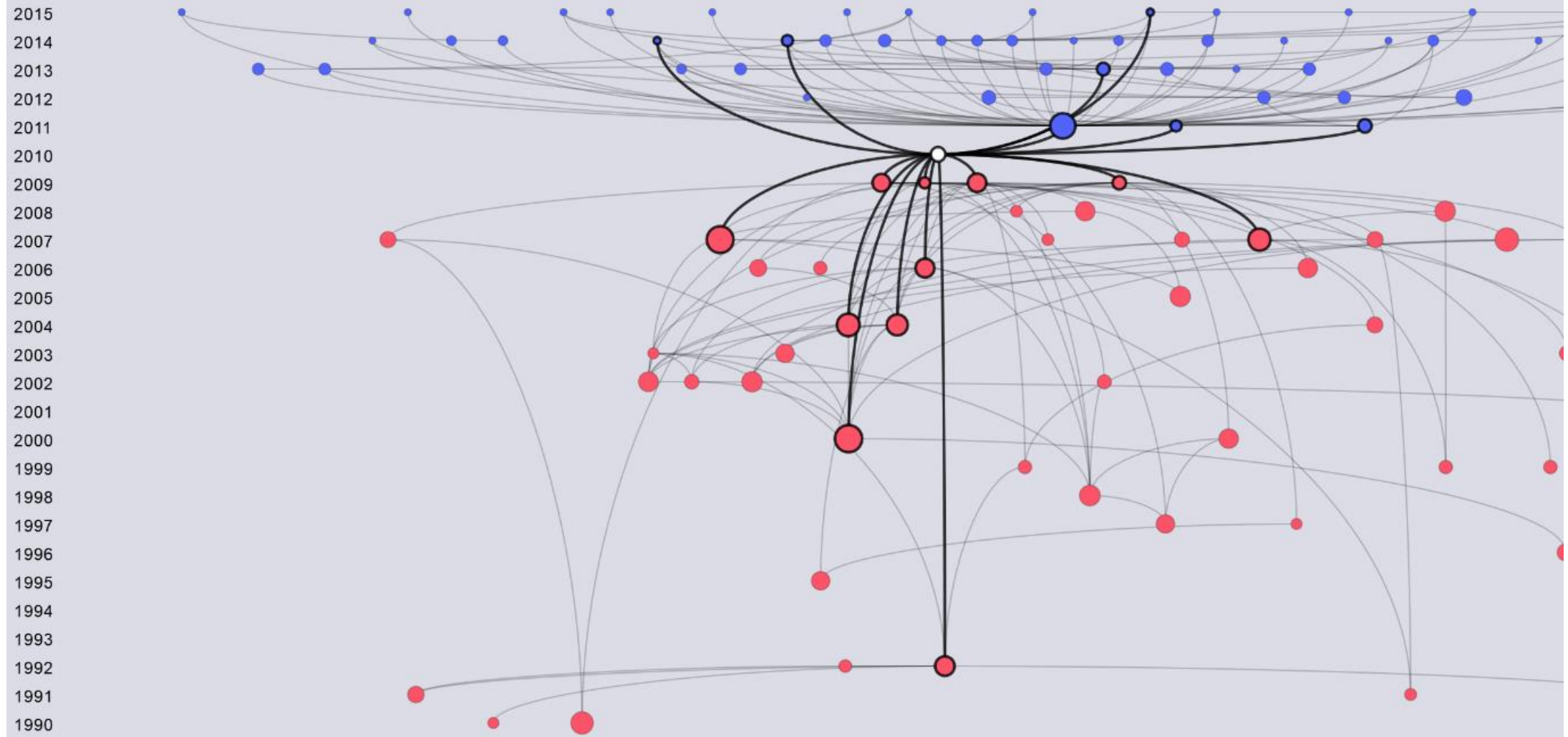
Huamin Qu



How can we support paper writing with citation information?

History

RefTree - A tool to help finding and exploring related articles



CONFERENCE ORGANIZATION

Conference Organisation

- Finding PC members
- Finding reviewers
- Proposing / updating keyword taxonomy
- ...

SUMMARY

vispubdata.org

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Visualization Publication Data Collection

VISUALIZATION PUBLICATIONS DATASET

▶ RECENTDATACHANGES

SITEMAP

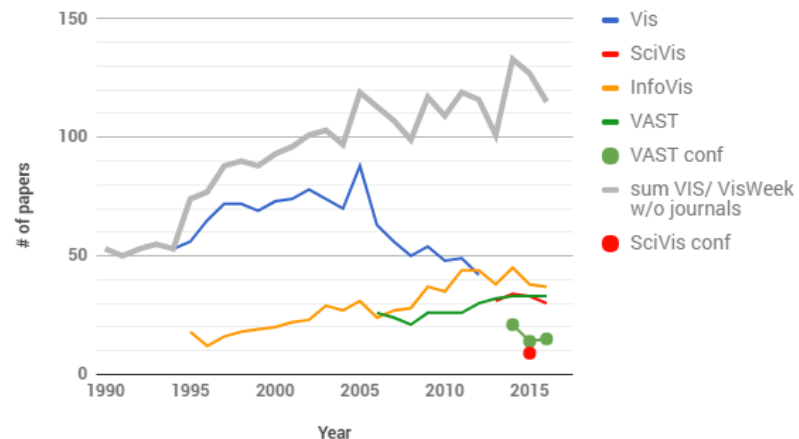
Visualization publications dataset

We are making available a dataset that contains information on IEEE Visualization (IEEE VIS) publications from 1990-2015. The dataset includes a variety of information about each paper including title, authors, DOI, etc., as well as a list of the citations to other previous VIS papers. To download the dataset open the Google spreadsheet through the link below and choose File->Download as. If you spot errors in the dataset feel free to leave a comment in the respective cells. We will try to maintain and fix the spreadsheet.

[Look at and download complete dataset here](#)

Current version: 7.00

Papers included in the dataset



GET MORE DATA

Visualization Paper Submission and Keyword Dataset

Description:

This is a dataset of the submission information for VGTC-sponsored, visualization-related conferences. Included are the regular *full-paper* submissions for IEEE Vis, IEEE InfoVis, IEEE SciVis, IEEE VAST, IEEE PacificVis, and EuroVis roughly from 2008. For each full paper submission, the dataset contains the title, conference information, potential publication data (in form of a DOI link), and all keywords marked in the submission system by the submitting authors based on the "PCS taxonomy" that has largely stayed stable since 2008/2009. For full details see the dataset's readme file.



Data download:  (0.2 MB)

Cross-References:

See other work that uses or relates to this data or that reports on the use of keywords in visualization:

- vispubdata.org: A Metadata Collection about IEEE Visualization (VIS) Publications
- Visualization as Seen Through its Research Paper Keywords

References:

This work was done at the AVIZ project group of Inria, France, with the help of numerous people who are acknowledged in the readme file.

(temporary location)



<https://tinyurl.com/pcskeywords>

FUTURE WORK

- EuroVis (STAR papers, short papers?)
- PacificVis
- (TVCG, CG&A) journal papers presented at EuroVis / PacificVis / VIS (?)

- Affiliations
- Going back to Lastname, Firstname (?)

vispubdata.org

A METADATA COLLECTION ABOUT IEEE VIS PUBLICATIONS

Petra Isenberg, Florian Heimerl, Steffen Koch, Tobias Isenberg, Panpan Xu,
Charles D. Stolper, Michael Sedlmair, Jian Chen, Torsten Möller, John Stasko

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Metadata Fields

Conference	Year	Title	DOI	Link	Author Name
VAST InfoVis SciVis Vis	1990 - 2016	Cleaned	+8 fake DOIs = Unique identifier	To paper in DL	First Last
First page	Last page	Paper type	Abstract	References	Author keywords
		Conference Journal Misc		To other IEEEVIS papers	