

Preface

Message from the Paper Chairs and Guest Editors

These are the proceedings of IEEE VIS 2014, held during November 9–14, 2014, in Paris, France. This year, VIS celebrates its 25th anniversary and is held in Europe for the first time, acknowledging its maturity and growing importance worldwide.

VIS consists of three conferences, held concurrently: the IEEE Visual Analytics Science and Technology Conference (VAST 2014), the IEEE Information Visualization Conference (InfoVis 2014), and the IEEE Scientific Visualization Conference (SciVis 2014).

Visualization continues to develop rapidly as a research discipline and the three conferences are maintaining their positions as the leading annual events for researchers and practitioners to share the most innovative and impactful results of an increasingly diverse and influential community.

REVIEW PROCESS

The three conferences continued to benefit from a common review process. This kicked off at the end of 2013 with the selection of a program committee of experts from academia, government and industry for each meeting. A general call for review volunteers was then issued. We asked all reviewers to identify their areas of expertise and read and agree with our ethics guidelines. These ensure that ideas are protected; reviews are detailed, specific, helpful and tactful; and that conflicts of interest are avoided: http://vgtc.org/about_us/conferences/ethics-guidelines.

Submitted papers were assigned to members of the conference program committees by the conference papers chairs who put great effort into matching paper topics to the areas of expertise of committee members. Committee members were then invited to express preferences for the submitted papers based on an initial reading of the abstracts prior to paper submission to facilitate this matching process. Careful effort was made at all levels of reviewing to identify potential conflicts of interest and to quarantine them from decision-making.

Reviewing itself was undertaken through a two-stage procedure. In the first review cycle, each paper was reviewed by at least four reviewers. Two international program committee members acted as the primary and secondary reviewers. Each primary and secondary reviewer appointed an external (tertiary) reviewer in addition to preparing a review themselves. In order to adhere to the TVCG standards, authors had the option of submitting their manuscript anonymously for a double-blind review. In such cases, the names and affiliations of authors were known only to the primary and secondary reviewers. After all reviews had been completed and individual recommendation scores had been made, the primary reviewer led a short discussion phase among all reviewers and was responsible for writing a summary review and making a recommendation based upon the consensus.

As papers chairs, we facilitated this process; evaluated the reviews, the discussion between all reviewers, and any confidential comments made; and considered the recommendation of the primary and secondary reviewers in conjunction with the scores and the self-specified expertise levels of the reviewers. This collection of 2503 reviews and summary reviews—IEEE VAST (750), IEEE InfoVis (1038) and IEEE SciVis (715)—enabled us to collectively finalize the decisions of the first review cycle. Decisions were based on the detailed reviewer's comments and recommendations, rather than on numerical scores alone. To inform conditional acceptance decisions, we consulted primary reviewers as needed in cases in which consensus was not achieved or in which the recommendation was uncertain or borderline.

Conditionally accepted papers then underwent a second review cycle, in which authors were given a list of improvements to make—including conditional changes and suggestions to improve the paper. Authors were also required to provide a cover letter describing how they addressed the reviewers' comments and on the changes that they decided to incorporate. In the second review cycle, the primary reviewer judged whether the authors satisfactorily addressed the issues raised by the reviewers in the first review cycle, and provided a corresponding final recommendation. Authors were able to clarify aspects through anonymous email with the primary reviewer or the papers chairs.

Numerous individuals have contributed their generous time and energy to making the IEEE VIS 2014 and this special issue a success. We would like to thank the authors of all submitted papers, the 145 members of the IEEE VAST (41), IEEE InfoVis (53) and IEEE SciVis (51) Program Committees, and all the other reviewers for their many hours of hard work.

IEEE VAST 2014

The IEEE Visual Analytics Science and Technology (VAST) Conference is now in its ninth year, and its fifth year as an IEEE Conference. It remains the primary venue for the rapidly growing field of visual analytics. Visual analytics is the science of analytical reasoning supported by highly interactive visual interfaces, and seeks to integrate computational analytics with human cognitive processes. Visual analytics requires interdisciplinary science, going beyond traditional visualization to include statistics, mathematics, knowledge representation, management and discovery technologies, cognitive and perceptual sciences, decision sciences, and more.

IEEE VAST 2014 offers an exciting papers program, which is significantly expanded from previous years. Its featured themes include fundamentals; user empowerment; visual analytics techniques for clustering, classification, search and tracking; visual analysis of spatiotemporal activities, relationships, changes and semantic meanings;

and scientific, infrastructural, environmental and societal applications. New this year, IEEE VAST 2014 presents an expanded set of accepted papers in two categories.

(a) *TVCG Track*. Papers that exhibit the highest quality in terms of originality, rigor and significance are included in this special issue of the IEEE Transactions on Visualization and Computer Graphics (*TVCG*), together with the papers from the IEEE Information Visualization and Scientific Visualization Conferences. IEEE VAST 2014 received 148 paper submissions, an 18% increase from last year. Following the initial processing by coauthors, 136 papers entered the review process. After two review cycles, 33 papers were finally accepted into the *TVCG* Track, for an acceptance rate of 24%.

(b) *Conference-only Track*. In order to increase the exposure of visual analytics applications, and participation of interdisciplinary researchers, this year we have introduced an additional track, which features innovative advances and applications in visual analytics that may have focuses beyond the scope of *TVCG*. 21 papers were finally accepted into the Conference-only Track.

Papers in both tracks will be presented in the conference, be included in the IEEE VIS USB, and appear in the IEEE Digital Library.

The VAST 2014 best paper was chosen by a best paper award committee consisting of Jonathan Roberts (chair), William A. Pike and William Ribarsky. The best paper committee considered the top 5 papers and their reviews. We congratulate Narges Mahyar and Melanie Tory for their paper “Supporting Communication and Coordination in Collaborative Sensemaking”. The motivation for the award was for “its strong and multifaceted contributions to collaborative visual analytics which is one of the grand challenges in VAST”. The committee also selected two honorable mentions, noted in the table of contents of this special issue.

IEEE INFOVIS 2014

IEEE InfoVis 2014 is the 20th annual IEEE InfoVis meeting and our eighth year as the IEEE Information Visualization Conference, a venue that remains the primary meeting in the field of information visualization. Information visualization seeks to provide interactive visual representations of data to support exploration, analysis and communication. Core research issues in the field include the design of perceptually and cognitively effective visual encodings for a variety of data types, novel interaction techniques for creating and manipulating visualizations, and application development and evaluation to advance real-world data visualization efforts.

InfoVis updates its international program committee each year, with a maximum of 3 years of consecutive service. This year’s committee consisted of 53 members. Of these, 33 people returned from last year, we welcomed back 8 members who had served longer before, and added 12 new members—each an established researcher who had provided strong reviews earlier.

This year’s IEEE InfoVis Conference received 196 sub-

missions. This submission count is a significant increase (+22%) from the previous year’s 151 submissions, indicating continued growth of the field. From the initial pool of 196 submissions, 45 papers were conditionally accepted with clearly specified requests for improvements. The revisions were considered by the primary reviewers and the papers chairs (with an additional round of edits being requested in some cases). Ultimately, all 45 of these papers were accepted for inclusion in the journal and presentation at the conference. The overall acceptance rate was 23%, slightly lower than the 25% in 2013.

Looking at specific categories of papers, we received 82 technique / algorithm papers (41.8% of all submissions, 12 accepted), 42 application / design study papers (21.4%, 10 accepted), 39 evaluation papers (19.9%, 13 accepted), 19 theory papers (9.7%, 5 accepted) and 14 systems papers (7.1%, 3 accepted). While the conference has retained a substantial proportion of technique and design study papers, this year marks a continued growth in the proportion of evaluation papers both submitted and accepted. Evaluation papers exhibited the highest per-category acceptance rate (33.3%), followed by theory / model papers (26.3%).

Long-standing topics of interest in this year’s proceedings include perceptual modeling, experimental evaluation, statistical graphics, and novel techniques for multivariate data, geographic data, text, trees, and networks. This year we see increased research attention paid to set-typed data, tangible (including 3D-printed) visualizations, touch-based interaction techniques, interactive visualization design tools, and process models for visualization design. We also have new applications and deployments in domains such as distributed systems, manufacturing, tennis, and biomechanics. The papers as a whole constitute a healthy balance of novel techniques and applications on the one hand, and, on the other, of empirical and theoretical work seeking to strengthen the foundations of the field.

The InfoVis 2014 best paper was chosen by a best paper award committee consisting of Martin Wattenberg (chair), Chris Weaver, and Jason Dykes. The best papers committee considered the top 7 papers and their reviews. We congratulate Stef van den Elzen and Jarke J. van Wijk for their paper “Multivariate Network Exploration and Presentation: From Detail to Overview via Selections and Aggregations”. The motivation for the award was the paper’s “likely uptake, potential utility, and accessible exposition”. The committee also selected three honorable mentions, noted in the table of contents of this special issue.

IEEE SciVis 2014

Scientific visualization continues to be a strong focus of the IEEE Visualization conference series since its inception 25 years ago. The goal of the SciVis conference is to promote fundamental research and development of techniques, systems, and interaction methods for analyzing data from a wide range of scientific and biomedical applications. In addition to its core, that focuses on scalar, vector, and tensor data visualization and analysis using topological, geometric,

and statistical methods, the conference also covers emerging areas such as visual computing, machine learning, data analytics, and data sciences that broaden the foundation of scientific visualization. An important component of the conference is the novel use of scientific visualization across a wide range of usage scenarios, which underlines the strong ties to application domains that the community builds upon.

The IEEE SciVis 2014 papers program accepted 34 papers describing state-of-the-art tools, techniques and technology in the field of scientific visualization. They were selected from 136 submissions by an international program committee of 51 members and numerous external reviewers after two review cycles. The acceptance rate is 25%. The available paper categories—technique papers, system papers, design studies, evaluation papers, and model papers—are used with different intensity by our community. Technique papers (with 87 of the submissions) are the strongest suit in our community, followed by design study papers (with 36 of the submissions). System papers (with 6 of the submissions), evaluation papers (with 6 of the submissions), and model papers (with 1 of the submissions) are a smaller, but highly relevant, subset of the submissions. The program contains a blend of emerging and traditional topics including scalar field analysis, topology, volume rendering, flow visualization, visual integration and design, perception and evaluation, comparative visualization, data transformation and compression, and biomedical and molecular visualization.

While the conference maintains its long standing role as the premier venue for foundational research, a trend for this year is the appearance of papers in topics that are more traditionally associated with information visualization or visual analytics, but build on technical method development in the SciVis domain. Papers on visualization of urban development and monitoring are examples of this.

The best paper for SciVis 2014 was chosen by a best paper award committee consisting of Min Chen (chair), Mike Kirby and Claudio Silva, who reviewed the top 7 papers and their peer reviews. We congratulate Sujal Bista, Jiachen Zhou, Rao Gullapalli and Amitabh Varshney for their paper, “Visualization of Brain Microstructure through Spherical Harmonics Illumination of High Fidelity Spatio-Angular Fields”. The motivation for the award is: “This paper provides a novel solution for visualizing higher-order tensor data with a potential to stimulate a new line of research in medical data visualization”. The committee also selected two honorable mentions, noted in the table of contents of this special issue.

ACKNOWLEDGMENTS

We warmly thank the IEEE VIS General Chair, Jean-Daniel Fekete, and the three conference chairs: Giuseppe Santucci (VAST), Jason Dykes (InfoVis) and David Laidlaw (SciVis) for their valuable advice and guidance at every stage. We thank the Program Chair, Gautam Chaudhary, for his considerable help in coordinating activities and the VIS publication and project coordinator, Meghan Haley, both for

guidance throughout the year and for bringing the publication together so effectively once again, and James Stewart, Precision Conference Solutions, for the smooth running of the PCS system, and for his prompt and effective support to many queries from us.

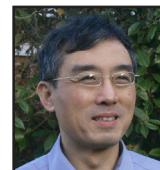
The IEEE VIS 2014 conference also features panels, tutorials, workshops, posters, the SciVis contest, the VAST challenge, meetups, the practitioner experiences track, the doctoral colloquium, the art program, VIS in other venues, industry outreach activity, exhibits, Compass activities and fast forward sessions among other activities and events held throughout the week. None of these would exist were it not for the time and effort spent by our community members. We appreciate the support from Klaus Mueller as Chair of the IEEE Visualization and Graphics Technical Committee (VGTC), Tamara Munzner as Chair of VIS Executive Committee and other colleagues involved in organizing VIS 2014.

We especially acknowledge the support of Ming Lin as Editor-in-Chief of TVCG, and the coordination by Charles Hansen for the presentation of TVCG papers in VIS 2014. We thank the IEEE CS Production team, Erin Espriu, Meera Patel, Alicia Stickley, Joyce Arnold and Alison Larkin, for their time and much effort in helping produce these proceedings.

PAPER CHAIRS AND GUEST EDITORS

MIN CHEN

University of Oxford



Min Chen is currently the professor of scientific visualization at University of Oxford and a fellow of Pembroke College. His research interests include visualization and visual analytics, computer graphics, human-computer interaction and aspects of computer vision. He has co-authored over 150 publications. His services include papers cochair of IEEE Visualization 2007 and 2008, Eurographics 2011; cochair of Volume Graphics 1999 and 2006, EuroVis 2014; associate editor-in-chief of IEEE TVCG; and co-director of Wales Research Institute of Visual Computing. He is a fellow of British Computer Society, European Computer Graphics Association, and Learned Society of Wales.

DAVID EBERT

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David Ebert is the Silicon Valley Professor of Electrical and Computer Engineering at Purdue University, a Fellow of the IEEE, and Director of the Visual Analytics for Command Control and Interoperability Center (VACCINE). He performs research in novel visualization techniques, visual analytics, information visualization, and illustrative visualization. Ebert has been very active in the visualization community, cochairing many conference program committees, serving as Editor in Chief of IEEE TVCG and serving on the IEEE Computer Society Board of Governors, and successfully managing a large program of external funding to develop more effective methods for visually communicating information.

HELWIG HAUSER

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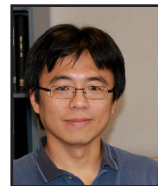
Helwig Hauser is Professor at the University of Bergen, Norway, where he leads a research group on visualization at the Department of Informatics. His research interests are diverse in visualization, including interactive visual analysis, information visualization and scientific visualization (and also their integration), etc. Helwig Hauser is (or was) Associate Editor for the journals *Computers & Graphics*, *Computer Graphics Forum*, and *IEEE TVCG*, and he worked as chair for a number of major events, including EuroVis 2011, PacificVis 2012, and IEEE InfoVis 2013, more recently. He is also member of the EuroVis Steering Committee, and he has received the Heinz Zemanek Award from OCG in 2006 and the Dirk Bartz Prize from Eurographics in 2013.



HAN-WEI SHEN

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Han-Wei Shen is a full professor at The Ohio State University. He received his BS degree from Department of Computer Science and Information Engineering at National Taiwan University in 1988, the MS degree in computer science from Stony Brook University in 1992, and the PhD degree in computer science from the University of Utah in 1998. From 1996 to 1999, he was a research scientist at NASA Ames Research Center in Mountain View California. His primary research interests are scientific visualization and computer graphics. Prof. Shen is a long time participant of IEEE Visualization conferences, attending his first one in 1993.



JEFFREY HEER

University of Washington

Jeffrey Heer is an Associate Professor of Computer Science & Engineering at the University of Washington, where he works on data visualization, human-computer interaction and social computing. His research investigates the perceptual, cognitive and social factors involved in making sense of large data sets, resulting in new interactive systems for visual analysis and communication. In 2009 Jeff was named to MIT Technology Review's TR35 and in 2012 he was named a Sloan Foundation Research Fellow.



MELANIE TORY

University of Victoria

Melanie Tory is an Associate Professor of Computer Science at the University of Victoria, where she leads the Visual Interaction Design research group. Her research spans visualization, human-computer interaction, and computer-supported cooperative work, and applies to a wide variety of areas including natural sciences and engineering, business, and personal informatics. She is also an associate editor for *IEEE Computer Graphics and Applications*.



CHRIS NORTH

Virginia Polytechnic Institute and State University

Chris North is a Professor of Computer Science and Associate Director of the Discovery Analytics Center at Virginia Tech, where he has received the Faculty Fellow and Research Achievement Awards. He leads the GigaPixel Display Laboratory, one of the most advanced display and interaction facilities in the world. His research interests include interactive visual analytics, information visualization, human-computer interaction, and large high-resolution display and interaction spaces. He has served as papers cochair of IEEE InfoVis and IEEE VAST, and as associate editor of *IEEE TVCG* and *Information Visualization*.



ANDERS YNNERMAN

Linköping University

Anders Ynnerman is chair of scientific visualization at Linköping University and the director of the Norrköping Visualization Center - C. He is chair of the scientific council for the Center for Medical Image Science and Visualization (CMIV) at the Linköping University hospital. Ynnerman is currently serving as vice chair of the Eurographics association, of which he is also a fellow, and as an associate editor of *IEEE Transactions on Visualization and Computer Graphics* and of *Computers & Graphics*. Ynnerman has received several awards for his work on visualization and computational science, including the Akzo-Nobel Science Award, and he is a member of the Swedish Royal Engineering Science Academy. Ynnerman's current research interest lies in the area of fundamental aspects of computer graphics and visualization, in particular large scale and complex data sets with a focus on volumetric data.



HUAMIN QU

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Huamin Qu is an associate professor in the Department of Computer Science and Engineering at the Hong Kong University of Science and Technology. He obtained a BS in Mathematics from Xi'an Jiaotong University, China, an MS and a PhD in Computer Science from Stony Brook University. His main research interests are in visualization and computer graphics. He is an associate editor of *IEEE TVCG* and serves on the steering committee of the IEEE Pacific Visualization Conferences.

