Preface

Message from the VIS Paper Chairs and Guest Editors

This January 2017 issue of the IEEE Transactions on Visualization and Computer Graphics contains the proceedings of IEEE VIS 2016, held during October 23-28, 2016. In 2016, IEEE VIS returns to the city of Baltimore, Maryland, USA, for the conference’s 27th year. The conference will be located at the Hilton Baltimore Hotel, connected to the Baltimore Convention Centre.

VIS consists of three conferences, held concurrently: the IEEE Visual Analytics Science and Technology Conference (IEEE VAST 2016), the IEEE Information Visualization Conference (IEEE InfoVis 2016), and the IEEE Scientific Visualization Conference (IEEE SciVis 2016).

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 2015 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 (http://vgtc.org/about_us/conferences/ethics-guidelines). These ensure that ideas are protected; reviews are detailed, specific, helpful and tactful; and that conflicts of interest are avoided.

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 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, only the primary and secondary reviewers knew the names and affiliations of authors. 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 reviews and discussions.

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 reviews and summary reviews enabled us to collectively finalize the decisions of the first review cycle. Decisions were based on the detailed reviewers’ 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 (if needed, in consultation with the secondary and external reviewers) judged whether the authors had 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 2016 and this special issue a success. We would like to thank the authors of all submitted papers, the members of the IEEE VAST, IEEE InfoVis and IEEE SciVis Program Committees, and all the other reviewers for their many hours of hard work.

IEEE VAST 2016

The IEEE Visual Analytics Science and Technology (VAST) Conference is now in its eleventh year, and its seventh 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 2016 offers an exciting papers program. Its featured themes include education and games; textual data; exploratory analysis; managing the visual analytics process;
machine learning; traffic and urban planning; biomedical visualization; social media data and events; visual knowledge discovery and sensemaking; time series data; user behaviors; and complementing visual and algorithmic analysis. Following the same format in the previous year, IEEE VAST 2016 presents accepted papers in two categories.

(a) TVCG-Track. Papers that exhibit the highest quality in terms of originality, rigor and significance will appear in a 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 2016 received 165 paper submissions. Following the initial processing by the papers chairs, 157 papers entered the review process. After two review cycles, 33 papers were finally accepted into the TVCG track, for an acceptance rate of 21%.

(b) Conference-only Track. In order to increase the exposure of visual analytics applications, and participation of interdisciplinary researchers, this additional track features innovative advances and applications in visual analytics that may have foci beyond the scope of TVCG. 15 papers were finally accepted into the Conference-only track.

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

The VAST 2016 best paper was chosen by a best paper award committee consisting of Daniel Keim, William Ribarsky, and Daniel Weiskopf. The best paper committee carefully considered five top papers and their reviews. We congratulate Gary K. L. Tam, Vivek Kothari, and Min Chen for their paper “An Analysis of Machine- and Human-Analytics in Classification.” As the award committee acknowledged, “The paper provides a quantitative study comparing machine-centric with human centric solutions to classification problems. In addition to solid case studies, it develops a novel information-theoretic approach to assessing the value of the human in the process. Use of this approach permits the paper to make a strong case for how and why insertion of human “soft knowledge” at the right points produces results superior to solely machine learning results. The approach should be generalizable beyond the classification problems presented. It should provide a basis for further research in an important direction.” The committee also selected two honorable mention papers. The first one is “A Visual Analytics Approach for Categorical Joint Distribution Reconstruction from Marginal Projections” from Cong Xie, Wen Zhong, and Klaus Mueller. This paper presents an interactive technique for generating a categorical joint probability distribution from marginal distributions. An extended parallel-coordinates visualization guides the user in interactively selecting a good solution. This is a strong visual analytics paper that shows the value of both a powerful analytics approach and interactive visualization that puts the user in the loop. The paper shows how powerful analytics methods can be obtained from different areas (in this case 3D reconstruction from 2D projections) and then modified and extended for another purpose.

One can see many applications. The second one is “ViDX: Visual Diagnostics of Assembly Line Performance in Smart Factories” from Panpan Xu, Honghui Mei, Liu Ren, and Wei Chen. This paper addresses the problem of assembly line performance in smart factories. It is a nice example of how visual analytics can be successful in a complex and timely application setting. The topic has been underexplored in the visual analytics community, but it is of broad interest in the practice of industry 4.0. The paper takes a systematic approach of careful data abstraction, description of the design process, and requirements analysis in order to arrive at a useful visual analytics system. It also comes with technical innovations such as outlier-preservation for Marey’s graphs and special brushes.

**IEEE InfoVis 2016**

Information visualization (InfoVis) concerns the design of visual depiction and manipulation of data to support human activities, where the spatial layout of the visual representation is chosen by the designer. IEEE InfoVis 2016 is the 22nd annual IEEE InfoVis meeting and our 10th year as the IEEE Information Visualization Conference, a venue that remains the primary meeting in the field of information visualization. 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 real-world application development and evaluation to advance this field of study.

IEEE InfoVis updates its international program committee each year, with a maximum of 3 years of consecutive service. This year the committee has 59 members. Of these, 44 people returned from last year, we welcomed back 10 members who had served some time before, and added 5 new members—established researchers who wrote strong reviews in prior years.

This year’s IEEE InfoVis Conference received 165 submissions. Of these, we ultimately accepted 37, following two rounds of review and revision. The overall acceptance rate was 22.4%, slightly higher than the 21.3% in 2015.

Regarding specific paper categories, we received 70 technique/algorithm papers (24.2% of all submissions, 17 accepted), 34 evaluation papers (26.4%, 9 accepted), 34 application/design study papers (14.7%, 5 accepted), 14 systems papers (21.4%, 3 accepted), and 13 theory papers (23%, 3 accepted). Compared to 2015, this year saw a substantial increase in the number of technique/algorithm papers submitted.

Long-standing topics of interest in this year’s proceedings include experimental evaluation, graph visualization, and novel techniques for multidimensional and spatiotemporal data. We also see a continuing interest in the development of design methodologies and applications covering various domains such as biomedicine, energy, health, education, etc. Compared to previous years, this year we see increased research attention paid to narrative visualization, immersive visualization, and interaction design. The papers as a whole constitute a healthy balance between novel tech-
niques and applications showing the potential and value of InfoVis, and empirical and theoretical work seeking to strengthen the foundations of the field.

Eight of the finally accepted papers were nominated for the best paper award by the IEEE InfoVis Papers Chairs. These were among the highest rated papers as determined by the reviewers and were considered to have made a significant contribution to the discipline of Information Visualization. IEEE VIS policy specifies that the IEEE InfoVis Papers Chairs are not eligible to receive a Best Paper Award or Honorable Mention.

The Best Paper Committee consists of three members chosen by the IEEE InfoVis Papers Chairs in consultation with the IEEE InfoVis Steering Committee to ensure expertise whilst avoiding any conflicts of interest. This year Frank van Ham chaired the committee. Melanie Tory and Stephen North participated as members. The committee read reviews and final versions of papers on the shortlist. They each ranked all the papers and met as a group to discuss and reach a consensus, selecting the Best Paper and three Honorable Mentions.

For the Best Paper award, the committee selected “Vega-Lite: A Grammar of Interactive Graphics” by Arvind Satyanarayan, Dominik Moritz, Kanit Wongsuphasawat, and Jeffrey Heer. Their motivation is as follows: “Vega-Lite is high-level visualization grammar that integrates an algebra for interaction techniques with operations on views. An important goal of this work is define a high-level language in which to specify sophisticated interactive visualizations that can be generated automatically. High level languages like these may help non-programmers to create interactive visualizations and ease them into specifying visualizations in a programmatic way.”

The committee also selected three papers for Honorable Mention (listed below in no particular order). The first one is “The Attraction Effect in Information Visualization” by Evanthia Dimara, Anastasia Bezerianos, and Pierre Dragicevic. This paper studies whether a well-known cognitive bias observed in comparing numerical data can also affect decisions involving visualizations, specifically, scatterplots. The second one is “Many-to-Many Geographically Embedded Flow Visualization: An Evaluation” by Yalong Yang, Tim Dwyer, Sarah Goodwin, and Kim Marriott. It contributes a matrix-based graphical encoding for flows on maps, an algorithm to generate them, and a user study comparing the proposed method with conventional flow maps. Finally, the third paper is “Map LineUps: Effects of Spatial Structure on Graphical Inference” by Roger Beecham, Jason Dykes, Wouter Meulemans, Aidan Slingsby, Cagatay Turkay, and Jo Wood. This paper adapts the visual line-up method to define a type of statistical power for geospatial data, showing that map line-up tests should be based on data that is spatially autocorrelated, not random.

We congratulate all of the authors for this excellent work and thank the Best Paper Committee for their diligence.

IEEE SciVis 2016

Scientific visualization continues to be a strong focus of the IEEE Visualization conference series. 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 application domains. 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 and applications, machine learning, data analytics, data sciences, interaction techniques, or display technologies and devices, that broaden the foundation of scientific visualization. IEEE SciVis has always given great emphasis to applications of scientific visualization. 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 IEEE VAST Conferences. These papers will be presented at the conference, be included in the IEEE VIS USB, and appear in the IEEE Digital Library.

The IEEE SciVis 2016 papers program accepted 30 papers describing state-of-the-art tools, techniques and technology in the field of scientific visualization. They were selected from 126 submissions by an international program committee and numerous external reviewers after two review cycles. The acceptance rate is 24%. The available paper categories (Algorithm/Technique, System, Application/Design Study, Evaluation, Theory/Model) are used with different intensity by our community. Technique papers (with 80 of the submissions) form the majority, followed by design study papers (with 25 of the submissions). System papers (with 12 of the submissions), evaluation papers (with 6 of the submissions), and model papers (with 3 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, or ensemble, multivariate and comparative visualization. Applications include surgical planning, colon visualization, teaching genome evolution, weather forecasting, understanding spatio-temporal activity in cities, heritage conservation, molecular interactions, and jet engine simulation.

The best paper for SciVis 2016 was chosen by a best paper award committee consisting of Huamin Qu (chair), Hans Hagen, and Daniel Keefe, who reviewed the top six papers and their peer reviews. We congratulate Julien Tierny and Hamish Carr with their best paper, “Jacobi Fiber Surfaces for Bivariate Reeb Space Computation”. The motivation for the award is: “This algorithm identifies the Jacobi set first. The Reeb Space is computed next and Jacobi Fiber Surfaces (the bivariate analogon of critical contours) are generated. This is a breakthrough in theory, which opens up the way to solve important application problems.” The committee also selected two honorable mentions. The first one
is for the paper “Correlated Photon Mapping for Interactive Global Illumination of Time-Varying Volumetric Data” by Daniel Jönsson and Anders Ynnerman, with the motivation: “This paper introduces a new correlated photon mapping technique for interactive global illumination of time-varying volumetric data during both parameter and data changes. The technical approach, based upon a visual importance map and temporal coherence, leads to an order of magnitude speed up in portions of the rendering pipeline, and the new perceptual metrics for guiding the rendering have great potential to inspire follow-on research within the SciVis community.” The second honorable mention is for the paper “In Situ Distribution Guided Analysis and Visualization of Transonic Jet Engine Simulations” by Soumya Dutta, Chun-Ming Chen, Gregory Heinlein, Han-Wei Shen, and Jenping Chen, with the motivation: “This paper presents an in-situ visual analytics approach to help understand the rotating stall phenomenon in turbine engine compressors from the vast amount of data generated by NASA’s state-of-the-art computational fluid dynamics simulator, TURBO. This is a practical and timely paper illustrating how the combination of statistical models and visualization techniques can provide in-situ analysis for a real-world challenging problem.”

**Acknowledgment**

We warmly thank the IEEE VIS General Chair, Terry Yoo, and Vice Chair, Jesus J Caban, for their leadership and coordination. We especially appreciate the valuable advice and guidance from Tamara Munzner as Chair of VIS Executive Committee. We thank the Program Chairs, James Ahrens and Gautam Chaudhary, for their considerable help in coordinating activities; the VIS publication and project coordinator, Meghan Haley, both for her 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 2016 conference also features panels, tutorials, workshops, posters, the SciVis contest and the VAST challenge, meetups, Vis In Practice (VIP), the doctoral colloquium, the art program, exhibits, community 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 all colleagues involved in organizing VIS 2016. We also take this opportunity to thank Cláudio T. Silva as Chair of the IEEE Visualization and Graphics Technical Committee (VGTC).

We especially acknowledge the support of Leila De Floriani as Editor-in-Chief of TVCG, and the coordination by Charles Hansen for the presentation of TVCG papers in VIS 2016. We thank the IEEE CS Production team, Erin Escriu, Meera Patel, Alicia Sticklely, Joyce Arnold, and Alison Larkin, for their time and much effort in helping produce these proceedings.

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**John Stasko, VAST**
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John Stasko is a Professor in the School of Interactive Computing at Georgia Tech where he has been on the faculty since 1989. He has been Papers Co-Chair for the InfoVis and VAST Conferences, and was General Chair for IEEE VIS 2013 in Atlanta. John is an IEEE Fellow, ACM Distinguished Scientist, and a member of the ACM CHI Academy. In 2012 he received the IEEE VGTC Visualization Technical Achievement Award.

Shixia Liu is an associate professor in the School of Software, Tsinghua University. She has published over 40 refereed papers in the leading journals and conferences such as *IEEE TVCG*, *IEEE TKDE*, *IEEE InfoVis*, *IEEE VAST*, KDD, and WWW. Shixia is the associate editor of *IEEE TVCG* and *Information Visualization*. She is the Papers Co-Chair of IEEE VAST 2016 and 2017 and was the Program Co-Chair of PacificVis 2014 and VINCI 2012.
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