

# Symposium on Geometry Processing 2018

Paris, France  
July 7 – 11, 2018

---

Organized by



**EUROGRAPHICS**  
THE EUROPEAN ASSOCIATION  
FOR COMPUTER GRAPHICS



---

## General Chairs

Maks Ovsjanikov (École Polytechnique)  
Pooran Memari (CNRS, École Polytechnique)  
Tamy Boubekeur (Télécom ParisTech)

## Program Co-Chairs

Tao Ju (Washington University in St. Louis)  
Amir Vaxman (Utrecht University)

## International Programme Committee

**Aigermann, Noam**

Adobe research, USA

**Alexa, Marc**

TU Berlin, Germany

**Alliez, Pierre**

INRIA, France

**Amenta, Nina**

UC Davis, USA

**Attene, Marco**

CNR-IMATI, Italy

**Azencot, Omri**

UCLA, USA

**Bærentzen, J. Andreas**

TUD, Denmark

**Ben-Chen, Mirela**

Technion, Israel

**Benes, Bedrich**

Purdue University, USA

**Bickel, Bernd**

IST, Austria

**Bommes, David**

RWTH Aachen, Germany

**Botsch, Mario**

Bielefeld University, Germany

**Boubekeur, Tamy**

Telecom ParisTech, France

**Bronstein, Michael**

Universita' della Svizzera Italiana, Switzerland

**Campen, Marcel**

New York University, USA

**Cazals, Frederic**

INRIA, France

**Chen, Baoquan**

Shenzhen University, China

**Chen, Renjie**

MPI Informatik, Germany

**Chien, Edward**

MIT, USA

**Cignoni, Paolo**

CNR-ISTI, Italy

**Cohen-Steiner, David**

INRIA, France

**Crane, Keenan**

CMU, USA

**Dey, Tamal**

Ohio State University, USA

**Diamanti, Olga**

Stanford University, USA

**Gao, Xifeng**

NYU, USA

**Gingold, Yotam**

George Mason University, USA

**Gotsman, Craig**

Technion, Israel

**Guennebaud, Gael**

INRIA, France

**Guerrero, Paul**

University College London, UK

**Hahn, David**

ETH Zurich, Switzerland

**He, Ying**

Nanyang Technological University

**Hildebrandt, Klaus**

TU Delft, Netherlands

**Hormann, Kai**

University of Lugano, Switzerland

**Huang, Jin**

Zhejiang University, China

**Huang, Hui**

Shenzhen University, China

**Huang, Qixing**

University of Texas at Austin, USA

**Jacobson, Alec**

University of Toronto, Canada

**Kavan, Ladislav**

University of Utah, USA

**Kazhdan, Misha**

Johns Hopkins University, USA

**Keyser, John**

Texas A&M University, USA

**Kim, Vladimir**

Princeton University, USA

**Kobbelt, Leif**

RWTH Aachen, Germany

## International Programme Committee

**Kosinka, Jiri**

University of Groningen, Netherlands

**Lai, Yu-Kun**

Cardiff University, UK

**Levy, Bruno**

INRIA, France

**Li, Hao**

University of Southern California, USA

**Lipman, Yaron**

Weizmann Institute of Science, Israel

**Liu, Ligang**

University of Science and Technology of China

**Liu, Yang**

MSRA, China

**Memari, Pooran**

Ecole Polytechnique, France

**Mitra, Niloy**

University College London, UK

**Nealen, Andrew**

NYU, USA

**Ovsjanikov, Maks**

Ecole Polytechnique, France

**Panozzo, Daniele**

NYU, USA

**Patane, Giuseppe**

CNR-IMATI, Italy

**Peters, Jorg**

University of Florida

**Pietroni, Nico**

University of Technology Sydney, Australia

**Polthier, Konrad**

FU Berlin, Germany

**Poranne, Roi**

University of Haifa, Israel

**Pottmann, Helmut**

TU Wien, Austria

**Rodolà, Emanuele**

Sapienza University of Rome, Italy

**Rossignac, Jarek**

Georgia Tech, USA

**Rumpf, Martin**

Universität Bonn, Germany

**Rusinkiewicz, Szymon**

Princeton University, USA

**Rustamov, Raif**

AT&T Labs Research, USA

**Schaefer, Scott**

Texas A&M University, USA

**Sheffer, Alla**

University of British Columbia, Canada

**Solomon, Justin**

MIT, USA

**Sorkine-Hornung, Olga**

ETH Zurich, Switzerland

**Spagnuolo, Michela**

CNR-IMATI, Italy

**Tagliasacchi, Andrea**

University of Victoria, Canada

**Takayama, Kenshi**

National Institute of Informatics, Japan

**Tang, Chengcheng**

Stanford, USA

**Tarini, Marco**

Università degli Studi dell'Insubria, Italy

**Thiery, Jean-Marc**

Telecom ParisTech, France

**Thomaszewski, Bernhard**

Université de Montréal, Canada

**Tong, Yiyang**

Michigan State University, USA

**van Kaick, Oliver**

Carleton University, Canada

**Vouga, Etienne**

University of Texas at Austin, USA

**Wallner, Johannes**

TU Graz, Austria

**Wand, Michael**

Mainz University, Germany

**Wang, Wenping**

University of Hong Kong, China

**Wardetzky, Max**

University of Goettingen, Germany

**Weber, Ofir**

Bar Ilan University, Israel

## **International Programme Committee**

**Wimmer, Michael**

TU Wien, Austria

**Wonka, Peter**

KAUST, Saudi Arabia

**Yang, Yongliang**

University of Bath, UK

**Zhang, Hao (Richard)**

Simon Fraser University, Canada

**Zhang, Eugene**

Oregon State University, USA

**Zhou, Kun**

Zhejiang University, China

**Zhou, Qingnan (James)**

Adobe Research, USA

## TABLE OF CONTENTS

### Functional Maps

<i>Interactive Curve Constrained Functional Maps</i>	1
Anne Gehre, Michael M. Bronstein, Leif Kobbelt, and Justin Solomon	
<i>Topological Function Optimization for Continuous Shape Matching</i>	13
Adrien Poulenard, Primoz Skraba, and Maks Ovsjanikov	
<i>Kernel Functional Maps</i>	27
Larry Wang, Anne Gehre, Michael M. Bronstein, and Justin Solomon	

### Geometric Optimization

<i>Efficient Path Generation with Reduced Coordinates</i>	37
Renjie Chen, Craig Gotsman, and Kai Hormann	
<i>Packing Irregular Objects in 3D Space via Hybrid Optimization</i>	49
Yuexin Ma, Zhonggui Chen, Wenchao Hu, and Wenping Wang	
<i>Error Propagation Control in Laplacian Mesh Compression</i>	61
Libor Váša and Jan Dvořák	

### Shape Analysis and Representation

<i>Learning Fuzzy Set Representations of Partial Shapes on Dual Embedding Spaces</i>	71
Minhyuk Sung, Anastasia Dubrovina, Vladimir G. Kim, and Leonidas J. Guibas	
<i>Effective Characterization of Relief Patterns</i>	83
Andrea Giachetti	

### Discrete Differential Geometry

<i>A Unified Discrete Framework for Intrinsic and Extrinsic Dirac Operators for Geometry Processing</i>	93
Zi Ye, Olga Diamanti, Chengcheng Tang, Leonidas J. Guibas, and Tim Hoffmann	
<i>An Explicit Structure-preserving Numerical Scheme for EPDiff</i>	107
Omri Azencot, Orestis Vantzos, and Mirela Ben-Chen	
<i>Fast Approximation of Laplace-Beltrami Eigenproblems</i>	121
Ahmad Nasikun, Christopher Brandt, and Klaus Hildebrandt	

### Meshing

<i>Hierarchical Quad Meshing of 3D Scanned Surfaces</i>	135
Dennis R. Bukenberger and Hendrik P. A. Lensch	
<i>QuadriFlow: A Scalable and Robust Method for Quadrangulation</i>	147
Jingwei Huang, Yichao Zhou, Matthias Niessner, Jonathan Richard Shewchuk, and Leonidas J. Guibas	
<i>Field-Aligned and Lattice-Guided Tetrahedral Meshing</i>	161
Saifeng Ni, Zichun Zhong, Jin Huang, Wenping Wang, and Xiaohu Guo	

### Spaces and Transformations

<i>Principal Geodesic Analysis in the Space of Discrete Shells</i>	173
Behrend Heeren, Chao Zhang, Martin Rumpf, and William Smith	

## TABLE OF CONTENTS

<i>Statistical Modeling of the 3D Geometry and Topology of Botanical Trees</i> Guan Wang, Hamid Laga, Jinyuan Jia, Ning Xie, and Hedi Tabia	185
<i>Modular Latent Spaces for Shape Correspondences</i> Vignesh Ganapathi-Subramanian, Olga Diamanti, and Leonidas J. Guibas	199
<i>Möbius Registration</i> Alex Baden, Keenan Crane, and Misha Kazhdan	211
<b>Point Clouds and Reconstruction</b>	
<i>Constructing 3D CSG Models from 3D Raw Point Clouds</i> Qiaoyun Wu, Kai Xu, and Jun Wang	221
<i>Sensor-aware Normal Estimation for Point Clouds from 3D Range Scans</i> Marc Comino Trinidad, Carlos Andujar, Antonio Chica, and Pere Brunet	233

## Author Index

Andujar Carlos	233	Kim Vladimir G.	71
Azencot Omri	107	Kobbelt Leif	1
Baden Alex	211	Laga Hamid	185
Ben-Chen Mirela	107	Lensch Hendrik P. A.	135
Brandt Christopher	121	Ma Yuexin	49
Bronstein Michael M.	1, 27	Nasikun Ahmad	121
Brunet Pere	233	Niessner Matthias	147
Bukenberger Dennis R.	135	Ni Saifeng	161
Chen Renjie	37	Ovsjanikov Maks	13
Chen Zhonggui	49	Poulenard Adrien	13
Chica Antonio	233	Rumpf Martin	173
Comino Trinidad Marc	233	Shewchuk Jonathan Richard	147
Crane Keenan	211	Skraba Primoz	13
Diamanti Olga	93, 199	Smith William	173
Dubrovina Anastasia	71	Solomon Justin	1, 27
Dvořák Jan	61	Sung Minhyuk	71
Ganapathi-Subramanian Vignesh	199	Tabia Hedi	185
Gehre Anne	1, 27	Tang Chengcheng	93
Giachetti Andrea	83	Vantzios Orestis	107
Gotsman Craig	37	Váša Libor	61
Guibas Leonidas J.	71, 93, 147, 199	Wang Guan	185
Guo Xiaohu	161	Wang Jun	221
Heeren Behrend	173	Wang Larry	27
Hildebrandt Klaus	121	Wang Wenping	49, 161
Hoffmann Tim	93	Wu Qiaoyun	221
Hormann Kai	37	Xie Ning	185
Huang Jingwei	147	Xu Kai	221
Huang Jin	161	Ye Zi	93
Hu Wenchao	49	Zhang Chao	173
Jia Jinyuan	185	Zhong Zichun	161
Kazhdan Misha	211	Zhou Yichao	147

## Keynote

### Towards Geometry Processing in Higher Dimensions

*Jean-Daniel Boissonnat*

Inria

#### Abstract

Geometry Processing is usually associated to 3d shapes but many applications in physics, biology, and engineering require processing the geometry of a variety of higher dimensional spaces like phase space in particle physics, invariant manifolds in dynamical systems, configuration spaces of mechanical systems, conformational spaces of molecules or image manifolds. Extending Geometry Processing to higher dimensional geometric objects is both of practical value and a challenging research area. The talk will survey recent results on some fundamental algorithmic problems in higher dimensional geometry : data structures to represent higher dimensional shapes, algorithms to reconstruct and mesh highly non-linear manifolds, and extracting robust topological features. It is hoped that this talk will attract researchers from Geometry Processing and stimulate new approaches and results in Higher Dimensional Geometry.

#### Short Biography

Jean-Daniel Boissonnat is a research director at Inria, the French Research Institute of Computer Science and Applied Mathematics. His research interests are in Computational Geometry and Topology. This includes geometric data structures, Voronoi diagrams, triangulations, randomized algorithms, robust computing, motion planning, shape reconstruction, mesh generation, topological data analysis.

He successively founded and led two project-teams at Inria, Prisme (1987-2002) and Geometrica (2003-2015). He is currently a member of the DataShape team and the principal investigator of the ERC project GUDHI (Geometric Understanding in Higher Dimensions). During the academic year 2016-2017, he was an invited professor at the Collège de France on the Chair Informatics and Computational Sciences.



## Keynote

### Deep Learning for 3D Data Processing

*Vladlen Koltun*

Intel Labs

#### Abstract

I will motivate the application of deep learning techniques to 3D data processing and will present recent work that demonstrates that deep learning can yield significant progress on geometric problems. One result is an approach to learning features that represent the local geometry around a point in an unstructured point cloud. We show that such features can be learned from data, by optimizing deep networks that map high-dimensional histograms into low-dimensional Euclidean spaces. Another result is an approach to semantic analysis of unstructured point clouds using deep convolutional networks. The approach is based on tangent convolutions - a new construction for convolutional networks on 3D data. I will also discuss infrastructure that can support related work, including the Tanks and Temples benchmark ([www.tanksandtemples.org](http://www.tanksandtemples.org)) and the Open3D library ([open3d.org](http://open3d.org)).

#### Short Biography

Vladlen Koltun is a Senior Principal Researcher and the director of the Intelligent Systems Lab at Intel. His lab conducts high-impact basic research on intelligent systems. Vladlen received a PhD in 2002 for new results in theoretical computational geometry, spent three years at UC Berkeley as a postdoc in the theory group, and joined the Stanford Computer Science faculty in 2005 as a theoretician. He joined Intel in 2015 to establish a new lab devoted to basic research.

## Keynote

### Geometry Processing and Animated Films

*Mark Meyer*  
Pixar Animations

#### **Abstract**

Geometry processing techniques have become essential in almost every stage of the film production pipeline. This artist centric environment creates difficulties that are often not encountered in an academic setting. This talk will describe example uses of geometry processing in feature film content creation, the unique challenges that this environment brings, as well as some open problems still facing the industry.

#### **Short Biography**

Mark Meyer is a Senior Scientist and lead of the Research Group at Pixar Animation Studios. He received his BS in Computer Science and Computer Engineering from Northwestern University and his Ph.D. from Caltech. Before joining Pixar in 2003, Mark worked on virtual reality and simulation at Argonne National Laboratory and instructed Computer Graphics courses in the Computer Science department at Caltech. Mark is currently working in Pixar's Research Group on projects including character articulation, rendering acceleration, physical simulation and machine learning.

## Keynote

### Discrete Developable Surfaces: Theory and Fabrication of 3D Shapes From 2D Sheets

*Olga Sorkine-Hornung*  
ETH Zurich

#### Abstract

Geometric modeling and geometry processing is an indispensable part of digital fabrication, which has become a highly relevant and challenging area of research. Although "digital fabrication" is often perceived as synonymous with 3D printing, there is much to be gained by exploring other, more traditional fabrication methods as well, and the geometric challenges therein. In particular, fabrication with standard materials such as fabric, wood and sheet metal is universal and poses exciting questions. While shapes can be made very precisely out of such materials using laser or robotic cutting, a unifying challenge is the 2D nature of the medium vs. the 3D target shape. In this talk, I'd like discuss this challenge by studying developable surfaces and freeform modeling with such surfaces. I will discuss a discrete model for developable surfaces that is local, so that it can be plugged in into the well familiar variational shape modeling framework. I'll show some theoretical properties of this model and touch upon a few applications of developable surfaces in digital fabrication.

#### Short Biography

Olga Sorkine-Hornung is a Professor of Computer Science at ETH Zurich, where she leads the Interactive Geometry Lab and is currently the head of the Institute of Visual Computing. Prior to joining ETH she was an Assistant Professor at the Courant Institute of Mathematical Sciences, New York University (2008-2011). She earned her BSc in Mathematics and Computer Science and PhD in Computer Science from Tel Aviv University (2000, 2006). Following her studies, she received the Alexander von Humboldt Foundation Fellowship and spent two years as a postdoc at the Technical University of Berlin. Olga is interested in theoretical foundations and practical algorithms for digital content creation tasks, such as shape representation and editing, modeling techniques, digital fabrication, computer animation and digital image manipulation. She also works on fundamental problems in digital geometry processing, including reconstruction, parameterization, filtering and compression of geometric data.

Olga received the EUROGRAPHICS Young Researcher Award (2008), the ACM SIGGRAPH Significant New Researcher Award (2011), the ERC Starting Grant (2012), the ETH Latsis Prize (2012), the Intel Early Career Faculty Award (2013), the EUROGRAPHICS Outstanding Technical Contributions Award (2017) and the Rossler Prize (2017), as well as a number of Best Paper/Software awards. She has been serving on the editorial boards of several journals, such as ACM TOG, IEEE TVCG and Computer Graphics Forum. In 2019 she will serve as the ACM SIGGRAPH technical papers chair.