MATHEMATICS AND VISUALIZATION

Hans-Christian Hege · Konrad Polthier
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Topology-Based Methods in Visualization II

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Topology Based Methods In Visualization Mathematics And Visualization

Ingrid Hotz,Talha Bin Masood,Filip Sadlo,Julien Tierny

Topology Based Methods In Visualization Mathematics And Visualization:

   Topology-based Methods in Visualization Helwig Hauser,Hans Hagen,Holger Theisel,2007-05-24 Enabling insight into large and complex datasets is a prevalent theme in visualization research for which different approaches are pursued Topology based methods are built on the idea of abstracting characteristic structures such as the topological skeleton from the data and to construct the visualizations accordingly There are currently new demands for and renewed interest in topology based visualization solutions This book presents 13 peer reviewed papers as written results from the 2005 workshop Topology Based Methods in Visualization that was initiated to enable additional stimulation in this field It contains a longer chapter dedicated to a survey of the state of the art as well as a great deal of original work by leading experts that has not been published before spanning both theory and applications It captures key concepts and novel ideas and serves as an overview of current trends in topology based visualization research   Topology-Based Methods in Visualization II Hans-Christian Hege,Konrad Polthier,Gerik Scheuermann,2009-02-07 Visualization research aims to provide insight into large complicated data sets and the phenomena behind them While there are di erent methods of reaching this goal topological methods stand out for their solid mathem ical foundation which guides the algorithmic analysis and its presentation Topology based methods in visualization have been around since the beg ning of visualization as a scienti c discipline but they initially played only a minor role In recent years interest in topology basedvisualization has grown andsigni cantinnovationhasledto newconceptsandsuccessfulapplications The latest trends adapt basic topological concepts to precisely express user interests in topological properties of the data This book is the outcome of the second workshop on Topological Methods in Visualization which was held March 4 6 2007 in Kloster Nimbschen near Leipzig Germany Theworkshopbroughttogethermorethan40international researchers to present and discuss the state of the art and new trends in the eld of topology based visualization Two inspiring invited talks by George Haller MIT and Nelson Max LLNL were accompanied by 14 presentations by participants and two panel discussions on current and future trends in visualization research This book contains thirteen research papers that have been peer reviewed in a two stage review process In the rst phase submitted papers where peer reviewed by the international program committee After the workshop accepted papers went through a revision and a second review process taking into account comments from the rst round and discussions at the workshop Abouthalfthepapersconcerntopology basedanalysisandvisualizationof uid owsimulations twopapersconcernmoregeneraltopologicalalgorithms while theremaining papers discuss topology based visualization methods in application areas like biology medical imaging and electromagnetism   Topology-based Methods in Visualization Helwig Hauser,Hans Hagen,Holger Theisel,2009-09-02 This book presents 13 peer reviewed papers as written results from the 2005 workshop Topology Based Methods in Visualization that was initiated to enable additional stimulation in this field It contains a survey of the state of the art as well original work by leading experts that has not been published

before spanning both theory and applications It captures key concepts and novel ideas and serves as an overview of current trends in its subject **Topological Methods in Data Analysis and Visualization** Valerio Pascucci,Xavier Tricoche,Hans Hagen,Julien Tierny,2010-11-23 Topology based methods are of increasing importance in the analysis and visualization of datasets from a wide variety of scientific domains such as biology physics engineering and medicine Current challenges of topology based techniques include the management of time dependent data the representation of large and complex datasets the characterization of noise and uncertainty the effective integration of numerical methods with robust combinatorial algorithms etc The editors have brought together the most prominent and best recognized researchers in the field of topology based data analysis and visualization for a joint discussion and scientific exchange of the latest results in the field This book contains the best 20 peer reviewed papers resulting from the discussions and presentations at the third workshop on Topological Methods in Data Analysis and Visualization held 2009 in Snowbird Utah US The 2009 TopoInVis workshop follows the two successful workshops in 2005 Slovakia and 2007 Germany Topological and Statistical Methods for Complex Data Janine Bennett,Fabien Vivodtzev,Valerio Pascucci,2014-11-19 This book contains papers presented at the Workshop on the Analysis of Large scale High Dimensional and Multi Variate Data Using Topology and Statistics held in Le Barp France June 2013 It features the work of some of the most prominent and recognized leaders in the field who examine challenges as well as detail solutions to the analysis of extreme scale data The book presents new methods that leverage the mutual strengths of both topological and statistical techniques to support the management analysis and visualization of complex data It covers both theory and application and provides readers with an overview of important key concepts and the latest research trends Coverage in the book includes multi variate and or high dimensional analysis techniques feature based statistical methods combinatorial algorithms scalable statistics algorithms scalar and vector field topology and multi scale representations In addition the book details algorithms that are broadly applicable and can be used by application scientists to glean insight from a wide range of complex data sets **Topological Methods in Data Analysis and Visualization IV** Hamish Carr,Christoph Garth,Tino Weinkauf,2017-06-01 This book presents contributions on topics ranging from novel applications of topological analysis for particular problems through studies of the effectiveness of modern topological methods algorithmic improvements on existing methods and parallel computation of topological structures all the way to mathematical topologies not previously applied to data analysis Topological methods are broadly recognized as valuable tools for analyzing the ever increasing flood of data generated by simulation or acquisition This is particularly the case in scientific visualization where the data sets have long since surpassed the ability of the human mind to absorb every single byte of data The biannual TopoInVis workshop has supported researchers in this area for a decade and continues to serve as a vital forum for the presentation and discussion of novel results in applications in the area creating a platform to disseminate knowledge about such implementations throughout and beyond the community The present volume resulting from the 2015 TopoInVis

workshop held in Annweiler Germany will appeal to researchers in the fields of scientific visualization and mathematics domain scientists with an interest in advanced visualization methods and developers of visualization software systems

Topological Methods in Data Analysis and Visualization II Ronald Peikert,Helwig Hauser,Hamish Carr,Raphael Fuchs,2012-01-10 When scientists analyze datasets in a search for underlying phenomena patterns or causal factors their first step is often an automatic or semi automatic search for structures in the data Of these feature extraction methods topological ones stand out due to their solid mathematical foundation Topologically defined structures as found in scalar vector and tensor fields have proven their merit in a wide range of scientific domains and scientists have found them to be revealing in subjects such as physics engineering and medicine Full of state of the art research and contemporary hot topics in the subject this volume is a selection of peer reviewed papers originally presented at the fourth Workshop on Topology Based Methods in Data Analysis and Visualization TopoInVis 2011 held in Zurich Switzerland The workshop brought together many of the leading lights in the field for a mixture of formal presentations and discussion One topic currently generating a great deal of interest and explored in several chapters here is the search for topological structures in time dependent flows and their relationship with Lagrangian coherent structures Contributors also focus on discrete topologies of scalar and vector fields and on persistence based simplification among other issues of note The new research results included in this volume relate to all three key areas in data analysis theory algorithms and applications *Computer Graphics* Nobuhiko Mukai,2012-03-30 Computer graphics is now used in various fields for industrial educational medical and entertainment purposes The aim of computer graphics is to visualize real objects and imaginary or other abstract items In order to visualize various things many technologies are necessary and they are mainly divided into two types in computer graphics modeling and rendering technologies This book covers the most advanced technologies for both types It also includes some visualization techniques and applications for motion blur virtual agents and historical textiles This book provides useful insights for researchers in computer graphics **Interactive Knowledge Discovery and Data Mining in Biomedical Informatics** Andreas Holzinger,Igor Jurisica,2014-06-17 One of the grand challenges in our digital world are the large complex and often weakly structured data sets and massive amounts of unstructured information This big data challenge is most evident in biomedical informatics the trend towards precision medicine has resulted in an explosion in the amount of generated biomedical data sets Despite the fact that human experts are very good at pattern recognition in dimensions of 3 most of the data is high dimensional which makes manual analysis often impossible and neither the medical doctor nor the biomedical researcher can memorize all these facts A synergistic combination of methodologies and approaches of two fields offer ideal conditions towards unraveling these problems Human Computer Interaction HCI and Knowledge Discovery Data Mining KDD with the goal of supporting human capabilities with machine learning ppThis state of the art survey is an output of the HCI KDD expert network and features 19 carefully selected and reviewed papers related to seven hot and promising

research areas Area 1 Data Integration Data Pre processing and Data Mapping Area 2 Data Mining Algorithms Area 3 Graph based Data Mining Area 4 Entropy Based Data Mining Area 5 Topological Data Mining Area 6 Data Visualization and Area 7 Privacy Data Protection Safety and Security **Progress in Image Analysis and Processing, ICIAP 2013** Alfredo Petrosino,2013-09-03 This two volume set LNCS 8156 and 8157 constitutes the refereed proceedings of the 17th International Conference on Image Analysis and Processing ICIAP 2013 held in Naples Italy in September 2013 The 162 papers presented were carefully reviewed and selected from 354 submissions The papers aim at highlighting the connection and synergies of image processing and analysis with pattern recognition and machine learning human computer systems biomedical imaging and applications multimedia interaction and processing 3D computer vision and understanding objects and scene *Advances in Visual Computing* George Bebis,Richard Boyle,Bahram Parvin,Darko Koracin,Fowlkes Charless,Wang Sen,Choi Min-Hyung,Stephan Mantler,Jurgen Schulze,Daniel Acevedo,Klaus Mueller,Michael Papka,2012-08-22 The two volume set LNCS 7431 and 7432 constitutes the refereed proceedings of the 8th International Symposium on Visual Computing ISVC 2012 held in Rethymnon Crete Greece in July 2012 The 68 revised full papers and 35 poster papers presented together with 45 special track papers were carefully reviewed and selected from more than 200 submissions The papers are organized in topical sections Part I LNCS 7431 comprises computational bioimaging computer graphics calibration and 3D vision object recognition illumination modeling and segmentation visualization 3D mapping modeling and surface reconstruction motion and tracking optimization for vision graphics and medical imaging HCI and recognition Part II LNCS 7432 comprises topics such as unconstrained biometrics advances and trends intelligent environments algorithms and applications applications virtual reality face processing and recognition **Advancing Pharmaceutical Processes and Tools for Improved Health Outcomes** Gasmelseid, Tagelsir Mohamed,2016-04-19 There has been a growing concern for the improvement of pharmaceutical services provided by healthcare institutions This concern is also shared by other stakeholders including patients regulatory organizations pharmaceutical companies insurance companies and research institutions Advancing Pharmaceutical Processes and Tools for Improved Health Outcomes presents research based perspectives on the pharmaceutical industry in today s digitally fueled world Focusing on technological innovations for pharmaceutical applications as well as current trends in the industry this publication is ideally designed for use by pharmacists medical professionals administrators in the medical field health insurance professionals researchers and graduate level students **See through** Jochen Jankowai,2024-12-13 The problem of visualising multivariate data and tensor fields inherits its complexity from the data it targets By definition complex data is hard to separate analyse or solve1 This becomes evident through the fact that methods for simple data such as scalars and vectors do not trivially extend to multivariate data and tensors In the light of increasing number of output variables from simulation models and measurements this lack of methods leads to a limited choice in the analysis and to a lower fidelity of the analysis In addition

split application of established methods to a subset of the data for example the separate rendering of isosurfaces for the different scalar fields contained in multivariate data brings about a number of challenges and pitfalls In this work I present several approaches to extending existing methods for scalar field visualisation and analysis to multivariate data and in some cases by extension tensor fields Specifically I have investigated the extraction of isosurfaces from multivariate data the topological analysis of multivariate data and tensor fields and the design of transfer functions for tensor fields Isosurfaces contours are a widely used visualisation modality They can be used to intuitively highlight regions of interest and are the goto choice for taking snapshots during large scale in situ simulations to verify results In domains such as meteorology where simulations yield a number of output variables for pressure temperature precipitation etc methods for visualising multivariate isosurfaces are needed Feature level sets offer such a method by interpreting an isosurface as the result of an intersection of the isovalue with the data in the domain From this we expand the notion of isovalues in this context called traits and isosurfaces to arbitrary dimensionality An intermediate product of the calculation of feature level sets is the distance field defining every data point s distance towards the trait Given this distance field we compute the merge tree for it and thereby enable topological analysis of multivariate data The choice of merge trees comes naturally as minima in the distance field correspond to regions closest to the trait The concept of derived fields as input is also used in our approach to topological analysis of tensor fields Special attention needs to be paid to the non linear behaviour of derived vector and scalar fields We use the field of eigenvectors derived from the tensor field to determine cells containing degenerate points in tensor fields and insert zero valued points in the corresponding anisotropy field This process yields a scalar field which can subsequently be used as input for further topological analysis Another challenge when it comes to the visualisation of tensor fields is the design of transfer functions in the context of volume rendering This is because of the high dimensional entity that is a tensor and its non linear derivatives We span a shape space which is populated by representatives which visually encode the tensor This allows the user to steer the rendering by selecting the desired shape of the tensor rather than adjusting a slider for a derived scalar value 1 Merriam Webster Complex In Merriam Webster dictionary Merriam Webster com Retrieved December 1st 2024 from https www merriam webster com dictionary complex Problemet med att visualisera multivariat data och tensorf lt beror p komplexiteten hos sj lva datan Enligt definitionen best r komplexa data av m nga delar som h nger samman p ett sv r versk dligt s tt2 Detta blir uppenbart genom det faktum att metoder f r enkla data s som skal rer och vektorer inte p ett trivialt s tt g r att utvidga till multivariat data och tensorer P grund av det kande antalet outputvariabler fr n simuleringsmodeller och m tningar leder denna brist till ett begr nsat val av metoder i analysen och till en l gre analystrohet Dessutom medf r en uppdelad till mpning av etablerade metoder p en delm ngd av data till exempel separat rendering av isoytor f r de olika skal ra f lten som ing r i multivariat data ett antal utmaningar och fallgropar I detta arbete presenterar jag flera tillv gag ngss tt f r att utvidga befintliga metoder f r skal rf ltsvisualisering och analys till

multivariat data och i vissa fall i f rl ngningen tensorf lt Specifikt har jag unders kt extraktion av isoytor fr n multivariat data den topologiska analysen av multivariat data och tensorf lt samt designen av verf ringsfunktioner f r tensorf lt Isoytor konturer r en v lk nd visualiseringsteknik De kan anv ndas f r att intuitivt lyfta fram omr den av intresse och r det naturliga valet f r att ta gonblicksbilder under storskaliga simuleringar p plats f r att verifiera resultat Inom omr den som meteorologi d r simuleringar ger ett antal utdatavariabler f r tryck temperatur nederb rd etc beh vs metoder f r att visualisera multivariata isoytor Feature level sets erbjuder en s dan metod genom att tolka en isoyta som resultatet av en sk rning av isov rdet med data i dom nen Genom detta ut kar vi begreppet isov rden i detta sammanhang kallade traits och isoytor till godtycklig dimensionalitet En mellanprodukt av ber kningen av feature level sets r avst ndsf ltet som definierar varje datapunkts avst nd till trait en Med tanke p detta avst ndsf lt ber knar vi merge trees f r det och m jligg r d rigenom topologisk analys av multivariata data Valet av merge trees kommer naturligt d minima i avst ndsf ltet motsvarar regioner n rmast trait en Konceptet med ber knade f lt som input anv nds ocks i v rt f rh llningss tt till topologisk analys av tensorf lt Det icke linj ra beteendet hos h rledda utr knade vektor och skal ra f lt b r h r gnas s rskild uppm rksamhet Vi anv nder f ltet av egenvektorer som h rleds fr n tensorf ltet f r att best mma celler som inneh ller degenererade punkter i tensorf lt och infogar nollv rdespunkter i motsvarande anisotropif lt Denna process ger ett skal rt f lt som sedan kan anv ndas som input f r ytterligare topologisk analys En annan utmaning n r det kommer till visualisering av tensorf lt r utformningen av verf ringsfunktioner i samband med volymrendering Detta beror p den h gdimensionella enheten som r en tensor och dess icke linj ra derivator Vi erbjuder ett bredd designutrymme f r att visuellt koda tensorn Detta g r att anv ndaren kan styra renderingen genom att v lja nskad form av tensorn ist llet f r att justera en skjutreglage f r ett h rlett skal rt v rde 2 Svensk ordbok Komplex I Svenska Akademiens ordbok svenska se H mtad den 1 a december 2024 fr n https svenska se so id 140703_ 1 pz 3 **Hierarchical and Geometrical Methods in Scientific Visualization** Gerald Farin,Bernd Hamann,Hans Hagen,2012-12-06 The nature of the physical Universe has been increasingly better understood in recent years and cosmological concepts have undergone a rapid evolution see e g 11 2 or 5 Although there are alternate theories it is generally believed that the large scale relationships and homogeneities that we see can only be explainedby having the universe expand suddenlyin a very early in ationary period Subsequent evolution of the Universe is described by the Hubble expansion the observation that the galaxies are ying away from each other We can attribute di erent rates of this expansion to domination of di erent cosmological processes beginning with radiation evolving to matter domination and relatively recently to vacuum domination the Cosmological Constant term 4 We assume throughout that we will be relying as much as possible on observational data with simulations used only for limited purposes e g the appearance of the Milky Wayfrom nearbyintergalactic viewpoints The visualization of large scale astronomical data sets using xed non interactive animations has a long history Several books and lms exist ranging from Cosmic View The Universe in Forty Jumps 3 by Kees Boeke to

Powers of 10 6 13 by Charles and Ray Eames and the recent Imax lm Cosmic Voyage 15 We have added our own contribution 9 Cosmic Clock which is an animation based entirely on the concepts and implementation described in this paper

   Topological Methods in Data Analysis and Visualization VI Ingrid Hotz,Talha Bin Masood,Filip Sadlo,Julien Tierny,2021-09-28 This book is a result of a workshop the 8th of the successful TopoInVis workshop series held in 2019 in Nyk ping Sweden The workshop regularly gathers some of the world s leading experts in this field Thereby it provides a forum for discussions on the latest advances in the field with a focus on finding practical solutions to open problems in topological data analysis for visualization The contributions provide introductory and novel research articles including new concepts for the analysis of multivariate and time dependent data robust computational approaches for the extraction and approximations of topological structures with theoretical guarantees and applications of topological scalar and vector field analysis for visualization The applications span a wide range of scientific areas comprising climate science material sciences fluid dynamics and astronomy In addition community efforts with respect to joint software development are reported and discussed   **Topological Methods in Data Analysis and Visualization V** Hamish Carr,Issei Fujishiro,Filip Sadlo,Shigeo Takahashi,2020-12-10 This collection of peer reviewed workshop papers provides comprehensive coverage of cutting edge research into topological approaches to data analysis and visualization It encompasses the full range of new algorithms and insights including fast homology computation comparative analysis of simplification techniques and key applications in materials and medical science The book also addresses core research challenges such as the representation of large and complex datasets and integrating numerical methods with robust combinatorial algorithms In keeping with the focus of the TopoInVis 2017 Workshop the contributions reflect the latest advances in finding experimental solutions to open problems in the sector They provide an essential snapshot of state of the art research helping researchers to keep abreast of the latest developments and providing a basis for future work Gathering papers by some of the world s leading experts on topological techniques the book represents a valuable contribution to a field of growing importance with applications in disciplines ranging from engineering to medicine   **Innovations for Shape Analysis** Michael Breuß,Alfred Bruckstein,Petros Maragos,2013-04-04 The concept of shape is at the heart of image processing and computer vision yet researchers still have some way to go to replicate the human brain s ability to extrapolate meaning from the most basic of outlines This volume reflects the advances of the last decade which have also opened up tough new challenges in image processing Today s applications require flexible models as well as efficient mathematically justified algorithms that allow data processing within an acceptable timeframe Examining important topics in continuous scale and discrete modeling as well as in modern algorithms the book is the product of a key seminar focused on innovations in the field It is a thorough introduction to the latest technology especially given the tutorial style of a number of chapters It also succeeds in identifying promising avenues for future research The topics covered include mathematical morphology skeletonization statistical shape modeling

continuous scale shape models such as partial differential equations and the theory of discrete shape descriptors Some authors highlight new areas of enquiry such as partite skeletons multi component shapes deformable shape models and the use of distance fields Combining the latest theoretical analysis with cutting edge applications this book will attract both academics and engineers   Topological Methods in Data Analysis and Visualization III Peer-Timo Bremer,Ingrid Hotz,Valerio Pascucci,Ronald Peikert,2014-04-22 This collection of peer reviewed conference papers provides comprehensive coverage of cutting edge research in topological approaches to data analysis and visualization It encompasses the full range of new algorithms and insights including fast homology computation comparative analysis of simplification techniques and key applications in materials and medical science The volume also features material on core research challenges such as the representation of large and complex datasets and integrating numerical methods with robust combinatorial algorithms Reflecting the focus of the TopoInVis 2013 conference the contributions evince the progress currently being made on finding experimental solutions to open problems in the sector They provide an inclusive snapshot of state of the art research that enables researchers to keep abreast of the latest developments and provides a foundation for future progress With papers by some of the world s leading experts in topological techniques this volume is a major contribution to the literature in a field of growing importance with applications in disciplines that range from engineering to medicine   **Nonlinearity** ,2009-04

The Mathematics of Surfaces IX Roberto Cipolla,2000 This book contains the Proceedings of the Ninth Mathematics of Surfaces Conference organised by the Institute of Mathematics and its Applications and held in Cambridge UK on 4th 6th September 2000 The papers describe the mathematical construction representation approximation recognition and manipulation of surfaces with an emphasis on computational methods Highlights include invited papers from M Floater SNTEF Norway O Faugeras INRIA France P Giblin Liverpool University UK M S Kim Seoul National University Korea J Koenderink University of Utrecht Netherlands N Patrikalakis MIT USA H Pottmann Technical University of Vienna Austria and R Schaback University of G ttingen Germany

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