

Ross Maciejewski

Data Representations, Transformations, and Statistics for Visual Reasoning

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Francesco Cafaro, Jessica Roberts



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Data Representations, Transformations, and Statistics for Visual Reasoning Ross Maciejewski, 2011-05-10

Analytical reasoning techniques are methods by which users explore their data to obtain insight and knowledge that can directly support situational awareness and decision making Recently the analytical reasoning process has been augmented through the use of interactive visual representations and tools which utilize cognitive design and perceptual principles These tools are commonly referred to as visual analytics tools and the underlying methods and principles have roots in a variety of disciplines This chapter provides an introduction to young researchers as an overview of common visual representations and statistical analysis methods utilized in a variety of visual analytics systems The application and design of visualization and analytical algorithms are subject to design decisions parameter choices and many conflicting requirements As such this chapter attempts to provide an initial set of guidelines for the creation of the visual representation including pitfalls and areas where the graphics can be enhanced through interactive exploration Basic analytical methods are explored as a means of enhancing the visual analysis process moving from visual analysis to visual analytics Table of Contents Data Types Color Schemes Data Preconditioning Visual Representations and Analysis Summary *Data Representations, Transformations, and Statistics for Visual Reasoning* Ross Maciejewski, 2022-06-01 Analytical reasoning techniques are methods by which users explore their data to obtain insight and knowledge that can directly support situational awareness and decision making Recently the analytical reasoning process has been augmented through the use of interactive visual representations and tools which utilize cognitive design and perceptual principles These tools are commonly referred to as visual analytics tools and the underlying methods and principles have roots in a variety of disciplines This chapter provides an introduction to young researchers as an overview of common visual representations and statistical analysis methods utilized in a variety of visual analytics systems The application and design of visualization and analytical algorithms are subject to design decisions parameter choices and many conflicting requirements As such this chapter attempts to provide an initial set of guidelines for the creation of the visual representation including pitfalls and areas where the graphics can be enhanced through interactive exploration Basic analytical methods are explored as a means of enhancing the visual analysis process moving from visual analysis to visual analytics Table of Contents Data Types Color Schemes Data Preconditioning Visual Representations and Analysis Summary **Semantic Interaction for Visual Analytics** Alex Endert, 2022-05-31 This book discusses semantic interaction a user interaction methodology for visual analytic applications that more closely couples the visual reasoning processes of people with the computation This methodology affords user interaction on visual data representations that are native to the domain of the data User interaction in visual analytics systems is critical to enabling visual data exploration Interaction transforms people from mere viewers to active participants in the process of analyzing and understanding data This discourse between people and data enables people to understand aspects of their data such as structure patterns trends

outliers and other properties that ultimately result in insight Through interacting with visualizations users engage in sensemaking a process of developing and understanding relationships within datasets through foraging and synthesis The book provides a description of the principles of semantic interaction providing design guidelines for the integration of semantic interaction into visual analytics examples of existing technologies that leverage semantic interaction and a discussion of how to evaluate these technologies Semantic interaction has the potential to increase the effectiveness of visual analytic technologies and opens possibilities for a fundamentally new design space for user interaction in visual analytics systems

Interactive GPU-based Visualization of Large Dynamic Particle Data Martin Falk, Sebastian

Grottel, Michael Krone, Guido Reina, 2022-05-31 Prevalent types of data in scientific visualization are volumetric data vector field data and particle based data Particle data typically originates from measurements and simulations in various fields such as life sciences or physics The particles are often visualized directly that is by simple representants like spheres Interactive rendering facilitates the exploration and visual analysis of the data With increasing data set sizes in terms of particle numbers interactive high quality visualization is a challenging task This is especially true for dynamic data or abstract representations that are based on the raw particle data This book covers direct particle visualization using simple glyphs as well as abstractions that are application driven such as clustering and aggregation It targets visualization researchers and developers who are interested in visualization techniques for large dynamic particle based data Its explanations focus on GPU accelerated algorithms for high performance rendering and data processing that run in real time on modern desktop hardware Consequently the implementation of said algorithms and the required data structures to make use of the capabilities of modern graphics APIs are discussed in detail Furthermore it covers GPU accelerated methods for the generation of application dependent abstract representations This includes various representations commonly used in application areas such as structural biology systems biology thermodynamics and astrophysics

Data through Movement

Francesco Cafaro, Jessica Roberts, 2022-06-01 When you picture human data interactions HDI what comes to mind The datafication of modern life along with open data initiatives advocating for transparency and access to current and historical datasets has fundamentally transformed when where and how people encounter data People now rely on data to make decisions understand current events and interpret the world We frequently employ graphs maps and other spatialized forms to aid data interpretation yet the familiarity of these displays causes us to forget that even basic representations are complex challenging inscriptions and are not neutral they are based on representational choices that impact how and what they communicate This book draws on frameworks from the learning sciences visualization and human computer interaction to explore embodied HDI This exciting sub field of interaction design is based on the premise that every day we produce and have access to quintillions of bytes of data the exploration and analysis of which are no longer confined within the walls of research laboratories This volume examines how humans interact with these data in informal not work or school

environments particularly in museums The first half of the book provides an overview of the multi disciplinary theoretical foundations of HDI in particular embodied cognition conceptual metaphor theory embodied interaction and embodied learning and reviews socio technical theories relevant for designing HDI installations to support informal learning The second half of the book describes strategies for engaging museum visitors with interactive data visualizations presents methodologies that can inform the design of hand gestures and body movements for embodied installations and discusses how HDI can facilitate people s sensemaking about data This cross disciplinary book is intended as a resource for students and early career researchers in human computer interaction and the learning sciences as well as for more senior researchers and museum practitioners who want to quickly familiarize themselves with HDI Visual Analysis of Multilayer Networks

Fintan McGee,Benjamin Renoust,Daniel Archambault,Mohammad Ghoniem,Andreas Kerren,Bruno Pinaud,2022-06-01 The emergence of multilayer networks as a concept from the field of complex systems provides many new opportunities for the visualization of network complexity and has also raised many new exciting challenges The multilayer network model recognizes that the complexity of relationships between entities in real world systems is better embraced as several interdependent subsystems or layers rather than a simple graph approach Despite only recently being formalized and defined this model can be applied to problems in the domains of life sciences sociology digital humanities and more Within the domain of network visualization there already are many existing systems which visualize data sets having many characteristics of multilayer networks and many techniques which are applicable to their visualization In this Synthesis Lecture we provide an overview and structured analysis of contemporary multilayer network visualization This is not only for researchers in visualization but also for those who aim to visualize multilayer networks in the domain of complex systems as well as those solving problems within application domains We have explored the visualization literature to survey visualization techniques suitable for multilayer network visualization as well as tools tasks and analytic techniques from within application domains We also identify the research opportunities and examine outstanding challenges for multilayer network visualization along with potential solutions and future research directions for addressing them **External**

Labeling Michael A. Bekos,Benjamin Niedermann,Martin Nöllenburg,2022-06-01 This book focusses on techniques for automating the procedure of creating external labelings also known as callout labelings In this labeling type the features within an illustration are connected by thin leader lines called leaders with their labels which are placed in the empty space surrounding the image In general textual labels describing graphical features in maps technical illustrations such as assembly instructions or cutaway illustrations or anatomy drawings are an important aspect of visualization that convey information on the objects of the visualization and help the reader understand what is being displayed Most labeling techniques can be classified into two main categories depending on the distance of the labels to their associated features Internal labels are placed inside or in the direct neighborhood of features while external labels which form the topic of this

book are placed in the margins outside the illustration where they do not occlude the illustration itself Both approaches form well studied topics in diverse areas of computer science with several important milestones The goal of this book is twofold The first is to serve as an entry point for the interested reader who wants to get familiar with the basic concepts of external labeling as it introduces a unified and extensible taxonomy of labeling models suitable for a wide range of applications The second is to serve as a point of reference for more experienced people in the field as it brings forth a comprehensive overview of a wide range of approaches to produce external labelings that are efficient either in terms of different algorithmic optimization criteria or in terms of their usability in specific application domains The book mostly concentrates on algorithmic aspects of external labeling but it also presents various visual aspects that affect the aesthetic quality and usability of external labeling

Interaction for Visualization Christian Tominski, 2022-06-01 Visualization has become a valuable means for data exploration and analysis Interactive visualization combines expressive graphical representations and effective user interaction Although interaction is an important component of visualization approaches much of the visualization literature tends to pay more attention to the graphical representation than to interaction The goal of this work is to strengthen the interaction side of visualization Based on a brief review of general aspects of interaction we develop an interaction oriented view on visualization This view comprises five key aspects the data the tasks the technology the human as well as the implementation Picking up these aspects individually we elaborate several interaction methods for visualization We introduce a multi threading architecture for efficient interactive exploration We present interaction techniques for different types of data e g multivariate data spatio temporal data graphs and different visualization tasks e g exploratory navigation visual comparison visual editing With respect to technology we illustrate approaches that utilize modern interaction modalities e g touch tangibles proxemics as well as classic ones While the human is important throughout this work we also consider automatic methods to assist the interactive part In addition to solutions for individual problems a major contribution of this work is the overarching view of interaction in visualization as a whole This includes a critical discussion of interaction the identification of links between the key aspects of interaction and the formulation of research topics for future work with a focus on interaction

Image-Based Visualization Christophe Hurter, 2022-05-31 Our society has entered a data driven era one in which not only are enormous amounts of data being generated daily but there are also growing expectations placed on the analysis of this data Some data have become simply too large to be displayed and some have too short a lifespan to be handled properly with classical visualization or analysis methods In order to address these issues this book explores the potential solutions where we not only visualize data but also allow users to be able to interact with it Therefore this book will focus on two main topics large dataset visualization and interaction Graphic cards and their image processing power can leverage large data visualization but they can also be of great interest to support interaction Therefore this book will show how to take advantage of graphic card computation power with techniques called

GPGPUs general purpose computing on graphics processing units As specific examples this book details GPGPU usages to produce fast enough visualization to be interactive with improved brushing techniques fast animations between different data representations and view simplifications i e static and dynamic bundling techniques Since data storage and memory limitation is less and less of an issue we will also present techniques to reduce computation time by using memory as a new tool to solve computationally challenging problems We will investigate innovative data processing techniques while classical algorithms are expressed in data space e g computation on geographic locations we will express them in graphic space e g raster map like a screen composed of pixels This consists of two steps 1 a data representation is built using straightforward visualization techniques and 2 the resulting image undergoes purely graphical transformations using image processing techniques This type of technique is called image based visualization The goal of this book is to explore new computing techniques using image based techniques to provide efficient visualizations and user interfaces for the exploration of large datasets This book concentrates on the areas of information visualization visual analytics computer graphics and human computer interaction This book opens up a whole field of study including the scientific validation of these techniques their limitations and their generalizations to different types of datasets

Design of Visualizations for Human-Information Interaction Kamran Sedig, Paul Parsons, 2022-05-31 Interest in visualization design has increased in recent years While there is a large body of existing work from which visualization designers can draw much of the past research has focused on developing new tools and techniques that are aimed at specific contexts Less focus has been placed on developing holistic frameworks models and theories that can guide visualization design at a general level a level that transcends domains data types users and other contextual factors In addition little emphasis has been placed on the thinking processes of designers including the concepts that designers use while they are engaged in a visualization design activity In this book we present a general holistic framework that is intended to support visualization design for human information interaction The framework is composed of a number of conceptual elements that can aid in design thinking The core of the framework is a pattern language consisting of a set of 14 basic abstract patterns and a simple syntax for describing how the patterns are blended We also present a design process made up of four main stages for creating static or interactive visualizations The 4 stage design process places the patterns at the core of designers thinking and employs a number of conceptual tools that help designers think systematically about creating visualizations based on the information they intend to represent Although the framework can be used to design static visualizations for simple tasks its real utility can be found when designing visualizations with interactive possibilities in mind in other words designing to support a human information interactive discourse This is especially true in contexts where interactive visualizations need to support complex tasks and activities involving large and complex information spaces The framework is intended to be general and can thus be used to design visualizations for diverse domains users information spaces and tasks in different fields such as business intelligence health and medical

informatics digital libraries journalism education scientific discovery and others Drawing from research in multiple disciplines we introduce novel concepts and terms that can positively contribute to visualization design practice and education and will hopefully stimulate further research in this area

Adaptive and Personalized Visualization Alvitta Ottley, 2022-05-31 There is ample evidence in the visualization community that individual differences matter These prior works highlight various personality traits and cognitive abilities that can modulate the use of the visualization systems and demonstrate a measurable influence on speed accuracy process and attention Perhaps the most important implication of this body of work is that we can use individual differences as a mechanism for estimating when a design is effective or to identify when people may struggle with visualization designs These effects can have a critical impact on consequential decision making processes One study that appears in this book investigated the impact of visualization on medical decision making showed that visual aides tended to be most beneficial for people with high spatial ability a metric that measures a person s ability to represent and manipulate two or three dimensional representations of objects mentally The results showed that participants with low spatial ability had difficulty interpreting and analyzing the underlying medical data when they use visual aids Overall approximately 50% of the studied population were unsupported by the visualization tools when making a potentially life critical decision As data fluency continues to become an essential skill for our everyday lives we must embrace the growing need to understand the factors that may render our tools ineffective and identify concrete steps for improvement This book presents my current understanding of how individual differences in personality interact with visualization use and draws from recent research in the Visualization Human Computer Interaction and Psychology communities We focus on the specific designs and tasks for which there is concrete evidence of performance divergence due to personality Additionally we highlight an exciting research agenda that is centered around creating tailored visualization systems that are aligned with people s abilities The purpose of this book is to underscore the need to consider individual differences when designing and evaluating visualization systems and to call attention to this critical research direction

Diversity in Visualization Ron Metoyer, Kelly Gaither, 2022-06-01 At the 2016 IEEE VIS Conference in Baltimore Maryland a panel of experts from the Scientific Visualization SciVis community gathered to discuss why the SciVis component of the conference had been shrinking significantly for over a decade As the panelists concluded and opened the session to questions from the audience Annie Preston a Ph D student at the University of California Davis asked whether the panelists thought diversity or more specifically the lack of diversity was a factor This comment ignited a lively discussion of diversity not only its impact on Scientific Visualization but also its role in the visualization community at large The goal of this book is to expand and organize the conversation In particular this book seeks to frame the diversity and inclusion topic within the Visualization community illuminate the issues and serve as a starting point to address how to make this community more diverse and inclusive This book acknowledges that diversity is a broad topic with many possible meanings Expanded definitions of

diversity that are relevant to the Visualization community and to computing at large are considered The broader conversation of inclusion and diversity is framed within the broader sociological context in which it must be considered Solutions to recruit and retain a diverse research community and strategies for supporting inclusion efforts are presented Additionally community members present short stories detailing their non inclusive experiences in an effort to facilitate a community wide conversation surrounding very difficult situations It is important to note that this is by no means intended to be a comprehensive authoritative statement on the topic Rather this book is intended to open the conversation and begin to build a framework for diversity and inclusion in this specific research community While intended for the Visualization community ideally this book will provide guidance for any computing community struggling with similar issues and looking for solutions

User-Centered Evaluation of Visual Analytics Jean Scholtz, 2022-05-31 Visual analytics has come a long way since its inception in 2005 The amount of data in the world today has increased significantly and experts in many domains are struggling to make sense of their data Visual analytics is helping them conduct their analyses While software developers have worked for many years to develop software that helps users do their tasks this task is becoming more and more onerous as understanding the needs and data used by expert users requires more than some simple usability testing during the development process The need for a user centered evaluation process was envisioned in *Illuminating the Path* the seminal work on visual analytics by James Thomas and Kristin Cook in 2005 We have learned over the intervening years that not only will user centered evaluation help software developers to turn out products that have more utility the evaluation efforts can also help point out the direction for future research efforts This book describes the efforts that go into analysis including critical thinking sensemaking and various analytics techniques learned from the intelligence community Support for these components is needed in order to provide the most utility for the expert users There are a good number of techniques for evaluating software that has been developed within the human computer interaction HCI community While some of these techniques can be used as is others require modifications These too are described in the book An essential point to stress is that the users of the domains for which visual analytics tools are being designed need to be involved in the process The work they do and the obstacles in their current processes need to be understood in order to determine both the types of evaluations needed and the metrics to use in these evaluations At this point in time very few published efforts describe more than informal evaluations The purpose of this book is to help readers understand the need for more user centered evaluations to drive both better designed products and to define areas for future research Hopefully readers will view this work as an exciting and creative effort and will join the community involved in these efforts

Visual and Spatial Analysis Boris Kovalerchuk, James Schwing, 2007-11-06 Advanced visual analysis and problem solving has been conducted successfully for millennia The Pythagorean Theorem was proven using visual means more than 2000 years ago In the 19th century John Snow stopped a cholera epidemic in London by proposing that a specific water pump be shut down He discovered that pump by

visually correlating data on a city map The goal of this book is to present the current trends in visual and spatial analysis for data mining reasoning problem solving and decision making This is the first book to focus on visual decision making and problem solving in general with specific applications in the geospatial domain combining theory with real world practice The book is unique in its integration of modern symbolic and visual approaches to decision making and problem solving As such it ties together much of the monograph and textbook literature in these emerging areas This book contains 21 chapters that have been grouped into five parts 1 visual problem solving and decision making 2 visual and heterogeneous reasoning 3 visual correlation 4 visual and spatial data mining and 5 visual and spatial problem solving in geospatial domains Each chapter ends with a summary and exercises The book is intended for professionals and graduate students in computer science applied mathematics imaging science and Geospatial Information Systems GIS In addition to being a state of the art research compilation this book can be used a text for advanced courses on the subjects such as modeling computer graphics visualization image processing data mining GIS and algorithm analysis

Visualizing Time Graham Wills, 2011-12-02 Art or Science Which of these is the right way to think of the field of visualization This is not an easy question to answer even for those who have many years experience in making graphical depictions of data with a view to help people understand it and take action In this book Graham Wills bridges the gap between the art and the science of visually representing data He does not simply give rules and advice but bases these on general principles and provide a clear path between them This book is concerned with the graphical representation of time data and is written to cover a range of different users A visualization expert designing tools for displaying time will find it valuable but so also should a financier assembling a report in a spreadsheet or a medical researcher trying to display gene sequences using a commercial statistical package

Visual Analytics for Data Scientists Natalia Andrienko, Gennady Andrienko, Georg Fuchs, Aidan Slingsby, Cagatay Turkay, Stefan Wrobel, 2020-08-30 This textbook presents the main principles of visual analytics and describes techniques and approaches that have proven their utility and can be readily reproduced Special emphasis is placed on various instructive examples of analyses in which the need for and the use of visualisations are explained in detail The book begins by introducing the main ideas and concepts of visual analytics and explaining why it should be considered an essential part of data science methodology and practices It then describes the general principles underlying the visual analytics approaches including those on appropriate visual representation the use of interactive techniques and classes of computational methods It continues with discussing how to use visualisations for getting aware of data properties that need to be taken into account and for detecting possible data quality issues that may impair the analysis The second part of the book describes visual analytics methods and workflows organised by various data types including multidimensional data data with spatial and temporal components data describing binary relationships texts images and video For each data type the specific properties and issues are explained the relevant analysis tasks are discussed and appropriate methods and procedures are introduced

The focus here is not on the micro level details of how the methods work but on how the methods can be used and how they can be applied to data. The limitations of the methods are also discussed and possible pitfalls are identified. The textbook is intended for students in data science and more generally anyone doing or planning to do practical data analysis. It includes numerous examples demonstrating how visual analytics techniques are used and how they can help analysts to understand the properties of data, gain insights into the subject reflected in the data, and build good models that can be trusted. Based on several years of teaching related courses at the City University of London, the University of Bonn, and TU Munich, as well as industry training at the Fraunhofer Institute IAIS and numerous summer schools, the main content is complemented by sample datasets and detailed illustrated descriptions of exercises to practice applying visual analytics methods and workflows.

[Visualize this](#) Nathan Yau, 2011. Presents information on ways to present data with visual representations covering such topics as data sources, visualization tools, proportions, and spatial relationships. *Foundations of Data Visualization* Min Chen, Helwig Hauser, Penny Rheingans, Gerik Scheuermann, 2021-08-13. This is the first book that focuses entirely on the fundamental questions in visualization. Unlike other existing books in the field, it contains discussions that go far beyond individual visual representations and individual visualization algorithms. It offers a collection of investigative discourses that probe these questions from different perspectives, including concepts that help frame these questions and their potential answers, mathematical methods that underpin the scientific reasoning of these questions, empirical methods that facilitate the validation and falsification of potential answers, and case studies that stimulate hypotheses about potential answers while providing practical evidence for such hypotheses. Readers are not instructed to follow a specific theory, but their attention is brought to a broad range of schools of thoughts and different ways of investigating fundamental questions. As such, the book represents the by now most significant collective effort for gathering a large collection of discourses on the foundation of data visualization. Data visualization is a relatively young scientific discipline. Over the last three decades, a large collection of computer-supported visualization techniques have been developed, and the merits and benefits of using these techniques have been evidenced by numerous applications in practice. These technical advancements have given rise to the scientific curiosity about some fundamental questions, such as why and how visualization works when it is useful or effective, and when it is not, what are the primary factors affecting its usefulness and effectiveness, and so on. This book signifies timely and exciting opportunities to answer such fundamental questions by building on the wealth of knowledge and experience accumulated in developing and deploying visualization technology in practice.

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