


Data Visualization

Principles and Practice

Second Edition

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 **CRC Press**
Taylor & Francis Group
Boca Raton London New York

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AN A K PETERS BOOK

First edition published in 2007 by A K Peters, Ltd.

Cover image: The cover shows the combination of scientific visualization and information visualization techniques for the exploration of the quality of a dimensionality reduction (DR) algorithm for multivariate data. A 19-dimensional dataset is projected to a 2D point cloud. False-positive projection errors are shown by the alpha-blended colored textures surrounding the points. The five most important point groups, indicating topics in the input dataset, are shown using image-based shaded cushions colored by group identity. The bundled graph shown atop groups highlights the all-pairs false-negative projection errors and is constructed by a mix of geometric and image-based techniques. For details, see Section 11.5.7, page 524, and [Martins et al. 14].

CRC Press
Taylor & Francis Group
6000 Broken Sound Parkway NW, Suite 300
Boca Raton, FL 33487-2742

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Printed on acid-free paper
Version Date: 20140514

International Standard Book Number-13: 978-1-4665-8526-3 (Hardback)

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Library of Congress Cataloging-in-Publication Data

Telea, Alexandru C., 1972-

Data visualization : principles and practice / Alexandru C. Telea. -- Second edition.
pages cm

Summary: "This book explores the study of processing and visually representing data sets. Data visualization is closely related to information graphics, information visualization, scientific visualization, and statistical graphics. This second edition presents a better treatment of the relationship between traditional scientific visualization and information visualization, a description of the emerging field of visual analytics, and updated techniques using the GPU and new generations of software tools and packages. This edition is also enhanced with exercises and downloadable code and data sets"-- Provided by publisher.

Includes bibliographical references and index.

ISBN 978-1-4665-8526-3 (hardback)

1. Computer graphics. 2. Information visualization. I. Title.

T385.T452 2014

001.4'226028566--dc23

2014008643

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Contents

Preface to Second Edition	xi
1 Introduction	1
1.1 How Visualization Works	3
1.2 Positioning in the Field	12
1.3 Book Structure	15
1.4 Notation	18
1.5 Online Material	18
2 From Graphics to Visualization	21
2.1 A Simple Example	22
2.2 Graphics-Rendering Basics	28
2.3 Rendering the Height Plot	30
2.4 Texture Mapping	36
2.5 Transparency and Blending	39
2.6 Viewing	43
2.7 Putting It All Together	47
2.8 Conclusion	50
3 Data Representation	53
3.1 Continuous Data	53
3.2 Sampled Data	57
3.3 Discrete Datasets	66
3.4 Cell Types	67
3.5 Grid Types	74

3.6	Attributes	81
3.7	Computing Derivatives of Sampled Data	96
3.8	Implementation	100
3.9	Advanced Data Representation	111
3.10	Conclusion	120
4	The Visualization Pipeline	123
4.1	Conceptual Perspective	123
4.2	Implementation Perspective	136
4.3	Algorithm Classification	144
4.4	Conclusion	145
5	Scalar Visualization	147
5.1	Color Mapping	147
5.2	Designing Effective Colormaps	149
5.3	Contouring	163
5.4	Height Plots	176
5.5	Conclusion	181
6	Vector Visualization	183
6.1	Divergence and Vorticity	184
6.2	Vector Glyphs	188
6.3	Vector Color Coding	196
6.4	Displacement Plots	200
6.5	Stream Objects	203
6.6	Texture-Based Vector Visualization	223
6.7	Simplified Representation of Vector Fields	234
6.8	Illustrative Vector Field Rendering	250
6.9	Conclusion	252
7	Tensor Visualization	253
7.1	Principal Component Analysis	254
7.2	Visualizing Components	259
7.3	Visualizing Scalar PCA Information	259
7.4	Visualizing Vector PCA Information	263
7.5	Tensor Glyphs	266
7.6	Fiber Tracking	269
7.7	Illustrative Fiber Rendering	274

7.8	Hyperstreamlines	280
7.9	Conclusion	283
8	Domain-Modeling Techniques	285
8.1	Cutting	285
8.2	Selection	290
8.3	Grid Construction from Scattered Points	292
8.4	Grid-Processing Techniques	312
8.5	Conclusion	324
9	Image Visualization	327
9.1	Image Data Representation	327
9.2	Image Processing and Visualization	329
9.3	Basic Imaging Algorithms	330
9.4	Shape Representation and Analysis	345
9.5	Conclusion	402
10	Volume Visualization	405
10.1	Motivation	406
10.2	Volume Visualization Basics	409
10.3	Image Order Techniques	422
10.4	Object Order Techniques	428
10.5	Volume Rendering vs. Geometric Rendering	430
10.6	Conclusion	432
11	Information Visualization	435
11.1	What Is Infovis?	436
11.2	Infovis vs. Scivis: A Technical Comparison	438
11.3	Table Visualization	446
11.4	Visualization of Relations	452
11.5	Multivariate Data Visualization	505
11.6	Text Visualization	532
11.7	Conclusion	547
12	Conclusion	549
	Visualization Software	555
A.1	Taxonomies of Visualization Systems	555
A.2	Scientific Visualization Software	557
A.3	Imaging Software	561

A.4 Grid Processing Software	566
A.5 Information Visualization Software	569
Bibliography	575
Index	599

Preface to Second Edition

THIS is the second edition of the book *Data Visualization: Principles and Practice* first published in 2008. Since its first edition, many advances and developments have been witnessed by the data-visualization field. Several techniques and methods have evolved from the research arena into the practitioner's toolset. Other techniques have been improved by new implementations or algorithms that capitalize on the increased computing power available in mainstream desktop or laptop computers. Different implementation and dissemination technologies, such as those based on the many facets of the Internet, have become increasingly important. Finally, existing application areas have gained increasing importance, such as those addressed by information visualization, and new application areas at the crossroads of several disciplines have emerged.

The second edition of this book provides a revised and refined view on data visualization principles and practice. The structure of the book in terms of chapters treating various visualization techniques was kept the same. So was the bottom-up approach that starts with the representation of discrete data, and continues with the description of the visualization pipeline, followed by a presentation of visualization techniques for increasingly complex data types (scalar, vector, tensor, domain modeling, images, volumes, and non-spatial datasets). The second edition revises and extends the presented material by covering a significant number of additional visualization algorithms and techniques, as follows. Chapter 1 positions the book in the broad context of scientific visualization, information visualization, and visual analytics, and also with respect to other books in the current visualization literature. Chapter 2 completes the transitional overview from graphics to visualization by listing the complete elements of a simple but self-contained OpenGL visualization application. Chapter 3 covers the gridless

interpolation of scattered datasets in more detail. Chapter 4 describes the desirable properties of a good visualization mapping in more detail, based on a concrete example. Chapter 5 discusses colormap design in additional detail, and also presents the enridged plots technique. Chapter 6 extends the set of vector visualization techniques discussed with a more detailed discussion of stream objects, including densely seeded streamlines, streaklines, stream surfaces, streak surfaces, vector field topology, and illustrative techniques. Chapter 7 introduces new examples of combined techniques for diffusion tensor imaging (DTI) visualization, and discusses also illustrative fiber track rendering and fiber bundling techniques. Chapter 8 introduces additional techniques for point-cloud reconstruction such as non-manifold classification, alpha shapes, ball pivoting, Poisson reconstruction, and sphere splatting. For mesh refinement, the Loop subdivision algorithm is discussed. Chapter 9 presents six additional advanced image segmentation algorithms (active contours, graph cuts, mean shift, superpixels, level sets, and dense skeletons). The shape analysis discussion is further refined by presenting several recent algorithms for surface and curve skeleton extraction. Chapter 10 presents several new examples of volume rendering. Chapter 11 has known arguably the largest expansion, as it covers several additional information visualization techniques (simplified edge bundles, general graph bundling, visualization of dynamic graphs, diagram visualization, and an expanded treatment of dimensionality reduction techniques). Finally, the appendix has been updated to include several important software systems and libraries. Separately, all chapters have been thoroughly revised to correct errors and improve the exposition, and several new references to relevant literature have been added.

Additionally, the second edition has been complemented by online material, including exercises, datasets, and source code. This material can serve both to practice the techniques described in the book, but also as a basis to construct a practical course in data visualization. Visit the book's website: <http://www.cs.rug.nl/svcg/DataVisualizationBook>.