APPENDIX A

History of Computer Graphics and Visualization

Some of the key events and developments that have advanced the computer graphics field are listed below. Students of data and information visualization would be well served by gaining a better understanding of the history of this field. Disclaimer: this history is by no means complete, and possibly has some inaccuracies in it. The authors welcome contributions and corrections, and we will maintain a "live" version of this document on the book's web site.

The 1960s:

- The term *computer graphics* was coined by William Fetter, Boeing (1960).
- First computer-animated film (*Two-Gyro Gravity-Gradient Attitude Control System*, by Edward Zajak, Bell Labs) (1961).
- First video game (Spacewar) developed by Steve Russell at MIT (1961).
- Sketchpad, by Ivan Sutherland, MIT—first extensive interactive drawing program (1963).
- First computer model of a human figure, by William Fetter, Boeing, for use in the study of cockpit design (1964).
- First computer animation language (BEFLIX), by Ken Knowlton, Bell Labs (1965).

- Jack Bresenham develops efficient algorithm to scan convert lines (1965).
- First computer-generated art show, Stuttgart (1965).
- Ivan Sutherland creates first head-mounted display (1966).
- Ralph Baer develops first home video game (Odyssey) that allowed users to move points around a screen (1966).
- Scan-line hidden surface removal algorithm developed by Wylie, Romney, Evans, and Erdahl (1967).
- Jacques Bertin's *Semiologie Graphique* is published (1967).
- Ray tracing invented by Appel (1968).
- First frame buffer built (three bits), at Bell Labs (1969).
- Area subdivision hidden surface removal algorithm developed by Warnock (1969).

The 1970s:

- Intensity interpolated shading developed by Gouraud (1971).
- Goldstein and Nagel perform first ray tracing using Boolean set operations (the basis of constructive solid geometry) (1971).
- First 8-bit frame buffer (with color map) built by Richard Shoup, Xerox PARC (1972). Evans and Sutherland started marketing frame buffers in 1973–74, with first ones sold to NYIT.
- Depth-sorting hidden surface removal algorithm developed by Newell, Newell, and Sancha (1972).
- *Westworld* debuts—first significant entertainment film that employed computer animation (1973).
- Herman Chernoff introduces the use of cartoon faces to convey multivariate data (1973).
- Ed Catmull pioneers texture mapping on curved surfaces (1974).
- Sutherland and Hodgman develop a polygon clipping algorithm (1974).
- PRIM-9, the first interactive visualization system for visual data analysis, is presented by Fishkiller, Friedman, and Tukey (1974).

- Phong Bui-Tuong develops the specular illumination model and normal interpolation shading (1975).
- Scatterplot Matrix introduced by John Hartigan (1975).
- Jim Blinn introduces environmental mapping (1976).
- Frank Crow develops solutions to the aliasing problem (1977).
- Jack Bresenham develops an efficient algorithm to scan convert circles (1977).
- Jim Blinn introduces bump mapping (1978).
- Cyrus and Beck develop a parametric line-clipping algorithm (1978).
- Linked brushing invented by Carol Newton (1978).
- First synthesis of rendering transparent surfaces, by Kay and Greenberg (1979).
- Herman and Liu demonstrate volume rendering on tomographic data (1979).

The 1980s:

- Turner Whitted creates a general ray-tracing paradigm that incorporates reflection, refraction, antialiasing, and shadows (1980).
- Fisheye lens developed by George Furnas (1981).
- *TRON* released by Disney films, containing 15 minutes and 235 scenes of computer-generated images. Companies involved were MAGI, Triple I, Digital Effects, and Robert Abel and Associates (1982).
- Octrees introduced as a mechanism for geometric modeling by Meager (1982).
- Silicon Graphics is founded by James Clark (1982).
- James Blinn wins first SIGGRAPH Computer Graphics Achievement Award (1983).
- Particle systems introduced by William Reeves (1983).
- Radiosity introduced by Goral, Torrance, Greenberg, and Battaile (1984).

- Liang and Barsky develop an efficient clipping algorithm for rectilinear clipping regions (1984).
- Grand Tour for exploring multivariate data invented by Daniel Asimov (1985).
- Parallel Coordinates introduced by Al Inselberg (1985).
- Pixar is bought from Lucasfilm by Steve Jobs (1986).
- Marching Cubes algorithm published by Lorensen and Cline (1987).
- *Tin Toy* wins Academy Award for best animated short film (1989).

The 1990s:

- First IEEE Visualization Conference (1990).
- Hanrahan and Lawson introduce Renderman (1990).
- Treemaps introduced by Ben Shneiderman (1991).
- IBM releases Visualization Data Explorer, later to become OpenDX (1991).
- Advanced Visual Systems releases AVS (1991).
- Silicon Graphics, Inc., release the OpenGL specifications (1992).
- First CAVE virtual reality environment presented at SIGGRAPH by the University of Illinois (1992).
- *Doom* and *Myst* released (1993).
- Table Lens introduced by Ramesh Rao and Stuart Card (1994).
- XmdvTool released to the public domain (1994).
- Keim introduces pixel-oriented techniques in VisDB (1994).
- First Information Visualization Conference (1995).
- Buena Vista Pictures releases *Toy Story*, the first full-length, computer-generated feature film (1995).
- First-generation GPUs released—ATI Rage, Nvidia TNT2, and 3Dfx Voodoo3 (1996).

- *Quake* released (1996).
- Founding of Spotfire, Inc. (1996); acquired by TIBCO in 2007.
- Second-generation GPUs released—NVidia GeForce 256, ATI Radeon 7500, and S3 Savage3D (1998).
- Alias Maya released (1998).
- Pixar's *Geri's Game* wins Academy Award for animated short film (1998).
- *Star Wars Episode I: The Phantom Menace* is released, containing 68 digital characters (including Jar Jar Binks) (1999).

The 2000s:

- Third-generation GPUs released—Nvidia GeForce 256, ATI Radeon 8500, and Microsoft Xbox (2001).
- Fourth-generation GPUs released—Nvidia GeForce FX and ATI Radeon 9700 (2003).
- Founding of Tableau Software, Inc. (2003).
- Thomas and Cook publish *Illuminating the Path: Research and Development Agenda Visual Analytics* (2005).
- First Visual Analytics Science and Technology Symposium (2006).

APPENDIX B

Example Data Sets

In this book, we use a variety of data sets to help explain techniques and illustrate design principles, all available from the book's web site (http://www.idvbook.com/). By using data from a wide range of disciplines, we hope to convey to the reader exactly how widespread the applications for visualization are; indeed, many innovations in the field have resulted from the exploration of ways to visualize data in new fields. It also is our experience that visualization specialists can find roles for themselves in virtually any domain, which enables us to expand our understanding of new disciplines while making a significant contribution to the advancement of both the visualization field and the application domain area.

One of the most common roadblocks to visualizing data is converting files from their original format (usually dependent on the tools used to acquire the data) to one that is acceptable to the visualization tool you wish to use. Thus, by providing a number of sample data sets, along with detailed descriptions of their formats, we hope to facilitate users in this process. All data sets used in this textbook can be found at the book's web site, along with links to other data repositories and sites containing very detailed descriptions and software for different popular data formats.

The Iris Data Set

The Iris data set, a small, well-understood and known data set, consists of the measurements of four attributes of 150 iris flowers from three types of irises. The typical task for the Iris data set is to classify the type of iris based on the measurements. It is one of the most analyzed data sets in statistics, data mining, and multivariate visualization. It was first published by R. A. Fisher in 1936 [127] and is widely available (our copy came from StatLib at CMU (http://lib.stat.cmu.edu)). The file is in CSV format, which can be imported to Excel and other programs. The data dimensions are as follows:

1. sepal length in cm;
2. sepal width in cm;
3. petal length in cm;
4. petal width in cm;
5. class:
   - Iris Setosa
   - Iris Versicolour
   - Iris Virginica

The Detroit Data Set

This is a small data set dealing with homicide rates in Detroit between the years 1961 and 1973. The goal should be to try to find the variables that best predict the homicide rate. The original data were collected by J.C. Fisher and used in his paper [128]. The copy we distribute is also from StatLib at CMU and is in ASCII format. There is one record per year.

The data dimensions are as follows:

- FTP—Full-time police per 100,000 population;
- UEMP—% unemployed in the population;
- MAN—number of manufacturing workers in thousands;
- LIC—Number of handgun licenses per 100,000 population;
- GR—Number of handgun registrations per 100,000 population;
- CLEAR—% homicides cleared by arrests;
- WM—Number of white males in the population;
- NMAN—Number of non-manufacturing workers in thousands;

- GOV—Number of government workers in thousands;
- HE—Average hourly earnings;
- WE—Average weekly earnings;
- HOM—Number of homicides per 100,000 of population;
- ACC—Death rate in accidents per 100,000 population;
- ASR—Number of assaults per 100,000 population.

The Breakfast Cereal Data Set

This data set contains nutritional information for 77 different breakfast cereals. It was used for the 1993 Statistical Graphics Exposition as a challenge data set. We retrieved this data from StatLib at CMU. The data is from the nutritional labels and is in CSV format. The variables are:

- cereal name;
- manufacturer (e.g., Kellogg's);
- type (cold/hot);
- calories (number);
- protein (g);
- fat (g);
- sodium (mg);
- dietary fiber (g);
- complex carbohydrates (g);
- sugars (g);
- display shelf (1, 2, or 3, counting from the floor);
- potassium (mg);
- vitamins and minerals (0, 25, or 100, respectively);
- weight (in ounces) of one serving (serving size);
- cups per serving.

Manufacturers are represented by their first initial: A = American Home Food Products, G = General Mills, K = Kelloggs, N = Nabisco, P = Post, Q = Quaker Oats, R = Ralston Purina.

The CT Head Data Set

This data set consists of a 113-slice MRI data set of a CT study of a cadaver head. Slices are stored in individual files as a 256 $\times$ 256 binary array (no header). Format is 16-bit integers (Mac ordering)—two consecutive bytes make up one binary integer. Data was acquired using a General Electric CT Scanner and provided courtesy of North Carolina Memorial Hospital. The data was acquired from http://graphics.stanford.edu/data/voldata/.

The UVW Data Set

This is a 3D vector data set generated via a computational fluid dynamics simulator. The data is in ASCII format and represents one time slice of unsteady velocity in a turbulent channel flow. After a 2-line header, the rows of the file consist of 6 dimensions—x, y, z, u, v, and w. The dimensions are 96 by 65 by 48. The data set was provided by Drs. Jiacai Lu and Gretar Tryggvason, ME Department, Worcester Polytechnic Institute. Note, there is roughly a 20:1:1 ratio between u, v, and w.

The Dow Jones Industrial Average Data Set

This is a time-series data set containing more than 100 years of daily averages for the Dow Jones. The source is http://www.analyzeindices.com/dow-jones-history.shtml, but it can also be found on StatLib. The format is ASCII text, with each line being of the form YYMMDD, closing value.

The Colorado Elevation Data Set

This is an array of elevations in Colorado. The data is included in the distribution of OpenDX (http://www.opendx.org/). The format is a binary file with a 268-byte header followed by a 400 by 400 array of 1-byte elevations.

The City-Temperature Data Set

This is an ASCII file containing the average January temperatures for a number of U.S. cities. It consists of the city name and state, the average temperature, and the longitude and latitude. It is in Excel format.

APPENDIX C

Sample Programs

Many different languages and programming environments can be used to design visualizations. Some, such as AVS and OpenDX, use a visual programming structure that allows users to construct programs via point-and-click. Other languages, such as Java and C++, have bindings to different graphics libraries (2D and 3D), that allow you to build significant applications, though the programmer needs a fair amount of programming experience to accomplish this. In between are languages such as Processing that try to hide some of the low-level details of the programming language, allowing you to rapidly construct nontrivial visualizations. In this appendix, we show some examples of such programs. Additional code is available on the book's web site.

A Processing Program for Terrain Visualization

```
/**
 * TopoSurface - by Matt Ward
 * This program reads in a file of elevation data and displays
 * a rubber sheet view.  Interactions supported include zooming,
 * panning, and rotation.  Panning is via mouse motions, while
 * zooming and rotation are keyboard clicks.
 */
int[][] distances = new int[400][400]; // buffer for elevation data
int shiftX, shiftY; // translation amounts
float angleX, angleY, angleZ; // rotation amounts
int camera_distance; // zooming amount

void setup() {
  size(400,400, P3D); // elevation data is 400 by 400
```

```
  shiftX = width/2; // center the initial translation
  shiftY = height/2;
  angleX = 0;
  angleY = 0;
  angleZ = 0;
  camera_distance = 500;

// open a file and read its binary data
byte b[] = loadBytes("colorado_elev.vit");

// skip 268 byte header and convert bytes to ints
  for(int i = 0; i < 400; i++)
   for(int j = 0;j < 400; j++)
      distances[i][j] = b[268 + i*400 + j] & 0xff;
}

void draw() {
  background(0);
  lights();
// set camera to look at middle of data
  camera(200, 200, camera_distance,
         200, 200, 0,
         0.0, 1.0, 0.0);
// interpret left mouse clicks as translates
  if(mousePressed && mouseButton == LEFT)  {
    shiftX = mouseX - width/2;
    shiftY = mouseY - height/2;
  }
  translate(shiftX, shiftY);
// now perform all rotations
  rotateY(angleY);
  rotateX(angleX);
  rotateZ(angleZ);
// don't draw edges, set fill to white, and draw the surface
  noStroke();
  fill(255, 255, 255);
  drawSurface(distances);
}

// handle all keystroke events for zoom and rotate (fixed amounts)
  void keyPressed()  {
    if(key == '-') camera_distance += 100;
    else  if (key == '+') camera_distance -= 100;
    else if(key == 'x') angleX += .25;
    else if(key == 'X') angleX -= .25;
    else if(key == 'y') angleY += .25;
```

```
    else if(key == 'Y') angleY -= .25;
    else if(key == 'z') angleZ += .25;
    else if(key == 'Z') angleZ -= .25;
  }

// to draw the surface, make a bunch of triangle strips
void drawSurface(int distances[][])  {

int x = 1; // x and y are the distances between adjacent data points
int y = 1;
float px = -width/2, py = -height/2; // we want things centered on
                                     // origin
float pts = 399; // the number of triangles in a strip

for(int j = 0;j < pts;j++)  {
// create a triangle strip for each row in the data
  beginShape(TRIANGLE_STRIP);
// first vertices are along edge
    vertex(px,py, (float)distances[j][0]);
    vertex(px,py+y, (float)distances[j+1][0]);
// for rest of vertices, alternate between 2 rows
    for (int i = 0; i < pts; i++) {
      px = px + x;
      vertex(px, py, (float)distances[j][i+1]);
      vertex(px, py+y, (float)distances[j+1][i+1]);
      }
  endShape();
// shift row and reset x to edge
  py = py + y;
  px = -width/2;
  }
}
```

A Processing Program to View Slices of Flow Data

```
/**
 * FlowSlicer - visualizing 3D flow data.  Written by Matt Ward
 *
 * Loads the file uvw.dat, which is an ascii file with about 400K
 * 3D vectors. The format is [x y z u v w] in floating point.
 * The output is an animation of the slices on a uniform grid
 * with 2 of the 3 vector components creating a line in the
 * direction of the vector.
 */
```

```
String[] lines; // lines of the input data
float[][][] u, v, w; // storage for the 3D vectors
int slice = 0;  // slice of the volume being visualized
void setup() {
  size(800, 800);
  background(0);
  stroke(255);
  frameRate(1); // put a little space between frams
  lines = loadStrings("uvw.dat");  // data set is hard coded
  u = new float[96][65][48];  // as are the dimensions!
  v = new float[96][65][48];
  w = new float[96][65][48];
  int index = 2;  // first 2 lines are metadata
  for(int i = 0; i < 48; i++)
    for(int j = 0;j < 65;j++)
      for(int k = 0;k < 96; k++)  {
        String[] pieces = split(lines[index], ' ');
                            // break line into tokens
        u[k][j][i] = float(pieces[3]) * 5.;
                // note dx/u is scaled different from others
        v[k][j][i] = float(pieces[4]) * 100.;
        w[k][j][i] = float(pieces[5]) * 100.;
        index++;  // get the next line of data
      }
}

// draw the current slice
void draw() {
  int sx, sy, ex, ey;
  background(0);  // clear the display first
  for(int j = 0;j < 65;j++)
    for(int k = 0; k < 96; k++)  {
      sx = j * 8;  // I space the points out so vectors don't overlap
      sy = k * 8;
      ex = sx + (int)u[k][j][slice];
                            // endpoint is based on 2 vector components
      ey = sy + (int)w[k][j][slice];
      line(sx, sy, ex, ey);
    }
   slice++;  // increment the slice - if the last one, start over
   if(slice >= 48) {
     slice = 0;
   }
}
```

A Java Program to View Slices of Flow Data

```
--------------FlowView.java-------------------------------------------
/* Program to view uvw.dat, a 3D flow data set.  Written by Zhenyu Guo.
 * Uses 2 classes - FlowView and Voxel (programs similar
 * to VolumeSlicer).
 * Note - it takes a little while to read in data.
 */

import java.util.*;
import java.awt.*;
import java.awt.event.*;
import java.awt.image.MemoryImageSource;
import javax.swing.*;
import java.io.*;
import javax.swing.event.ChangeEvent;
import javax.swing.event.ChangeListener;

public class FlowView {

private JFrame frm;

private JPanel p1;

JLabel jlabel;
JSlider jslider;
JComboBox jcb;

SlicingFlowData svd;

//  set volume size - Note this is fixed
int l = 96;
int h = 65;
int w = 48;

// set up UI
public FlowView() {

frm = new JFrame("Flow Dataset Visualization");
Container c = frm.getContentPane();
c.setLayout(null);

p1 = new JPanel();
svd = new SlicingFlowData();
svd.setBackground(Color.WHITE);
svd.orientation = 0;
```

```
svd.setBounds(0,0,1400,900);
c.add(p1);
c.add(svd);
jslider = new JSlider(0, 100, 0);
jslider.setMaximum(w-1);
jslider.addChangeListener(listener);
jlabel = new JLabel("0");
jcb = new JComboBox();
jcb.addItem("aligned with x");
jcb.addItem("aligned with y");
jcb.addItem("aligned with z");
jcb.addActionListener(new action());
p1.add(jcb);
p1.add(jslider);
p1.add(jlabel);
p1.setBounds(100,900,200,100);

frm.setSize(1450, 1050);
frm.setLocation(0, 0);
frm.setVisible(true);
frm.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
}


// respond to slider changes
ChangeListener listener = new ChangeListener() {
        public void stateChanged(ChangeEvent e) {
            if (e.getSource() == jslider) {
                int i = jslider.getValue();
                jlabel.setText(String.valueOf(i));
                svd.pos = i;
                Graphics g = svd.getGraphics();
                svd.paintComponent(g);
            }
        }
    };

// respond to orientation selection
    class action implements ActionListener {
public void actionPerformed(ActionEvent e) {

// decide which button is pressed and execute operation
if (e.getSource() == jcb){
int i = jcb.getSelectedIndex();
svd.orientation = i;
jlabel.setText("0");
```

```
jslider.setValue(0);
if(i==0){
jslider.setMaximum(w - 1);
}else if (i==1){
jslider.setMaximum(h - 1);
}else if(i==2){
jslider.setMaximum(l - 1);
}
Graphics g = svd.getGraphics();
                svd.paintComponent(g);
}
}
}

// Start it up
    public static void main(String[] args) {
     try {
     new MainFrame();
     } catch (Exception e) {
     e.printStackTrace();
     }
    }
}

class SlicingFlowData extends JPanel {

Voxel [][][] dataset;  // each voxel has a 3D vector in it

Color [] ColorMap;  // a discrete ramp that is then interpolated

//  set volume size
int l = 96;
int h = 65;
int w = 48;

//  three orientations for a cut slice
//  acceptable value: 0, 1 or 2
int orientation;

//  the cut slice position
int pos = 0;

double minMagnitude = 10000000;
double maxMagnitude = -10000;

SlicingFlowData() {
```

```
dataset = new Voxel [l][h][w];
Read();
initColorMap();
}

// A yellow-to-blue discrete ramp
void initColorMap(){
ColorMap = new Color[9];
ColorMap[0] = new Color(255, 255, 217);
ColorMap[1] = new Color(237, 248, 177);
ColorMap[2] = new Color(199, 233, 180);
ColorMap[3] = new Color(127, 205, 187);
ColorMap[4] = new Color(65, 182, 196);
ColorMap[5] = new Color(29, 145, 192);
ColorMap[6] = new Color(34, 94, 168);
ColorMap[7] = new Color(37, 52, 148);
ColorMap[8] = new Color(8, 29, 88);
}


//  how to paint for visualization
public void paintComponent(Graphics g) {
clear(g);
Graphics2D g2d = (Graphics2D) g;

int pixDis = 14;  // set separation between base points of vectors
int maxArrowLength = 12;  // set maximum length of arrow

int startX = 10;  // set the position for the initial arrow
int startY = 10;

int r = 1;  // half the radius of the circle at the head of the arrow

BasicStroke bs0 = (BasicStroke) g2d.getStroke();
BasicStroke bs = new BasicStroke(2.5f);
g2d.setStroke(bs);

if (orientation == 0) {
// find min and max sizes in this projection
double min = 100000;
double max = -100000;
for (int i = 0; i < l; i++) {
for (int j = 0; j < h; j++) {
Voxel v = dataset[i][j][pos];
double m = v.orientation_x*v.orientation_x
                        + v.orientation_y*v.orientation_y;
```

```
if(m<min){
min = m;
}
if(m>max){
max = m;
}
}
}
min = Math.sqrt(min);
max = Math.sqrt(max);

// compute position, dimensions, and color for each vector
for (int i = 0; i < l; i++) {
for (int j = 0; j < h; j++) {
int x = startX + i*pixDis;
int y = startY + j*pixDis;
Voxel v = dataset[i][j][pos];
double m = Math.sqrt(v.orientation_x*v.orientation_x
                        + v.orientation_y*v.orientation_y);
int deltaX = (int)(v.orientation_x * (double)maxArrowLength
                        * ((m-min)/(max-min)));
int deltaY = (int)(v.orientation_y * (double)maxArrowLength
                        * ((m-min)/(max-min)));
g2d.setColor(getColor(v.magnitude));
// draw the vector with a filled circle at the head
g2d.drawLine(x, y, x + deltaX, y + deltaY);
g2d.drawOval(x + deltaX-r, y + deltaY-r, 2*r, 2*r);
}
}
// do the same for the other orientations
} else if (orientation == 1) {
double min = 100000;
double max = -100000;
for (int i = 0; i < l; i++) {
for (int j = 0; j < w; j++) {
Voxel v = dataset[i][pos][j];
double m = v.orientation_x*v.orientation_x + v.orientation_z
                         * v.orientation_z;
if(m<min){
min = m;
}
if(m>max){
max = m;
}
}
}
```

```
min = Math.sqrt(min);
max = Math.sqrt(max);
for (int i = 0; i < l; i++) {
for (int j = 0; j < w; j++) {
int x = startX + i*pixDis;
int y = startY + j*pixDis;
Voxel v = dataset[i][pos][j];
double m = Math.sqrt(v.orientation_x*v.orientation_x
                        + v.orientation_z*v.orientation_z);
int deltaX = (int)(v.orientation_x * (double)maxArrowLength
                         * ((m-min)/(max-min)));
int deltaY = (int)(v.orientation_z * (double)maxArrowLength
                         * ((m-min)/(max-min)));
g2d.setColor(getColor(v.magnitude));
g2d.drawLine(x, y, x + deltaX, y + deltaY);
g2d.drawOval(x + deltaX -r, y + deltaY-r, 2*r, 2*r);
}
}
}else if (orientation == 2) {
double min = 100000;
double max = -100000;
for (int i = 0; i < h; i++) {
for (int j = 0; j < w; j++) {
Voxel v = dataset[pos][i][j];
double m = v.orientation_y*v.orientation_y
                        + v.orientation_z*v.orientation_z;
if(m<min){
min = m;
}
if(m>max){
max = m;
}
}
}
min = Math.sqrt(min);
max = Math.sqrt(max);
for (int i = 0; i < h; i++) {
for (int j = 0; j < w; j++) {
int x = startX + i*pixDis;
int y = startY + j*pixDis;
Voxel v = dataset[pos][i][j];
double m = Math.sqrt(v.orientation_y*v.orientation_y
                         + v.orientation_z*v.orientation_z);
int deltaX = (int)(v.orientation_y * (double)maxArrowLength
                         * ((m-min)/(max-min)));
int deltaY = (int)(v.orientation_z * (double)maxArrowLength
```

```
                        * ((m-min)/(max-min)));
g2d.setColor(getColor(v.magnitude));
g2d.drawLine(x, y, x + deltaX, y + deltaY);
g2d.drawOval(x + deltaX-r, y + deltaY-r, 2*r, 2*r);
}
}
}

g2d.setStroke(bs0);
}

// The color is a yellow-to-blue ramp, interpolated from a discrete
// set of 8 colors
Color getColor(double magnitude){
double colorRange = this.maxMagnitude - this.minMagnitude;
// compute the index into the discrete ramp
double v = 8.0 * (magnitude - this.minMagnitude) / colorRange;
int lowColorIdx = (int)v;
// if this is the maximum magnitude, just return highest color
if(lowColorIdx==8){
return this.ColorMap[lowColorIdx];
}
// need to interpolate between this color and next
int highColorIdx = lowColorIdx + 1;

// interpolation to get a color
double r = (v-(double)lowColorIdx)*
           ((double)this.ColorMap[highColorIdx].getRed()-
           (double)this.ColorMap[lowColorIdx].getRed()) +
           (double)this.ColorMap[lowColorIdx].getRed();
double g = (v-(double)lowColorIdx)*
           ((double)this.ColorMap[highColorIdx].getGreen()-
           (double)this.ColorMap[lowColorIdx].getGreen()) +
           (double)this.ColorMap[lowColorIdx].getGreen();
double b = (v-(double)lowColorIdx)*
           ((double)this.ColorMap[highColorIdx].getBlue()-
           (double)this.ColorMap[lowColorIdx].getBlue()) +
           (double)this.ColorMap[lowColorIdx].getBlue();

return new Color((int)r, (int)g, (int)b);
}

// input the data and compute min and max magnitudes
void Read() {
String s = "uvw.dat";  // the input filename
try {
```

```
File f = new File(s);
System.out.println("reading: " + s);
if (!f.exists()) {
System.out.println(s + "doesn't exist");
}
FileInputStream inputStream = new FileInputStream(f);
BufferedReader br = new BufferedReader(new InputStreamReader(inputStream));

String [] line;  // one line of input file

// pass the first two lines - these are header information
br.readLine();
br.readLine();

// read a single file - note we scale v and w, as otherwise u dominates
for(int k=0; k<w; k++){
for(int j=0; j<h; j++){
for(int i=0; i<l; i++){
line = br.readLine().split(" ");
Voxel curReadingVoxel = new Voxel(Double.parseDouble(line[0]),
Double.parseDouble(line[1]), Double.parseDouble(line[2]),
Double.parseDouble(line[3]), Double.parseDouble(line[4])* 20.,
Double.parseDouble(line[5]) * 20.);
dataset[i][j][k] = curReadingVoxel;
}
}
}

//get max and min magnitude
for(int k=0; k<w; k++){
for(int j=0; j<h; j++){
for(int i=0; i<l; i++){
double mag = dataset[i][j][k].getMagnitude();
if(mag<minMagnitude){
minMagnitude = mag;
}
if(mag>maxMagnitude){
maxMagnitude = mag;
}
}
}
}


} catch (Exception e) {
e.printStackTrace();
```

```
}
}

void clear(Graphics g) {
super.paintComponent(g);
}
}

--------------Voxel.java------------------------------
// A class to hold a 3D vector from a flow field.
// Written by Zhenyu Guo.

public class Voxel {

double pos_x, pos_y, pos_z;
double magnitude;
double orientation_x, orientation_y, orientation_z;

Voxel(){
}

Voxel(double _pos_x, double _pos_y, double _pos_z, double u,
        double v, double w){
this.pos_x = _pos_x;
this.pos_y = _pos_y;
this.pos_z = _pos_z;

this.magnitude = Math.sqrt(u*u + v*v + w*w);

this.orientation_x = u/this.magnitude;
this.orientation_y = v/this.magnitude;
this.orientation_z = w/this.magnitude;
}


double getMagnitude(){
return this.magnitude;
}
}
```

Bibliography

[1] J. Abello, F. van Ham, and N. Krishnan. "ASK-GraphView: A Large Scale Graph Visualization System." *IEEE Trans. Visualization and Computer Graphics* 12:5 (2006), 669–676.

[2] Inc. ADVIZOR Solutions. "ADVIZOR Visual Discovery Software." http://www.advizorsolutions.com/, accessed February 2003.

[3] Maneesh Agrawala, Wilmot Li, and Floraine Berthouzoz. "Design Principles for Visual Communication." *Communications of the ACM* 54:4 (2011), 60–69.

[4] Wolfgang Aigner, Silvia Miksch, Bettina Thurnher, and Stefan Biffl. "PlanningLines: Novel Glyphs for Representing Temporal Uncertainties and Their Evaluation." In *Proceedings of the International Conference Information Visualisation (IV)*, pp. 457–463. Los Alamitos, CA: IEEE Computer Society, 2005.

[5] Wolfgang Aigner, Silvia Miksch, Heidrun Schumann, and Christian Tominski. *Visualization of Time-Oriented Data*. London: Springer, 2011.

[6] D. J. Aks and J. T. Enns. "Visual Search for Size Is Influenced by a Background Texture Gradient." *Journal of Experimental Psychology: Human Perception & Performance* 22:6 (1996), 1467–1481.

[7] Réka Albert and Albert-László Barabási. "Statistical Mechanics of Complex Networks." *Reviews of Modern Physics* 74:1 (2002), 47.

[8] V. V. Alexandrov and N. D. Gorsky. *From Humans to Computers: Cognition through Visual Perception*, World Scientific Series in Computer Science, 22. Singapore: World Scientific, 1991.

[9] James P. Allen. *Middle Egyptian: An Introduction to the Language and Culture of Hieroglyphs*, tenth edition. Cambridge, UK: Cambridge University Press, 2000.

[10] Erik W. Anderson, Kristin C. Potter, Laura E. Matzen, Jason F. Shepherd, Gilbert A. Preston, and Cláudio T. Silva. "A User Study of Visualization

Effectiveness Using EEG and Cognitive Load." *Computer Graphics Forum* 30:3 (2011), 791–800.

[11] E. Anderson. "A Semigraphical Method for the Analysis of Complex Problems." *Proceedings of the National Academy of Science* 13 (1957), 923–927.

[12] K. Andrews and H. Heidegger. "Information Slices: Visualizing and Exploring Large Hierarchies Using Cascading, Semicircular Discs." Late Breaking Hot Topics paper presented at IEEE Symposium on Information Visualization (InfoVis'98), Research Triangle Park, North Carolina, 1998.

[13] D. F. Andrews. "Plots of High Dimensional Data." *Biometrics* 28 (1972), 125–136.

[14] Gennady L. Andrienko and Natalia V. Andrienko. "Interactive Maps for Visual Data Exploration." *International Journal of Geographical Information Science* 13:4 (1999), 355–374.

[15] Natalia V. Andrienko and Gennady L. Andrienko. "Informed Spatial Decisions through Coordinated Views." *Information Visualization* 2:4 (2003), 270–285.

[16] Natalia Andrienko and Gennady Andrienko. *Exploratory Analysis of Spatial and Temporal Data: A Systematic Approach*. Berlin: Springer, 2006.

[17] Gennady Andrienko, Natalia Andrienko, Peter Bak, Daniel Keim, and Stefan Wrobel. *Visual Analytics of Movement*. Berlin: Springer, 2013.

[18] M. Ankerst, D. Keim, and H. Kriegel. "Circle Segments: A Technique for Visually Exploring Large Multidimensional Data Sets." Hot Topics paper presented at presented at IEEE Visualization '96, San Francisco, CA, October 27–November 1, 1996.

[19] Mihael Ankerst, Stefan Berchtold, and Daniel A. Keim. "Similarity Clustering of Dimensions for an Enhanced Visualization of Multidimensional Data." In *INFOVIS '98 Proceedings of the 1998 IEEE Symposium on Information Visualization*, pp. 52–60. Washington, DC: IEEE Computer Society, 1998.

[20] Francis J. Anscombe. "Graphs in statistical analysis." *The American Statistician* 27:1 (1973), 17–21.

[21] Hassan Aref, Richard D. Charles, and T. Todd Elvins. "Scientific Visualization of Fluid Flow." In *Frontiers of Scientific Visualization*, edited by Clifford A. Pickover and Stuart K. Tewksbury, pp. 7–44. New York: John Wiley and Sons, Inc., 1994.

[22] David Asimov. "The Grand Tour: A Tool for Viewing Multidimensional Data." *SIAM Journal of Scientific and Statistical Computing* 6:1 (1985), 128–143.

[23] AVS. "Advanced Visual Systems Home Page." http://www.avs.com/, accessed July 1, 2008.

[24] M. P. Baker and C. Bushell. "After the Storm: Considerations for Information Visualization." *IEEE Computer Graphics and Applications* 15 (1995), 12–15.

[25] Lyn Bartram, Colin Ware, and Tom Calvert. "Filtering and Integrating Visual Information with Motion." *Information Visualization* 1:1 (2002), 66–79.

[26] Lyn Bartram, Colin Ware, and Tom Calvert. "Moticons: Direction, distraction, and task." *International Journal of Computer-Human Studies* 58:5 (2003), 515–545.

[27] G. Di Battista, P. Eades, R. Tamassia, and I. G. Tollis. *Graph Drawing: Algorithms for the Visualization of Graphs*. Upper Saddle River, NJ: Prentice Hall, 1998.

[28] Richard A. Becker, Stephen G. Eick, and Allan R. Wilks. "Visualizing Network Data." *IEEE Transactions on Visualization and Computer Graphics* 1:1 (1995), 16–28.

[29] Jeff Beddow. "Shape Coding of Multidimensional Data on a Microcomputer Display." In *VIS '90: Proceedings of the 1st IEEE Conference on Visualization '90*, pp. 238–246. Los Alamitos, CA: IEEE Computer Society Press, 1990.

[30] R. Daniel Bergeron and Georges G. Grinstein. "A Reference Model for Scientific Visualization." In *Proceedings Eurographics '89*, pp. 393–399. Aire-la-Ville, Switzerland: Eurographics Association, 1989.

[31] L. D. Bergman, B. E. Rogowitz, and L. A. Treinish. "A Rule-Based Tool for Assisting Colormap Selection." In *VIS '95: Proceedings of the 6th Conference on Visualization '95*, p. 118. Washington, DC: IEEE Computer Society, 1995.

[32] Berkeley Institute of Design. "Prefuse Home Page." http://prefuse.org, accessed July 1, 2008.

[33] Jacques Bertin and Myriam Daru. "Matrix Theory of Graphics: Jacques Bertin's Theories." *Information Design Journal* 10:1 (2000), 5–19.

[34] Jacques Bertin. *Semiology of Graphics: Diagrams, Networks, Maps*. Madison, WI: University of Wisconsin Press, 1983. Translated by Wiliam J. Berg. Originally published in 1967 in French.

[35] Clifford Beshers and Steven Feiner. "Automated Design of Virtual Worlds for Visualizing Multivariate Relations." In *VIS '92: Proceedings of the Third Conference on Visualization '92*, pp. 283–290. Los Alamitos, CA: IEEE Computer Society Press, 1992.

[36] Clifford Beshers and Steven Feiner. "Auto Visual: Rule-Based Design of Interactive Multivariate Visualizations." *IEEE Computer Graphics and Applications* 13:4 (1993), 41–49.

[37] C. G. Beshers and S. K. Feiner. "Automated Design of Data Visualizations." In *Scientific Visualization: Advances and Challenges*, edited by L. Rosemblum et al., pp. 88–102. New York: Academic Press, 1994.

[38] Claudio Bettini, Curtis Dyreson, William Evans, Richard Snodgrass, and X. Wang. *Time Granularities in Databases, Data Mining, and Temporal Reasoning*. Berlin: Springer, 2000.

[39] Faber Birren. *A Grammar of Color: A Basic Treatise on the Color System of Albert H. Munsell*. New York: Van Nostrand Reinhold Company, 1969.

[40] James F. Blinn. "A Generalization of Algebraic Surface Drawing." *ACM Trans. Graph.* 1:3 (1982), 235–256.

[41] Jules Bloomenthal and Brian Wyvill, editors. *Introduction to Implicit Surfaces.* San Francisco: Morgan Kaufmann Publishers Inc., 1997.

[42] Markus Bögl, Wolfgang Aigner, Peter Filzmoser, Tim Lammarsch, Silvia Miksch, and Alexander Rind. "Visual Analytics for Model Selection in Time Series Analysis." *IEEE Transactions on Visualization and Computer Graphics, Special Issue "VIS 2013"* 19:12 (2013), 2237–2246. Available online (http://publik.tuwien.ac.at/files/PubDat_220251.pdf).

[43] O. J. Braddick and I. E. Holliday. "Serial Search for Targets Defined by Divergence or Deformation of Optic Flow." *Perception* 20 (1991), 345–354. Available online (http://www.perceptionweb.com/abstract.cgi?id=p200345).

[44] Matthew Brehmer and Tamara Munzner. "A Multi-level Typology of Abstract Visualization tasks." *IEEE Transactions Visualization and Computer Graphics* 19:12 (2013), 2376–2385.

[45] C. A. Brewer. "Guidelines for Use of the Perceptual Dimensions of Color for Mapping and Visualization." In *Color Hard Copy and Graphic Arts III*, Society of Photo-Optical Instrumentation Engineers (SPIE) Conference Series, 2171, edited by J. Bares, pp. 54–63. Bellingham, WA: SPIE, 1994.

[46] Manfred Brill, Hans Hagen, Hans-Christian Rodrian, Wladimir Djatschin, and Stanislav V. Klimenko. "Streamball Techniques for Flow Visualization." In *VIS '94: Proceedings of the Conference on Visualization '94*, pp. 225–231. Los Alamitos, CA: IEEE Computer Society Press, 1994.

[47] D. Brodbeck and L. Girardin. "Design Study: Using Multiple Coordinated Views to Analyze Geo-referenced High-Dimensional Datasets." In *Proceedings of the International Conference on Coordinated and Multiple Views in Exploratory Visualization*, pp. 104–111. Los Alamitos, CA: IEEE Computer Society Press, 2003.

[48] Dominique Brodbeck, Matthew Chalmers, Aran Lunzer, and Pamela Cotture. "Domesticating Bead: Adapting an Information Visualization System to a Financial Institution." In *Proceedings of the IEEE Symposium on Information Visualization '97*, pp. 73–80. Los Alamitos, CA: IEEE Computer Society Press, 1997.

[49] C. Brown and B. Shepherd. *Graphics File Formats: Reference and Guide.* Greenwich, CT: Manning Publications, 1995.

[50] J. L. Brown. "Flicker and Intermittent Stimulation." In *Vision and Visual Perception*, edited by C. H. Graham, pp. 251–320. New York: John Wiley and Sons, 1965.

[51] M. Bruls, K. Huizing, and J. van Wijk. "Squarified Treemaps." In *Proceedings of Joint Eurographics and IEEE TCVG Symposium on Visualization*, pp. 33–42. Los Alamitos, CA: IEEE Computer Society Press, 2000. Available online (citeseer.ist.psu.edu/bruls99squarified.html).

[52] Steve Bryson and Creon Levit. "The Virtual Windtunnel: An Environment for the Exploration of Three-Dimensional Unsteady Flows." In *VIS '91: Proceedings of the Second Conference on Visualization*, pp. 17–24. Los Alamitos, CA: IEEE Computer Society Press, 1991.

[53] Christopher J. C. Burges. "Dimension Reduction: A Guided Tour." *Foundations and Trends in Machine Learning* 2:4 (2010), 275–365.

[54] Brian Cabral and Leith Casey Leedom. "Imaging Vector Fields Using Line Integral Convolution." In *SIGGRAPH '93: Proceedings of the 20th Annual Conference on Computer Graphics and Interactive Techniques*, pp. 263–270. New York: ACM Press, 1993.

[55] T. C. Callaghan. "Dimensional Interaction of Hue and Brightness in Preattentive Field Segregation." *Perception & Psychophysics* 36:1 (1984), 25–34.

[56] T. C. Callaghan. "Interference and Domination in Texture Segregation: Hue, Geometric Form, and Line Orientation." *Perception & Psychophysics* 46:4 (1989), 299–311.

[57] T. C. Callaghan. "Interference and Dominance in Texture Segregation." In *Visual Search*, edited by D. Brogan, pp. 81–87. New York: Taylor & Francis, 1990.

[58] Stuart K. Card and Jock Mackinlay. "The Structure of the Information Visualization Design Space." In *Proceedings of the IEEE Symposium on Information Visualization, 1997*, pp. 92–99. Los Alamitos, CA: IEEE Press, 1997.

[59] Stuart K. Card, Jock D. Mackinlay, and Ben Shneiderman, editors. *Readings in Information Visualization: Using Vision to Think*. San Francisco: Morgan Kaufmann Publishers Inc., 1999.

[60] M. Carpendale, D. Cowperthwaite, and F. Fracchia. "Three-Dimensional Pliable Surfaces: For the Effective Presentation of Visual Information." In *Proceedings of the 8th Annual ACM Symposium on User Interface and Software Technology*, pp. 217–226. New York: ACM Press, 1995.

[61] M. Carpendale, D. Cowperthwaite, and F. Fracchia. "Extending Distortion Viewing from 2D to 3D." *IEEE Computer Graphics and Applications* 17 (1997), 42–51.

[62] M. S. T. Carpendale, D. J. Cowperthwaite, M. Tigges, A. Fall, and F. D. Fracchia. "The Tardis: A Visual Exploration Environment for Landscape Dynamics." In *Visual Data Exploration and Analysis VI*, Proc. SPIE, 3643, pp. 110–119. Bellingham, WA: SPIE, 1999.

[63] Stephen M. Casner. "Task-analytic approach to the automated design of graphic presentations." *ACM Trans. Graph.* 10:2 (1991), 111–151.

[64] C. Cauvin, C. Schneider, and G. Cherrier. "Cartographic Transformations and the Piezopleth Method." *The Cartographic Journal* 26:2 (1989), 96–104.

[65] Center for Integrative Biomedical Computing. "SCIRun Home Page." http://software.sci.utah.edu/scirun.html, accessed July 1, 2008.

[66] K. Chang. *Introduction to Geographic Information System*, Fourth edition. New York: McGraw Hill, 2007.

[67] D. W. Chapman. “Relative Effects of Determinate and Indeterminate.” *Amer. J. Psychology* 44 (1932), 163–174.

[68] Chaomei Chen and Mary P. Czerwinski. “Empirical Evaluation of Information Visualizations: An Introduction.” *Int. J. Hum.-Comput. Stud.* 53:5 (2000), 631–635.

[69] Hong Chen. “Toward Design Patterns for Dynamic Analytical Data Visualization.” In *Electronic Imaging 2004*, pp. 75–86. Bellingham, WA: International Society for Optics and Photonics, 2004.

[70] Chaomei Chen. “Top 10 Unsolved Information Visualization Problems.” *IEEE Comput. Graph. Appl.* 25:4 (2005), 12–16.

[71] H. Chernoff. “The Use of Faces to Represent Points in k-Dimensional Space Graphically.” *Journal of the American Statistical Association* 68 (1973), 361–368.

[72] Ed Chi. “A Framework for Information Visualization Spreadsheets.” Ph.D. thesis, University of Minnesota, 1999.

[73] Ed H. Chi. “A Taxonomy of Visualization Techniques Using the Data State Reference Model.” In *INFOVIS ’00: Proceedings of the IEEE Symposium on Information Vizualization 2000*, p. 69. Washington, DC: IEEE Computer Society, 2000.

[74] E. Chi. *A Framework for Visualizing Information.* New York: Springer, 2002.

[75] Jon Christensen, Joe Marks, and Stuart Shieber. “An Empirical Study of Algorithms for Point-Feature Label Placement.” *ACM Trans. Graph.* 14:3 (1995), 203–232.

[76] Mei C. Chuah and Stephen G. Eick. “Information Rich Glyphs for Software Management Data.” *IEEE Comput. Graph. Appl.* 18:4 (1998), 24–29.

[77] CIE. “Official Recommendations on Uniform Color Spaces, Color-Difference Equations, and Metric Color Terms. Commission Internationale de L’Éclairge.” CIE Publication No. 15, Supplement Number 2 (E-1.3.1), 1976.

[78] J.C. Claussen and T. Wilhelm. “Introduction to Network Complexity.” In *International Workshop and Conference on Complex Networks and Their Applications.* Norwich, UK: PUBLISHER, 2008.

[79] W. Cleveland and R. McGill. “Graphical Perception: Theory, Experimentation and Application to the Development of Graphical Methods.” *J. Am. Stat. Assoc.* 79:387 (1984), 531–554.

[80] William S. Cleveland. *The Elements of Graphing Data.* Belmont, CA: Wadsworth, Inc., 1985.

[81] William S. Cleveland. *Visualizing Data.* Summit, NJ: Hobart Press, 1993.

[82] Christopher Collins. "DocuBurst: Document Content Visualization Using Language Structure." Poster presented at the Symposium on Information Visualization (InfoVis '06), Baltimore, MD, October 29–November 3, 2006. Available online (http://faculty.uoit.ca/collins/publications/docs/ivposter2006.pdf).

[83] D. Cook and D. Swayne. *Interactive and Dynamic Graphics for Data Analysis: With R and GGobi*. New York: Springer, 2007.

[84] K. A. Cook and J. J. Thomas. *Illuminating the Path: The Research and Development Agenda for Visual Analytics*. Los Alamitos, CA: IEEE Computer Society Press, 2005.

[85] L. F. Costa, Francisco A. Rodrigues, Gonzalo Travieso, and Paulino Ribeiro Villas Boas. "Characterization of Complex Networks: A Survey of Measurements." *Advances in Physics* 56:1 (2007), 167–242.

[86] Nelson Cowan. "Evolving Conceptions of Memory Storage, Selective Attention, and Their Mutual Constraints within the Human Information-Processing System." *Psychological Bulletin* 104 (1988), 163–191.

[87] K. C. Cox, S. G. Eick, and T. He. "3D Geographic Network Displays." *SIGMOD Record* 25:4 (1996), 50–54.

[88] David Crystal. "Logograms." In *The Cambridge Encyclopedia of Language*, pp. 200–201. Cambridge, UK: Cambridge University Press, 1987.

[89] J. E. Cutting and R. T. Millard. "Three Gradients and the Perception of Flat and Curved Surfaces." *Journal of Experimental Psychology: General* 13:2 (1984), 198–216.

[90] Hervé Delingette, Stéphane Cotin, and Nicholas Ayache. "A Hybrid Elastic Model Allowing Real-Time Cutting, Deformations and Force-Feedback for Surgery Training and Simulation." In *CA '99: Proceedings of the Conference on Computer Animation*, pp. 70–81. Washington, DC: IEEE Computer Society, 1999.

[91] Borden Dent. "A Note on the Importance of Shape in Cartogram Communication." *The Journal of Geography* 71:7 (1972), 393–401.

[92] Borden Dent. "Communication Aspects of Value-By-Area Cartograms." *The American Cartogapher* 2:2 (1975), 154–168.

[93] Borden D. Dent. *Cartography: Thematic Map Design*, Fourth edition. Dubuque, IA: William C. Brown, 1996.

[94] Alan Dix, Janet E. Finlay, Gregory D. Abowd, and Russell Beale. *Human-Computer Interaction*, Third edition. Upper Saddle River, NJ: Prentice Hall, 2003.

[95] Srinivas Doddi, Madhav V. Marathe, Andy Mirzaian, Bernard M. E. Moret, and Binhai Zhu. "Map Labeling and Its Generalizations." In *SODA '97: Proceedings of the Eighth Annual ACM-SIAM Symposium on Discrete Algorithms*, pp. 148–157. Philadelphia: Society for Industrial and Applied Mathematics, 1997.

[96] Daniel Dorling. *Area Cartograms: Their Use and Creation.* Bristol, UK: Department of Geography, University of Bristol, 1996.

[97] James A. Dougenik, Nicholas Chrisman, and Duane R. Niemeyer. “An Algorithm to Construct Continuous Area Cartograms.” *The Professional Geographer* 37:1 (1985), 75–81.

[98] Pierre Dragicevic and Stephane Huot. “SpiraClock: A Continuous and Non-Intrusive Display for Upcoming Events.” In *Proceedings ACM SIGCHI Conference Human Factors in Computing Systems (CHI)*, pp. 604–605. New York: ACM Press, 2002. Extended Abstracts.

[99] J. Driver, P. McLeod, and Z. Dienes. “Motion Coherence and Conjunction Search: Implications for Guided Search Theory.” *Perception & Psychophysics* 51:1 (1992), 79–85.

[100] S. du Toit, A. Steyn, and R. Stumpf. *Graphical Exploratory Data Analysis.* Berlin: Springer-Verlag, 1986.

[101] J. Duncan and G. W. Humphreys. “Visual Search and Stimulus Similarity.” *Psychological Review* 96:3 (1989), 433–458. Available online (http://view.ncbi.nlm.nih.gov/pubmed/2756067).

[102] J. Duncan. “Boundary Conditions on Parallel Processing in Human Vision.” *Perception* 18:4 (1989), 457–469. Available online (http://view.ncbi.nlm.nih.gov/pubmed/2813022).

[103] J. Dykes, A. M. MacEachren, and M.-J. Kraak. *Exploring Geovisualization.* Burlington, MA: Elsevier, 2005.

[104] Herbert Edelsbrunner and Roman Waupotitsch. “A Combinatorial Approach to Cartograms.” *Computational Geometry* 7:5–6 (1997), 343–360.

[105] Martin Dodge (editor), Mary McDerby (co editor), and Martin Turner. *Geographic Visualization: Concepts, Tools and Applications.* New York: Wiley, 2008.

[106] H. E. Egeth and S. Yantis. “Visual Attention: Control, Representation, and Time Course.” *Annu. Rev. Psychol.* 48 (1997), 269–297.

[107] Stephen G. Eick and Graham J. Wills. “Navigating Large Networks with Hierarchies.” In *Proceedings of the 4th Conference on Visualization ’93*, pp. 204–210. Washington, DC: IEEE Computer Society, 1993.

[108] S. G. Eick, J. L. Steffen, and E. E. Sumner. “Seesoft—A Tool for Visualizing Line Oriented Software Statistics.” *IEEE Transactions on Software Engineering* 18:11 (1992), 957–968.

[109] Geoffrey Ellis and Alan Dix. “An Explorative Analysis of User Evaluation Studies in Information Visualisation.” In *BELIV ’06: Proceedings of the 2006 AVI Workshop on Beyond Time and Errors*, pp. 1–7. New York: ACM Press, 2006.

[110] Geoffrey Ellis, Enrico Bertini, and Alan Dix. “The Sampling Lens: Making Sense of Saturated Visualisations.” In *CHI ’05 Extended Abstracts on Human Factors in Computing Systems*, pp. 1351–1354. New York: ACM Press, 2005.

[111] John Ellson, Emden R. Gansner, Lefteris Koutsofios, Stephen North, and Gordon Woodhull. "Graphviz: Open Source Graph Drawing Tools." In *Graph Drawing: 9th International Symposium, GD 2001 Vienna, Austria, September 23–26, 2001, Revised Papers*, Lecture Notes in Computer Science, 2265, edited by Petra Mutzel, Michael Jünger, and Sebastian Leipert, pp. 483–484. Berlin: Springer, 2002.

[112] Niklas Elmqvist and Jean-Daniel Fekete. "Hierarchical Aggregation for Information Visualization: Overview, Techniques, and Design Guidelines." *Visualization and Computer Graphics, IEEE Transactions on* 16:3 (2010), 439–454.

[113] Linda S Elting, James M Walker, Charles G Martin, Scott B Cantor, and Edward B Rubenstein. "Influence of Data Display Formats on Decisions to Stop Clinical Trials." *British Medical Journal* 318 (1999), 1527–1531.

[114] ERDAS Inc. "ERDAS Home Page." http://gi.leica-geosystems.com/, accessed July 1, 2008.

[115] ESRI. "ArcView." http://www.esri.com/software/arcgis/arcview/index.html, 2003.

[116] ESRI. "List of Supported Map Projections." http://webhelp.esri.com/arcgisdesktop/9.2/index.cfm?TopicName=List_of_supported_map_projections, August 3, 2007.

[117] ESRI. "MapLex." http://www.esri.com/library/whitepapers/pdfs/maplexwp.pdf, August 1998.

[118] Jonathan Feinberg. "Wordle Home Page." http://www.wordle.net/, accessed August 31, 2009.

[119] S. K. Feiner and Clifford Beshers. "Worlds within Worlds: Metaphors for Exploring n-Dimensional Virtual Worlds." In *Proceedings of the 3rd Annual ACM SIGGRAPH Symposium on User Interface Software and Technology*, pp. 76–83. New York: ACM Press, 1990.

[120] Jean-Daniel Fekete. "The InfoVis Toolkit." http://ivtk.sourceforge.net, 2005.

[121] Jean-Daniel Fekete and Catherine Plaisant. "Excentric Labeling: Dynamic Neighborhood Labeling for Data Visualization." In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, pp. 512–519. New York: ACM Press, 1999.

[122] Ronen Feldman and James Sanger. *The Text Mining Handbook: Advanced Approaches in Analyzing Unstructured Data.* Cambridge, UK: Cambridge University Press, 2006.

[123] Stephen Few. *Show Me the Numbers: Designing Tables and Graphs to Enlighten.* Oakland, CA: Analytics Press, 2004.

[124] Stephen Few. *Information Dashboard Design: The Effective Visual Communication of Data.* Cambridge, MA: O'Reilly Media, Inc., 2006.

[125] Stephen Few. *Now You See It: Simple Visualization Techniques for Quantitative Analysis.* Oakland, CA: Analytics Press, 2009.

[126] Fabian Fischer, Florian Mansmann, Daniel A. Keim, Stephan Pietzko, and Marcel Waldvogel. “Large-Scale Network Monitoring for Visual Analysis of Attacks.” In *Visualization for Computer Security: 5th International Workshop, VizSec 2008, Cambridge, MA, USA, September 15, 2008, Proceedings*, Lecture Notes in Computer Science, 5210, pp. 111–118. Berlin: Springer-Verlag, 2008.

[127] R. A. Fisher. “The Use of Multiple Measurements in Taxonomic Problems.” *Annual Eugenics* 7:Part II (1936), 179–188.

[128] J. C. Fisher. “Homicide in Detroit: The Role of Firearms.” *Criminology* 14 (1976), 387–400.

[129] J. J. Flannery. “The Relative Effectiveness of Some Common Graduated Point Symbols in the Presentation of Quantitative Data.” *The Canadian Cartographer* 2 (2009), 96–109.

[130] James D. Foley, Andries Van Dam, Steven K. Feiner, John F. Hughes, and Richard L. Phillips. *Introduction to Computer Graphics*. Reading, MA: Addison-Wesley, 1994.

[131] Michael Formann and Frank Wagner. “A Packing Problem with Applications to Lettering of Maps.” In *SCG ’91: Proceedings of the Seventh Annual Symposium on Computational Geometry*, pp. 281–288. New York: ACM Press, 1991.

[132] Andrew U. Frank. “Different Types of ‘Times’ in GIS.” In *Spatial and Temporal Reasoning in Geographic Information Systems*, Chapter 3, pp. 40–62. New York: Oxford University Press, 1998.

[133] Herbert Freeman. “Automated Cartographic Text Placement.” *Pattern Recogn. Lett.* 26:3 (2005), 287–297.

[134] J. Friedman, E. Farrell, R. Goldwyn, M. Miller, and J. Sigel. “A Graphic Way of Describing Changing Multivariate Patterns.” In *Proceeding of the Sixth Interface Symposium on Computer Science and Statistics*, pp. 56–59. North Hollywood, CA: Western Periodicals Co., 1972.

[135] M. Friendly. “A Brief History of Data Visualization.” In *Handbook of Computational Statistics: Data Visualization*, III, edited by C. Chen, W. Härdle, and A. Unwin, pp. 15–56. Heidelberg: Springer-Verlag, 2006.

[136] Michael Friendly. “Michael Friendly’s Home Page.” http://www.math.yorku.ca/SCS/friendly.html, 2008.

[137] Ying-Huey Fua, Matthew O. Ward, and Elke A. Rundensteiner. “Hierarchical Parallel Coordinates for Exploration of Large Datasets.” In *VIS ’99: Proceedings of the Conference on Visualization ’99*, pp. 43–50. Los Alamitos, CA: IEEE Computer Society Press, 1999.

[138] Ying-Huey Fua, Matthew O. Ward, and Elke A. Rundensteiner. “Structure-Based Brushes: A Mechanism for Navigating Hierarchically Organized Data and Information Spaces.” *IEEE Trans. Visualization and Computer Graphics* 6:2 (2000), 150–159.

[139] Anton Fuhrmann and Eduard Gröller. "Real-Time Techniques for 3D Flow Visualization." In *Proceedings of the Conference on Visualization '98*, pp. 305–312. Los Alamitos, CA: IEEE Computer Society, 1998.

[140] G. Furnas. "Generalized Fisheye Views." In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, pp. 16–23. New York: ACM Press, 1986.

[141] Everette S. Gardner. "Exponential Smoothing: The State of the Art." *Journal of Forecasting* 4:1 (1985), 1–28.

[142] J. W. Gebb, G. H. Mowbray, and C. L. Byham. "Difference Lumens for Photic Intermittence." *Quarterly Journal of Experimental Psychology* 7 (1955), 49–55.

[143] J. Geier, L. Bernath, M. Hudak, and L. Sera. "Straightness as the Main Factor of the Hermann Grid Illusion." *Perception* 37 (2008), 651–665.

[144] Gary Geisler. "Making Information More Accessible: A Survey of Information, Visualization Applications and Techniques." http://www.ischool.utexas.edu/~geisler/info/infovis/paper.html, January 31, 1998.

[145] "GGobi Home Page." http://www.ggobi.org, accessed July 1, 2008.

[146] E. W. Gilbert. "Pioneer Maps of Health and Disease in England." *Geographical Journal* 124 (1958), 172–183.

[147] E. W. Gilbert. "The Map as Intent: Variations on the Theme of John Snow." *Cartographica* 30 (2004), 1–14.

[148] A. S. Glassner. *Principles of Digitial Image Synthesis,* Vol. 1. San Francisco: Morgan Kaufmann, 1995.

[149] R. Gnanadesikan. *Methods of Statistical Data Analysis of Multivariate Observations.* New York: John Wiley and Sons, 1977.

[150] Goddard Institute for Space Studies. "GISS Surface Temperature Analysis: Global Maps from GHCN Data." http://data.giss.nasa.gov/gistemp/maps/, accessed July 1, 2008.

[151] Joseph Goldberg and Jonathan Helfman. "Eye Tracking for Visualization Evaluation: Reading Values on Linear versus Radial Graphs." *Information Visualization* 10:3 (2011), 182–195.

[152] Gene Golovchinsky, Klaus Reichenberger, and Thomas Kamps. "Subverting Structure: Data-Driven Diagram Generation." In *Proceedings of the IEEE Conference on Visualization '95*, pp. 217–223. Los Alamitos, CA: IEEE Computer Society, 1995.

[153] R. Gonzalez and R. Woods. *Digital Image Processing.* Upper Saddle River, NJ: Prentice Hall, 2007.

[154] Iqbal A. Goralwalla, M. Tamer Özsu, and Duane Szafron. "An Object-Oriented Framework for Temporal Data Models." In *Temporal Databases: Research and Practice*, edited by Etzion et al., pp. 1–35. Berlin: Springer, 1998.

[155] C. Gorg, Z. Liu, N. Parekh, K. Singhal, and J. Stasko. "Jigsaw Meets Blue Iguanodon—The VAST 2007 Contest." In *Proceedings of the 2007 IEEE Symposium on Visual Analytics Science and Technology*, pp. 235–236. Washington, DC: IEEE Computer Society, 2007.

[156] "GraphViz—Graph Visualization Software." http://www.graphviz.org, accessed July 1, 2008.

[157] GRASS Development Team. "Grass GIS Home Page." http://grass.itc.it/, accessed July 1, 2008.

[158] M. Greenacre. *Correspondence Analysis in Practice*, Second edition. Boca Raton, FL: Chapman and Hall/CRC, 2007.

[159] D. L. Gresh, B. E. Rogowitz, R. L. Winslow, D. F. Scollan, and C. K. Yung. "WEAVE: A System for Visually Linking 3D and Statistical Visualizations, Applied to Cardiac Simulation and Measurement Data." In *VIS '00: Proceedings of the conference on Visualization '00*, pp. 489–492. Los Alamitos, CA: IEEE Computer Society Press, 2000. Available online (http://www.research.ibm.com/visualanalysis/papers/weave.pdf).

[160] G. Grinstein, D. Keim, and T. Munzner. "Grand Challenges in Information Visualization." Panel from VisWeek 2008, Columbus, OH, October 20, 2008. Report available at http://www.cs.uml.edu/~grinstei/GrandChallengesPanelVisWeek2008.pdf.

[161] Georges G. Grinstein, Ronald M. Pickett, and M. Williams. "EXVIS: An Exploratory Data Visualization Environment." In *Proceedings Graphics Interface '89*, pp. 254–261. Toronto: Canadian Information Processing Society, 1989.

[162] Georges G. Grinstein, Patrick E. Hoffman, and Ronald M. Pickett. "Benchmark Development for the Evaluation of Visualization for Data Mining." In *Information Visualization in Data Mining and Knowledge Discovery*, edited by U. Fayyad, G. Grinstein, and A. Wierse, pp. 129–176. San Francisco: Morgan Kaufmann Publishers, Inc., 2002.

[163] Theresia Gschwandtner, Wolfgang Aigner, Katharina Kaiser, Silvia Miksch, and Andreas Seyfang. "CareCruiser: Exploring and Visualizing Plans, Events, and Effects Interactively." In *Proceedings of the IEEE Pacific Visualization Symposium (PacificVis 2011)*, pp. 43–50. Los Alamitos, CA: IEEE Computer Society, 2011.

[164] Antal Guszlev. "Map Projections." http://lazarus.elte.hu/~guszlev/vet/, June 2003.

[165] Helmut Haase and Christoph Dohrmann. "Doing It Right: Psychological Tests to Ensure the Quality of Scientific Visualization." In *Proceedings of the Eurographics Workshop on Virtual Environments and Scientific Visualization*, pp. 243–256. London: Springer-Verlag, 1996.

[166] Elżbieta Hajnicz. *Time Structures: Formal Description and Algorithmic Representation*, Lecture Notes in Computer Science, 1047. Berlin: Springer, 1996.

[167] C. Hansen and C. Johnson, editors. *The Visualization Handbook*. Burlington, MA: Elsevier Butterworth-Heinemann, 2005.

[168] Robert M. Haralick, K. Shanmugam, and Its'hak Dinstein. "Textural Features for Image Classification." *Systems, Man and Cybernetics, IEEE Transactions on* 3:6 (1973), 610–621.

[169] John Brian Harley and David Woodward. *The History of Cartography: Cartography in Prehistoric, Ancient, and Medieval Europe and the Mediterranean*. Clifton, NJ: Humana Press, 1987.

[170] Robert L. Harris. *Information Graphics: A Comprehensive Illustrated Reference*. New York: Oxford University Press, 1999.

[171] J. Hartigan. "Printer Graphics for Clustering." *J. of Stat. Comp. and Sim* 4 (1975), 187–213.

[172] Susan Havre, Elizabeth Hetzler, and Lucy Nowell. "ThemeRiver: Visualizing Theme Changes Over Time." In *Proceedings of the IEEE Symposium on Information Visualization (InfoVis)*, pp. 115–124. Los Alamitos, CA: IEEE Computer Society, 2000.

[173] S. Havre, E. Hetzler, P. Whitney, and L. Nowell. "Themeriver: Visualizing Thematic Changes in Large Document Collections." *IEEE Transactions on Visualization and Computer Graphics* 8:1 (2002), 9–20.

[174] Christopher G. Healey. "Perception in Visualization." http://www.csc.ncsu.edu/faculty/healey/PP/index.html, 2009.

[175] Christopher G. Healey and James T. Enns. "Building Perceptual Textures to Visualize Multidimensional Datasets." In *Proceedings of the Conference on Visualization '98*, pp. 111–118. IEEE Computer Soceity Press: Los Alamitos, CA, 1998.

[176] Christopher G. Healey and James T. Enns. "Large Datasets at a Glance: Combining Textures and Colors in Scientific Visualization." *IEEE Transactions on Visualization and Computer Graphics* 5 (1999), 145–167.

[177] Christopher G. Healey. "Choosing Effective Colours for Data Visualization." In *Proceedings of the 7th Conference on Visualization '96*, pp. 263–270. Los Alamitos, CA: IEEE Computer Society Press, 1996.

[178] M. A. Hearst. "Tilebars: Visualization of Term Distribution Information in Full Text Information Access." In *Proceedings of the SIGCHI Conference on Human factors in Computing Systems*, pp. 59–66. New York: ACM Press/Addison-Wesley Publishing Co., 1995.

[179] Marti Hearst. *Search User Interfaces*. Cambridge, UK: Cambridge University Press, 2009.

[180] Jeffrey Heer and George G. Robertson. "Animated Transitions in Statistical Data Graphics." *Visualization and Computer Graphics, IEEE Transactions on* 13:6 (2007), 1240–1247.

[181] Jeffrey Heer and Ben Shneiderman. "Interactive Dynamics for Visual Analysis." *Queue* 10:2 (2012), 30.

[182] Jeffrey Heer, Stuart K. Card, and James A. Landay. "Prefuse: A Toolkit for Interactive Information Visualization." In *CHI '05: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, pp. 421–430. New York: ACM Press, 2005.

[183] Jeffrey Heer, Maneesh Agrawala, and Wesley Willett. "Generalized Selection via Interactive Query Relaxation." In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, pp. 959–968. New York: ACM Press, 2008.

[184] Roland Heilmann, Daniel A. Keim, Christian Panse, and Mike Sips. "RecMap: Rectangular Map Approximations." In *INFOVIS '04: Proceedings of the IEEE Symposium on Information Visualization*, pp. 33–40. Washington, DC: IEEE Computer Society, 2004.

[185] Jeffrey J. Hemphill. "TIN Errors—Flat Triangles, Slivers and the 'Wedding Cake Effect'." *La Conchita*. http://www.geog.ucsb.edu/~jeff/projects/la_conchita/tinerror/1869_tinerror.html, accessed July 1, 2008.

[186] Ivan Herman, Guy Melançon, and M. Scott Marshall. "Graph Visualization and Navigation in Information Visualization: A Survey." *IEEE Transactions on Visualization and Computer Graphics* 6:1 (2000), 24–43. Available online (citeseer.ist.psu.edu/herman00graph.html).

[187] William L. Hibbard, Charles R. Dyer, and Brian E. Paul. "A Lattice Model for Data Display." In *VIS '94: Proceedings of the Conference on Visualization '94*, pp. 310–317. Los Alamitos, CA: IEEE Computer Society Press, 1994.

[188] Patrick Hoffman, Georges Grinstein, Kenneth Marx, Ivo Grosse, and Eugene Stanley. "DNA Visual and Analytic Data Mining." In *VIS '97: Proceedings of the 8th Conference on Visualization '97*, pp. 437–ff. Los Alamitos, CA: IEEE Computer Society Press, 1997.

[189] Patrick Edward Hoffman. "Table Visualizations: A Formal Model and Its Applications." Ph.D. thesis, University of Massachusetts Lowell, 2000.

[190] J. Hohnsbein and S. Mateeff. "The Time It Takes to Detect Changes in the Speed and Direction of Visual Motion." *Vision Research* 38:17 (1998), 2569–2573.

[191] Danny Holten. "Hierarchical Edge Bundles: Visualization of Adjacency Relations in Hierarchical Data." *IEEE Transactions on Visualization and Computer Graphics* 12:5 (2006), 741–748.

[192] A. Hotho, A. Nurnberger, and G. Paaß. "A Brief Survey of Text Mining." *LDV Forum-GLDV Journal for Computational Linguistics and Language Technology* 20:1 (2005), 19–62.

[193] Stephen D. Houston. *The First Writing: Script Invention as History and Process*, Illustrated edition. Cambridge, UK: Cambridge University Press, 2004.

[194] P. Huber. "Projection Pursuit." *Annals of Statistics* 13 (1985), 435–475.

[195] Jon Hutchins. "Dodgers Loop Sensor Data Set." *UCI Machine Learning Repository*, http://archive.ics.uci.edu/ml/datasets/Dodgers+Loop+Sensor, 2006.

[196] IBM. "Many Eyes Home Page." http://manyeyes.alphaworks.ibm.com/, accessed August 31, 2009.

[197] Peter Imrich, Klaus Mueller, Dan Imre, Alla Zelenyuk, and Wei Zhu. "Interactive Poster: 3D ThemeRiver." In *Poster Compendium of IEEE Symposium on Information Visualization (InfoVis)*. Los Alamitos, CA: IEEE Computer Society, 2003.

[198] Information Interfaces Group. "Jigsaw: Visualization for Investigative Analysis." http://www.cc.gatech.edu/gvu/ii/jigsaw/, accessed August 31, 2009.

[199] Alfred Inselberg. "The Plane with Parallel Coordinates." *The Visual Compter* 1:2 (1985), 69–91.

[200] Instituteo de Expanseo Commercial. "Brasil: Graphicos Economicos-Estatisticas." Technical report, Rio de Janeiro, Brazil, 1929.

[201] Victoria Interrante and Sunghee Kim. "Investigating the Effect of Texture Orientation on the Perception of 3D Shape." In *Human Vision and Electronic Imaging VI*, Proceedings of SPIE, 4299, edited by Bernice E. Rogowitz and Thrasyvoulos N. Pappas, pp. 330–339. Bellingham, WA: SPIE, 2001.

[202] Victoria Interrante, Sunghee Kim, and Haleh Hagh-Shenas. "Conveying 3D Shape with Texture: Recent Advances and Experimental Results." In *Human Vision and Electronic Imaging VII*, Proceedings of SPIE, 4662, edited by Bernice E. Rogowitz and Thrasyvoulos N. Pappas, pp. 197–206. Bellingham, WA: SPIE, 2002.

[203] T. K. Poiker J. Thurston and J. Patrick Moore. *Integrated Geospatial Technologies: A Guide to GPS, GIS, and Data Logging*, First edition. Hoboken, NJ: Wiley, 2003.

[204] Anil K. Jain and Richard C. Dubes. *Algorithms for Clustering Data*. Upper Saddle River, NJ: Prentice Hall, Inc., 1988.

[205] Dean Jenkins and Stephen Gerred. *ECGs by Example*, First edition. Edinburgh: Churchill Livingstone, 1997.

[206] Brian Johnson and Ben Shneiderman. "Tree-Maps: A Space-Filling Approach to the Visualization of Hierarchical Information Structures." In *VIS '91: Proceedings of the 2nd Conference on Visualization '91*, pp. 284–291. Los Alamitos, CA: IEEE Computer Society Press, 1991.

[207] C. R. Johnson, R. Moorhead, T. Munzner, H. Pfister, P. Rheingans, and T. S. Yoo, editors. *NIH-NSF Visualization Research Challenges Report*. Los Alamitos, CA: IEEE Computer Society Press, 2006.

[208] Chris R. Johnson. "Top Scientific Visualization Research Problems." *IEEE Comput. Graph. Appl.* 24:4 (2004), 13–17.

[209] Bela Julész, E. N. Gilbert, L. A. Shepp, and H. L. Frisch. "Inability of Humans to Discriminate between Visual Textures that Agree in Second-Order Statistics—Revisited." *Perception* 2 (1973), 391–405.

[210] Bela Julész, E. N. Gilbert, and J. D. Victor. "Visual Discrimination of Textures with Identical Third-Order Statistics." *Biological Cybernetics* 31:3 (1978), 137–140.

[211] Bela Julész. *Foundations of Cyclopean Perception*. Chicago: University of Chicago Press, 1971.

[212] Bela Julész. "Experiments in the Visual Perception of Texture." *Scientific American* 232:4 (1975), 34–43.

[213] Bela Julész. "Textons, the Elements of Texture Perception, and Their Interactions." *Nature* 290:5802 (1981), 91–97.

[214] Bela Julész. "A Theory of Preattentive Texture Discrimination Based on First-Order Statistics of Textons." *Biological Cybernetics* 41:2 (1981), 131–138.

[215] Bela Julész. "A Brief Outline of the Texton Theory of Human Vision." *Trends in Neuroscience* 7:2 (1984), 41–45.

[216] T. Kamps. *Diagram Design: A Constructive Theory*. New York: Springer, 1999.

[217] R. Kasturi and R. C. Jain, editors. *Computer Vision: Principles*. Los Alamitos, CA: IEEE Computer Society Press, 1991.

[218] T. Keahey. "Area-Normalized Thematic Views." Paper presented at the 19th International Cartographic Coference, Ottawa, Canada, August 14, 1999.

[219] T. Keahey and E. Robertson. "Techniques for Nonlinear Magnification Transformations." In *Proceedings of the IEEE Symposium on Information Visualization '96*, pp. 38–45. Los Alamitos, CA: IEEE Computer Society, 1996.

[220] T. Keahey and E. Robertson. "Nonlinear Magnification Fields." In *Proceedings of the IEEE Symposium on Information Visualization '97*, pp. 51–58. Los Alamitos, CA: IEEE Computer Society, 1997.

[221] Daniel A. Keim and Hans-Peter Kriegel. "VisDB: Database Exploration Using Multidimensional Visualization." *IEEE Comput. Graph. Appl.* 14:5 (1994), 40–49.

[222] D. A. Keim and D. Oelke. "Literature Fingerprinting: A New Method for Visual Literary Analysis." In *Proceedings of the IEEE Symposium on Visual Analytics Science and Technology (VAST 2007)*, pp. 115–122. Los Alamitos, CA: IEEE Computer Society Press, 2007.

[223] Daniel A. Keim, Mihael Ankerst, and Hans-Peter Kriegel. "Recursive Pattern: A Technique for Visualizing Very Large Amounts of Data." In *VIS '95: Proceedings of the 6th Conference on Visualization '95*, pp. 279–286. Los Alamitos, CA: IEEE Computer Society, 1995.

[224] Daniel A. Keim, E. Koutsofios, and S. C. North. "Visual Exploration of Large Telecommunication Data Sets." In *Proceedings of the Workshop on User Interfaces to Data Intensive Systems*, pp. 12–20. Los Alamitos, CA: IEEE Computer Society, 1999.

[225] Daniel A. Keim, Ming C. Hao, and Umeshwar Dayal. "Hierarchical Pixel Bar Charts." *IEEE Trans. Vis. Comput. Graph.* 8:3 (2002), 255–269.

[226] Daniel A. Keim, Ming C. Hao, Umeshwar Dayal, and Meichun Hsu. "Pixel Bar Charts: A Visualization Technique for Very Large Multi-attribute Data Sets?" *Information Visualization* 1:1 (2002), 20–34.

[227] Daniel A. Keim, Christian Panse, and Mike Sips. "Visual Data Mining of Large Spatial Data Sets." In *Databases in Networked Information Systems*, Lecture Notes in Computer Science, 2822, pp. 201–215. Berlin: Springer, 2003.

[228] Daniel A. Keim, Christian Panse, Mike Sips, and Stephen C. North. "PixelMaps: A New Visual Data Mining Approach for Analyzing Large Spatial Data Sets." In *Proceedings of the Third IEEE International Conference on Data Mining*, pp. 565–568. Los Alamitos, CA: IEEE Computer Society, 2003.

[229] Daniel A. Keim, Stephen C. North, and Christian Panse. "CartoDraw: A Fast Algorithm for Generating Contiguous Cartograms." *IEEE Transactions on Visualization and Computer Graphics* 10:1 (2004), 95–110.

[230] Daniel A. Keim, Christian Panse, Mike Sips, and Stephen C. North. "Pixel Based Visual Mining of Geo-Spatial Data." *Computers and Graphics* 28:3 (2004), 327–344. Available online (http://kops.ub.uni-konstanz.de/volltexte/2008/6967).

[231] Daniel A. Keim, Christian Panse, and Stephen C. North. "Medial-Axis-Based Cartograms." *IEEE Comput. Graph. Appl.* 25:3 (2005), 60–68.

[232] D. A. Keim. "Pixel-Oriented Database Visualizations." *ACM SIGMOD Record* 25:4 (1996), 35–39.

[233] Daniel A. Keim. "Designing Pixel-Oriented Visualization Techniques: Theory and Applications." *IEEE Transactions on Visualization and Computer Graphics* 6:1 (2000), 59–78.

[234] Daniel A. Keim. "Information Visualization and Visual Data Mining." *IEEE Transactions on Visualization and Computer Graphics* 8:1 (2002), 1–8.

[235] Christa Kelleher and Thorsten Wagener. "Ten Guidelines for Effective Data Visualization in Scientific Publications." *Environmental Modelling & Software* 26:6 (2011), 822–827.

[236] Peter R. Keller and Mary M. Keller. *Visual Cues: Practical Data Visualization*. Los Alamitos, CA: IEEE Computer Society Press, 1994.

[237] G. David Kerlick. "Moving Iconic Objects in Scientific Visualization." In *VIS '90: Proceedings of the 1st Conference on Visualization '90*, pp. 124–130. Los Alamitos, CA: IEEE Computer Society Press, 1990.

[238] Andreas Kerren, Helen C. Purchase, and Matthew O. Ward, editors. *Multivariate Network Visualization*, Lecture Notes in Computer Science, 8380. Berlin: Springer, 2014.

[239] Jongkwang Kim and Thomas Wilhelm. "What Is a Complex Graph?" *Physica A: Statistical Mechanics and its Applications* 387:11 (2008), 2637–2652.

[240] Sunghee Kim, Haleh Hagh-Shenas, and Victoria Interrante. "Conveying Shape with Texture: An Experimental Investigation of the Impact of Texture Type on Shape Categorization Judgments." In *Proceedings of the Ninth Annual IEEE Conference on Information Visualization*, pp. 163–170. Washington, DC: IEEE Computer Society, 2003.

[241] Sunghee Kim, Haleh Hagh-Shenas, and Victoria Interrante. "Showing Shape with Texture: Two Directions Seem Better than One." In *Human Vision and Electronic Imaging VIII*, Proceedings of SPIE, 5007, edited by Bernice E. Rogowitz and Thrasyvoulos N. Pappas, pp. 332–339. Bellingham, WA: SPIE, 2003.

[242] Gordon Kindlmann and James W. Durkin. "Semi-automatic Generation of Transfer Functions for Direct Volume Rendering." In *VVS '98: Proceedings of the 1998 IEEE Symposium on Volume Visualization*, pp. 79–86. New York: ACM Press, 1998.

[243] R. M. Kirby, H. Marmanis, and David H. Laidlaw. "Visualizing Multivalued Data from 2D Incompressible Flows Using Concepts from Painting." In *VIS '99: Proceedings of the Conference on Visualization '99*, 20, pp. 333–340. Los Alamitos, CA: IEEE Computer Society Press, 1999.

[244] Kitware, Inc. "VTK Home Page." http://www.vtk.org, accessed July 1, 2008.

[245] R. Victor Klassen and Steven J. Harrington. "Shadowed Hedgehogs: A Technique for Visualizing 2D Slices of 3D Vector Fields." In *VIS '91: Proceedings of the 2nd Conference on Visualization '91*, pp. 148–153. Los Alamitos, CA: IEEE Computer Society Press, 1991.

[246] B. Kleiner and J. Hartigan. "Representing Points in Many Dimensions by Trees and Castles." *Journal of the American Statistical Association* 76 (1981), 260–269.

[247] Christopher J. Kocmoud and Donald H. House. "Continuous Cartogram Construction." In *Proceedings of the Confrence on Visualization '98*, pp. 197–204. Los Alamitos, CA: IEEE Computer Society Press, 1998.

[248] T. Kohonen. *Self-Organizing Maps*, Springer Series in Information Sciences, 30, Third edition. Berlin: Springer, 2001.

[249] Polina Kondratieva, Jens Kruger, and Rudiger Westermann. "The Application of GPU Particle Tracing to Diffusion Tensor Field Visualization." In *Proceedings of the IEEE Visualization Conference*, pp. 73–78. Los Alamitos, CA: IEEE Computer Society, 2005.

[250] Robert Kosara, Gerald N. Sahling, and Helwig Hauser. "Linking Scientific and Information Visualization with Interactive 3D Scatterplots." *WSCG (Short Papers)* 12:1–3 (2004), 133–140.

[251] S. M. Kosslyn. *Elements of Graph Design.* New York: W. H. Freeman and Co., 1994.

[252] S. M. Kosslyn. *Graph Design for the Eye and Mind.* New York: Oxford University Press, 2006.

[253] E. Koutsofios, D. A. Keim, and S. C. North. "Visualizing Large Telecommunication Data Sets." *IEEE Computer Graphics and Applications Journal* 19:3 (1999), 16–19.

[254] Eleftherios E. Koutsofios, Stephen C. North, Russell Truscott, and Daniel A. Keim. "Visualizing Large-Scale Telecommunication Networks and Services (Case Study)." In *VIS '99: Proceedings of the Conference on Visualization '99*, pp. 457–461. Los Alamitos, CA: IEEE Computer Society Press, 1999.

[255] Menno-Jan Kraak and Ferjan Ormeling. *Cartography: Visualization of Geospatial Data*, Second edition. Upper Saddle River, NJ: Pearson Education, 2003.

[256] Menno-Jan Kraak and Ferjan Ormeling. *Cartography: Visualization of Geospatial Data*, Second edition. Harlow, UK: Pearson Education, 2003.

[257] Menno-Jan Kraak, Ferjan Ormeling, and Menno-Jan Kroak. *Cartography: Visualization of Spatial Data*. Reading, MA: Addison-Wesley Publishing Co., 1996.

[258] M. Kreuseler, N. Lopez, and H. Schumann. "A Scalable Framework for Information Visualization." In *Proceedings of IEEE Symposium on Information Visualization 2000*, pp. 27–36. Los Alamitos, CA: IEEE Computer Society, 2000.

[259] J. B. Kruskal and M. Wish. *Multidimensional Scaling*. Quantitative Applications in the Social Sciences Series, Newbury Park: Sage Publications, 1978.

[260] R. Kurzweil. *The Age of Spiritual Machines*. London: Penguin, 2000.

[261] P. Laarhoven and E. Aarts. *Simulated Annealing: Theory and Applications*. Mathematics and Its Applications, Dordrecht: Kluwer Academic Publishers, 1987.

[262] Tim Lammarsch, Wolfgang Aigner, Alessio Bertone, Johannes Gärtner, Eva Mayr, Silvia Miksch, and Michael Smuc. "Hierarchical Temporal Patterns and Interactive Aggregated Views for Pixel-based Visualizations." In *Proceedings of the International Conference Information Visualisation (IV)*, pp. 44–49. Los Alamitos, CA: IEEE Computer Society, 2009.

[263] David A. Lane. "UFAT: A Particle Tracer for Time-Dependent Flow Fields." In *VIS '94: Proceedings of the Conference on Visualization '94*, pp. 257–264. Los Alamitos, CA: IEEE Computer Society Press, 1994.

[264] John T. Langton, Astrid A. Prinz, and Timothy J. Hickey. "NeuroVis: Combining Dimensional Stacking and Pixelization to Visually Explore, Analyze, and Mine Multidimensional Multivariate Data." In *Visualization and Data Analysis (VDA 2007)*, Proceedings of SPIE, 6495, pp. 64950H–1–64950H–12. Bellingham, WA: SPIE, 2007.

[265] E. Lawler, J. Lenstra, A A. Rinnooy Kan, and D. Shmoys. *The Traveling Salesman Problem: A Guided Tour of Combinatorial Optimization*. New York: J. Wiley, 1985.

[266] J. LeBlanc, M. Ward, and N. Wittels. "Exploring N-Dimensional Databases." In *Proceedings of the 1st Conference on Visualization '90*, pp. 230–237. Los Alamitos, CA: IEEE Computer Society Press, 1990.

[267] Bongshin Lee, Catherine Plaisant, Cynthia Sims Parr, Jean-Daniel Fekete, and Nathalie Henry. "Task Taxonomy for Graph Visualization." In *Proceedings of the 2006 AVI Workshop on Beyond Time and Errors: Novel Evaluation Methods for Information Visualization*, pp. 1–5. New York: ACM Press, 2006.

[268] Y. K. Leung and M. D. Apperley. "A Review and Taxonomy of Distortion-Oriented Presentation Techniques." *ACM Transactions on Computer-Human Interaction* 1:2 (1994), 126–160.

[269] Martin D. Levine. *Vision in Man and Machine*. New York: McGraw-Hill, 1985.

[270] Haim Levkowitz. "Color Icons: Merging Color and Texture Perception for Integrated Visualization of Multiple Parameters." In *VIS '91: Proceedings of the 2nd Conference on Visualization '91*, pp. 164–170. Los Alamitos, CA: IEEE Computer Society Press, 1991.

[271] Haim Levkowitz. *Color Theory and Modeling for Computer Graphics, Visualization, and Multimedia Applications*. Norwell, MA: Kluwer Academic Publishers, 1997.

[272] B. Lichtenbelt, R. Crane, and S. Naqvi. *Introduction to Volume Rendering*. Upper Saddle River, NJ: Prentice Hall, 1998.

[273] Sharon Lin, Julie Fortuna, Chinmay Kulkarni, Maureen Stone, and Jeffrey Heer. "Selecting Semantically-Resonant Colors for Data Visualization." *Computer Graphics Forum* 32:3pt4 (2013), 401–410.

[274] Ling Liu and Tamer M. Özsu. *Encyclopedia of Database Systems*. Berlin: Springer, 2009.

[275] G. Liu, C. G. Healey, and J. T. Enns. "Target Detection and Localization in Visual Search: A Dual Systems Perspective." *Perception & Psychophysics* 65:5 (2003), 678–694.

[276] H. Lohninger. "INSPECT: A Program System to Visualize and Interpret Chemical Data." *Chemometrics and Intelligent Laboratory Systems* 22 (1994), 147–153.

[277] M. Looks, B. Goertzel, and C. Pennachin. "Novamente: An Integrative Architecture for Artificial General Intelligence." In *Proceedings of the AAAI Fall Symposium on Achieving Human-Level Intelligence through Integrated Systems and Research*, *AAAI Fall Symposium Series*, pp. 54–61. Menlo Park, CA: AAAI Press, 2004.

[278] William E. Lorensen and Harvey E. Cline. "Marching Cubes: A High Resolution 3D Surface Construction Algorithm." In *SIGGRAPH '87: Proceedings of the 14th Annual Conference on Computer Graphics and Interactive Techniques*, pp. 163–169. New York: ACM Press, 1987.

[279] A. M. MacEachren and M.-J. Kraak. "Research Challenges in Geovisualization." *Cartography and Geographic Information Science* 28:1 (2001), 3–12.

[280] A. M. MacEachren, B. P. Buttenfield, J. B. Campbell, D. W. DiBiase, and M. Monmonier. "Visualization." In *Geography's Inner Worlds*, edited by Ronald F. Abler, Melvin G. Marcus, and Judy M. Olson, pp. 99–137. Piscataway, NJ: Rutgers University Press, 1992.

[281] Alan M. MacEachren. *How Maps Work: Presentation, Visualization, and Design*. New York: The Guilford Press, 1995.

[282] A. Mack and I. Rock. *Inattentional Blindness*. Cambridge, MA: MIT Press, 1998.

[283] J. Mackinlay, G. Robertson, and S. Card. "The Perspective Wall: Detail and Context Smoothly Integrated." In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems: Reaching through Technology*, pp. 173–179. New York: ACM Press, 1991.

[284] Jock Mackinlay. "Automating the Design of Graphical Presentations of Relational Information." *ACM Trans. Graph.* 5:2 (1986), 110–141.

[285] Macrofocus GmbH. "Macrofocus Home Page." http://www.macrofocus.com, accessed July 1, 2008.

[286] Florian Mansmann, Fabian Fischer, Daniel A. Keim, and Stephen C. North. "Visualizing Large-Scale IP Traffic Flows." Paper presented at the 12th International Workshop on Vision, Modeling, and Visualization, Saarbrücken, Germany, 2007.

[287] Allen R. Martin and Matthew O. Ward. "High Dimensional Brushing for Interactive Exploration of Multivariate Data." In *Proceedings of the 6th Conference on Visualization '95*, pp. 271–278. Los Alamitos, CA: IEEE Computer Society Press, 1995.

[288] S. Mateeff, G. Dimitrov, and J. Hohnsbein. "Temporal Thresholds and Reaction Time to Changes in Velocity of Visual Motion." *Vision Research* 35:3 (1995), 355–363.

[289] Tony McLoughlin, Robert S. Laramee, Ronald Peikert, Frits H. Post, and Min Chen. "Over Two Decades of Integration-Based, Geometric Flow." *Computer Graphics Forum* 29 (2009), 1807–1829.

[290] J. Mezzich and D. Worthington. "A Comparison of Graphical Representations of Multidimensional Psychiatric Diagnostic Data." In *Graphical Representation of Multivariate Data*, edited by P. Wang, pp. 123–141. New York: Academic Press, 1978.

[291] Ted Mihalisin, John Timlin, and John Schwegler. "Visualizing Multivariate Functions, Data, and Distributions." *IEEE Comput. Graph. Appl.* 11:3 (1991), 28–35.

[292] Silvia Miksch and Wolfgang Aigner. "A Matter of Time: Applying a Data-Users-Tasks Design Triangle to Visual Analytics of Time-Oriented Data." *Computers & Graphics, Special Section on Visual Analytics* 38 (2014), 286–290. Available online (http://www.ifs.tuwien.ac.at/~silvia/pub/publications/miksch_cag_design-triangle-2014.pdf).

[293] John J. Miller and Edward J. Wegman. "Construction of Line Densities for Parallel Coordinate Plots." In *Computing and Graphics in Statistics*, edited by A. Buja and P. Tukey, pp. 107–123. New York: Springer-Verlag, 1991.

[294] A. H. Miller, E. N. Goldenberg, and L. Erbring. "Type-set Politics: Impact of Newspapers on Public Confidence." *American Political Science Review* 73 (1979), 67–84.

[295] George A. Miller. "The Magic Number Seven, Plus or Minus Two: Some Limits on Our Capacity for Processing Information." *Psychological Review* 63:2 (1956), 81–97.

[296] Sushmita Mitra and Tinku Acharya. "Gesture Recognition: A Survey." *Systems, Man, and Cybernetics, Part C: Applications and Reviews, IEEE Transactions on* 37:3 (2007), 311–324.

[297] E. Morse, M. Lewis, and K. A. Olsen. "Evaluating Visualizations: Using a Taxonomic Guide." *Int. J. Hum.-Comput. Stud.* 53:5 (2000), 637–662.

[298] G. H. Mowbray and J. W. Gebhard. "Differential Sensitivity of the Eye to White Light." *Science* 121 (1955), 137–175.

[299] H. J. Müller, G. W. Humphreys, P. T. Quinlan, and M. J. Riddoch. "Combined-Feature Coding in the Form Domain." In *Visual Search*, edited by D. Brogan, pp. 47–55. New York: Taylor & Francis, 1990.

[300] K. Mullet and D. Sano. *Designing Visual Interfaces*. Mountain View, CA: SunSoft Press, 1995.

[301] A. H. Munsell. *A Color Notation*. Boston: Geo. H. Ellis Co., 1905.

[302] Tamara Munzner. "H3: Laying Out Large Directed Graphs in 3D Hyperbolic Space." In *Proceedings of the 1997 IEEE Symposium on Information Visualization*, pp. 2–10. Washington, DC: IEEE Computer Society, 1997.

[303] Tamara Munzner. "Exploring Large Graphs in 3D Hyperbolic Space." *IEEE Computer Graphics & Applications* 18:4 (1998), 18–23.

[304] Ken Nakayama and Gerald H. Silverman. "Serial and Parallel Processing of Visual Feature Conjunctions." *Nature* 320:6059 (1986), 264–265.

[305] NCSA. "Visualization Study of the NSFNET." http://archive.ncsa.uiuc.edu/SCMS/DigLib/text/technology/Visualization-Study-NSFNET-Cox.html, 2003.

[306] NOAA. "Online Climate Data Repository." http://www.ncdc.noaa.gov/oa/climate/climatedata.html, accessed July 1, 2008.

[307] Matej Novotny and Helwig Hauser. "Outlier-Preserving Focus+Context Visualization in Parallel Coordinates." *IEEE Transactions on Visualization and Computer Graphics* 12:5 (2006), 893–900.

[308] OpenDX.org. "OpenDX Home Page." http://www.opendx.org/, accessed July 1, 2008.

[309] T. Ott and F. Swiaczny. *Time-Integrative Geographic Information Systems: Management and Analysis of Spatio-temporal Data*, First edition. Berlin: Springer, 2001.

[310] I. Overington. *Computer Vision: A Unified, Biologically-Inspired Approach.* Amsterdam: Elsevier Science, 1992.

[311] Giuliano Andrea Pagani and Marco Aiello. "Cost and Benefits of Denser Topologies for the Smart Grid." In *Computer and Information Sciences III*, edited by Erol Gelenbe and Ricardo Lent, pp. 73–81. London: Springer, 2013.

[312] W. B. Paley. "TextArc: Showing Word Frequency and Distribution in Text." Poster presented at IEEE Symposium on Information Visualization, Boston, MA, October 27–November 1, 2002.

[313] Rick Parent. *Computer Animation: Algorithms and Techniques*, Third edition. Burlington, MA: Morgan Kaufmann/Elsevier, 2012.

[314] Robert E. Patterson, Leslie M. Blaha, Georges G. Grinstein, Kristen K. Liggett, David E. Kaveney, Kathleen C. Sheldon, Paul R. Havig, and Jason A. Moore. "A Human Cognition Framework for Information Visualization." *Computers & Graphics* 42 (2014), 42–58.

[315] Theodosios Pavlidis. *Algorithms for Graphics and Image Processing.* Berlin: Springer-Verlag, 1982.

[316] Roger D. Peng and Leah J. Welty. "The NMMAPSdata Package." *R News* 4:2 (2004), 10–14.

[317] Wei Peng, Matthew O. Ward, and Elke A. Rundensteiner. "Clutter Reduction in Multi-Dimensional Data Visualization Using Dimension Reordering." In *INFOVIS '04: Proceedings of the IEEE Symposium on Information Visualization*, pp. 89–96. Washington, DC: IEEE Computer Society, 2004.

[318] Doantam Phan, Ling Xiao, Ron Yeh, Pat Hanrahan, and Terry Winograd. "Flow Map Layout." In *INFOVIS '05: Proceedings of the Proceedings of the 2005 IEEE Symposium on Information Visualization*, p. 29. Washington, DC: IEEE Computer Society, 2005.

[319] R. Pickett and G. Grinstein. "Iconographic Displays for Visualizing Multidimensional Data." In *Proceedings of the 1988 IEEE Conference on Systems, Man, and Cybernetics*, pp. 164–170. Los Alamitos, CA: IEEE Computer Society Press, 1988.

[320] Filip Piekniewski and Leszek Rybicki. "Visualizing and Analyzing Multidimensional Output from MLP Networks via Barycentric Projections." In *Artificial Intelligence and Soft Computing—ICAISC 2004: 7th International Conference, Zakopane, Poland, June 7–11, 2004, Proceedings*, Lecture Notes in Computer Science, 3070, pp. 247–252. Berlin/Heidelberg: Springer, 2004.

[321] Catherine Plaisant. "The Challenge of Information Visualization Evaluation." In *AVI '04: Proceedings of the Working Conference on Advanced Visual Interfaces*, pp. 109–116. New York: ACM Press, 2004.

[322] William Playfair. *The Commercial and Political Atlas and Statistical Breviary*, Reprint of Third edition. New York: Cambridge University Press, 2005.

[323] J. Pomerantz and E. A. Pristach. "Emergent Features, Attention, and Perceptual Glue in Visual Form Perception." *Journal of Experimental Psychology: Human Perception & Performance* 15:4 (1989), 635–649.

[324] Frits H. Post, Frank J. Post, Theo Van Walsum, and Deborah Silver. "Iconic Techniques for Feature Visualization." In *Proceedings of the IEEE Conference on Visualization*, pp. 288–295. Los Alamitos, CA: IEEE Computer Society, 1995.

[325] P. T. Quinlan and G. W. Humphreys. "Visual Search for Targets Defined by Combinations of Color, Shape, and Size: An Examination of Task Constraints on Feature and Conjuction Searches." *Perception & Psychophysics* 41:5 (1987), 455–472.

[326] "The R Project for Statistical Computing." http://www.r-project.org/, accessed July 1, 2009.

[327] Erwin Raisz. *Principles of Cartography.* New York: McGraw-Hill, 1962.

[328] R. Rao and S. Card. "The Table Lens: Merging Graphical and Symbolic Representations in an Interactive Focus + Context Visualization for Tabular Information." In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems: Celebrating Interdependence*, pp. 318–322. New York: ACM Press, 1994.

[329] A. Ravishankar Rao and Gerald L. Lohse. "Identifying High Level Features of Texture Perception." *CVGIP: Graph. Models Image Process.* 55:3 (1993), 218–233.

[330] A. Ravishankar Rao and Gerald L. Lohse. "Towards a Texture Naming System: Identifying Relevant Dimensions of Texture." In *Proceedings of the IEEE Conference on Visualization '93*, pp. 220–227. Los Alamitos, CA: IEEE Computer Society, 1993.

[331] Hannes Reijner. "The Development of the Horizon Graph." In *Electronic Proceedings of the Vis08 Workshop: From Theory to Practice: Design, Vision and Visualization*, edited by Lyn Bartram, Maureen Stone, and Diane Gromala, http://www.stonesc.com/Vis08_Workshop/DVD/, 2008.

[332] Benjamin Renoust. "Analysis and Visualisation of Edge Entanglement in Multiplex Networks." Ph.D. thesis, University of Massachusetts Lowell, 2014.

[333] Roland Rensink. "The Need for Attention to See Change." http://www.psych.ubc.ca/~rensink/flicker, March 2, 2003.

[334] R. A. Rensink. "Seeing, Sensing, and Scrutinizing." *Vision Research* 40:10-12 (2000), 1469–1487.

[335] R. J. Resnick, M. O. Ward, and E. A. Rundensteiner. "FED: A Framework for Iterative Data Selection in Exploratory Visualization." In *Proceedings of the 10th International Conference Scientific and Statistical Database Management*, pp. 180–189. Washington, DC: IEEE Computer Society, 1998.

[336] Penny Rheingans and Brice Tebbs. "A Tool for Dynamic Explorations of Color Mappings." In *Proceedings of the 1990 Symposium on Interactive 3D Graphics*, pp. 145–146. New York: ACM Press, 1990.

[337] William Ribarsky, Eric Ayers, John Eble, and Sougata Mukherjea. "Glyphmaker: Creating Customized Visualizations of Complex Data." *Computer* 27:7 (1994), 57–64.

[338] Alexander Rind, Silvia Miksch, Wolfgang Aigner, Thomas Turic, and Margit Pohl. "VisuExplore: Gaining New Medical Insights from Visual Exploration." In *Proceedings of the 1st International Workshop on Interactive Systems in Healthcare (WISH@CHI2010)*, edited by Gillian R. Hayes and Desney S. Tan, pp. 149–152. New York: ACM Press, 2010. Available online (http://ike.donau-uni.ac.at/publications/PDF/2010/CHI2010/final/rind_2010_wish_visuexplore.pdf).

[339] Alexander Rind, Tim Lammarsch, Wolfgang Aigner, Bilal Alsallakh, and Silvia Miksch. "TimeBench: A Data Model and Software Library for Visual Analytics of Time-Oriented Data." *IEEE Transactions on Visualization and Computer Graphics, Special Issue "VIS 2013"* 19 (2013), 2247–2256. Available online (http://publik.tuwien.ac.at/files/PubDat_219700.pdf).

[340] B. Roberts, M. G. Harris, and T. A. Yates. "The Roles of Inducer Size and Distance in the Ebbinghaus Illusion (Titchener Circles)." *Perception* 34:7 (2005), 847–56.

[341] George G. Robertson, Jock D. Mackinlay, and Stuart K. Card. "Cone Trees: Animated 3D Visualizations of Hierarchical Information." In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, pp. 189–194. New York: ACM Press, 1991.

[342] George Robertson, Mary Czerwinski, Kevin Larson, Daniel C. Robbins, David Thiel, and Maarten van Dantzich. "Data Mountain: Using Spatial Memory for Document Management." In *Proceedings of the 11th Annual ACM Symposium on User Interface Software and Technology*, pp. 153–162. New York: ACM Press, 1998.

[343] Philip K. Robertson. "A Methodology for Scientific Data Visualisation: Choosing Representations Based on a Natural Scene Paradigm." In *VIS '90: Proceedings of the First Conference on Visualization '90*, pp. 114–123. Los Alamitos, CA: IEEE Computer Society Press, 1990.

[344] Bernice E. Rogowitz and Lloyd A. Treinish. "An Architecture for Rule-Based Visualization." In *VIS '93: Proceedings of the 4th Conference on Visualization '93*, pp. 236–243. Washington, DC: IEEE Computer Society, 1993.

[345] Randall M. Rohrer, John L. Sibert, and David S. Ebert. "The Shape of Shakespeare: Visualizing Text Using Implicit Surfaces." In *INFOVIS '98: Proceedings of the 1998 IEEE Symposium on Information Visualization*, pp. 121–129. Washington, DC: IEEE Computer Society, 1998.

[346] Timo Ropinski, Steffen Oeltze, and Bernhard Preim. "Survey of Glyph-Based Visualization Techniques for Spatial Multivariate Medical Data." *Computers & Graphics* 35:2 (2011), 392–401.

[347] Geraldine E. Rosario, Elke A. Rundensteiner, David C. Brown, Matthew O. Ward, and Shiping Huang. "Mapping Nominal Values to Numbers for Effective Visualization." *Information Visualization* 3:2 (2004), 80–95.

[348] Steven F. Roth, John Kolojejchick, Joe Mattis, and Jade Goldstein. "Interactive Graphic Design Using Automatic Presentation Knowledge." In *CHI*

'94: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, pp. 112–117. New York: ACM Press, 1994.

[349] S. F. Roth, P. Lucas, J. A. Senn, C. C. Gomberg, M. B. Burks, P. J. Stroffolino, A. J. Kolojechick, and C. Dunmire. "Visage: A User Interface Environment for Exploring Information." In *INFOVIS '96: Proceedings of the 1996 IEEE Symposium on Information Visualization (INFOVIS '96)*, pp. 3–12. Washington, DC: IEEE Computer Society, 1996.

[350] Sam T. Roweis and Lawrence K. Saul. "Nonlinear Dimensionality Reduction by Locally Linear Embedding." *Science* 290:5500 (2000), 2323–2326. Available online (http://www.sciencemag.org/content/290/5500/2323.abstract).

[351] Elke A. Rundensteiner, Matthew O. Ward, Zaixian Xie, Qingguang Cui, Charudatta V. Wad, Di Yang, and Shiping Huang. "XmdvtoolQ: Quality-Aware Interactive Data Exploration." In *SIGMOD '07: Proceedings of the 2007 ACM SIGMOD International Conference on Management of Data*, pp. 1109–1112. New York: ACM Press, 2007.

[352] T. A. Runkler. *Data Analytics: Models and Algorithms for Intelligent Data Analysis*. Bücher: Springer Vieweg, 2012.

[353] S. J. Russell and P. Norvig. *Artificial Intelligence: A Modern Approach*, Second edition. Upper Saddle River, NJ: Prentice Hall, 2002.

[354] Takafumi Saito, Hiroko Nakamura Miyamura, Mitsuyoshi Yamamoto, Hiroki Saito, Yuka Hoshiya, and Takumi Kaseda. "Two-Tone Pseudo Coloring: Compact Visualization for One-Dimensional Data." In *Proceedings of the IEEE Symposium on Information Visualization (InfoVis)*, pp. 173–180. Los Alamitos, CA: IEEE Computer Society, 2005.

[355] Gerard Salton and Christopher Buckley. "Term-Weighting Approaches in Automatic Text Retrieval." *Information Processing and Management* 24:5 (1988), 513–523.

[356] G. Salton, A. Wong, and C. S. Yang. "A Vector Space Model for Automatic Indexing." *Commun. ACM* 18:11 (1975), 613–620.

[357] Hanan Samet. *The Design and Analysis of Spatial Data Structures*. Reading, MA: Addison-Wesley, 1990.

[358] Beatriz Sousa Santos and Paulo Dias. "Evaluation in Visualization: Some Issues and Best Practices." In *Visualization and Data Analysis 2014*, SPIE Proceedings, 9017, p. 90170O. Bellingham, WA: SPIE, 2013.

[359] Purvi Saraiya, Chris North, and Karen Duca. "An Insight-Based Methodology for Evaluating Bioinformatics Visualizations." *IEEE Transactions on Visualization and Computer Graphics* 11:4 (2005), 443–456.

[360] M. Sarkar, S. Snibbe, O. Tversky, and S. Reiss. "Stretching the Rubber Sheet: A Metaphor for Viewing Large Layouts on Small Screens." In *Proceedings of the 6th Annual ACM Symposium on User Interface Software and Technology*, pp. 81–91. New York: ACM Press, 1993.

[361] SAS Institute. "SAS Home Page." http://www.sas.com, accessed July 1, 2008.

[362] J. L. Schafer. *Analysis of Incomplete Multivariate Data*. Boca Raton, FL: CRC Press, 1997.

[363] Sebastian Schmidt, Miguel A. Nacenta, Raimund Dachselt, and Sheelagh Carpendale. "A Set of Multi-touch Graph Interaction Techniques." In *ACM International Conference on Interactive Tabletops and Surfaces*, pp. 113–116. New York: ACM Press, 2010.

[364] M. Schrauf, B. Lingelbach, E. Lingelbach, and E. R. Wist. "The Hermann Grid and the Scintillation Effect." *Perception* 24, Supplement A (1995), 88–89.

[365] W. J. Schroeder, C. R. Volpe, and W. E. Lorensen. "The Stream Polygon: A Technique for 3D Vector Field Visualization." In *VIS '91: Proceedings of the 2nd Conference on Visualization '91*, pp. 126–132. Los Alamitos, CA: IEEE Computer Society Press, 1991.

[366] Will Schroeder, Ken Martin, and Bill Lorensen. *The Visualization Toolkit: An Object-Oriented Approach to 3D Graphics*, Fourth edition. Clifton Park, NY: Kitware, Inc., 2006.

[367] Hans-Jörg Schulz, Thomas Nocke, Magnus Heitzler, and Heidrun Schumann. "A Design Space of Visualization Tasks." *IEEE Transactions Visualization and Computer Graphics* 19:12 (2013), 2366–2375.

[368] Michael Sedlmair, Petra Isenberg, Dominikus Baur, and Andreas Butz. "Information Visualization Evaluation in Large Companies: Challenges, Experiences and Recommendations." *Information Visualization* 10:3 (2011), 248–266.

[369] S. Selvin, D. Merrill, J. Schulman, S. Sacks, L. Bedell, and L. Wong. "Transformations of Maps to Investigate Clusters of Disease." *Social Science and Medicine* 26:2 (1988), 215–221.

[370] Hikmet Senay and Eve Ignatius. "A Knowledge-Based System for Visualization Design." *IEEE Comput. Graph. Appl.* 14:6 (1994), 36–47.

[371] L. Shapiro and G. Stockman. *Computer Vision*. Upper Saddle River, NJ: Prentice Hall, 2001.

[372] John Sharko, Georges Grinstein, and Kenneth A. Marx. "Vectorized Radviz and Its Application to Multiple Cluster Datasets." *IEEE Transactions on Visualization and Computer Graphics* 14:6 (2008), 1427–1444.

[373] Helen Sharp, Yvonne Rogers, and Jenny Preece. *Interaction Design: Beyond Human-Computer Interaction*, Second edition. New York: J. Wiley, 2007.

[374] Ben Shneiderman and Catherine Plaisant. *Designing the User Interface: Strategies for Effective Human-Computer Interaction*, Fourth edition. Boston: Addison Wesley, 2004.

[375] Ben Shneiderman. "Dynamic Queries for Visual Information Seeking." *IEEE Software* 11 (1994), 70–77.

[376] Ben Shneiderman. "The Eyes Have It: A Task by Data Type Taxonomy for Information Visualizations." In *Proceedings of the 1996 IEEE Symposium on*

Visual Languages, pp. 336–343. Los Alamitos, CA: IEEE Computer Society, 1996.

[377] Ben Shneiderman. “Extreme Visualization: Squeezing a Billion Records into a Million Pixels.” In *SIGMOD ’08: Proceedings of the 2008 ACM SIGMOD International Conference on Management of Data*, pp. 3–12. New York: ACM Press, 2008.

[378] J. Siegel, E. Farrell, R. Goldwyn, and H. Friedman. “The Surgical Implication of Physiologic Patterns in Myocardial Infarction Shock.” *Surgery* 72 (1972), 126–141.

[379] Simeon Simoff, Michael H. Böhlen, and Arturas Mazeika, editors. *Visual Data Mining: Theory, Techniques and Tools for Visual Analytics*. Berlin: Springer, 2008.

[380] D. J. Simons and D. T. Levin. “Change Blindness.” *Trends in Cognitive Sciences* 1 (1997), 261–267.

[381] D. J. Simons. “In Sight, Out of Mind: When Object Representations Fail.” *Psychological Science* 7:5 (1996), 301–305.

[382] D. J. Simons. “Current Approaches to Change Blindness.” *Visual Cognition* 7:1/2/3.

[383] Terry A. Slocum, Robert B. McMaster, Fritz C. Kessler, and Hugh H. Howard. *Thematic Cartography and Geovisualization*, Third edition. Upper Saddle River, NJ: Prentice Hall, 2009.

[384] Terry A. Slocum. *Thematic Cartography and Visualization*. Upper Saddle River, NJ: Prentice Hall, 1999.

[385] Lindsay I. Smith. “A Tutorial on Principal Component Analysis.” http://www.cs.otago.ac.nz/cosc453/student_tutorials/principal_components.pdf, February 26, 2002.

[386] Douglas Smith. “Beyond the Cave: Lascaux and the Prehistoric in Post-War French Culture.” *French Studies* 58 (2004), 219–232.

[387] R. J. Snowden. “Texture Segregation and Visual Search: A Comparison of the Effects of Random Variations along Irrelevant Dimensions.” *Journal of Experimental Psychology: Human Perception & Performance* 24:5 (1998), 1354–1367.

[388] John P. Snyder. *Map Projections: A Working Manual*. Washington, DC: US Government Printing Office, 1987.

[389] Pierre Soille. *Morphological Image Analysis: Principles and Applications*. Berlin: Springer-Verlag Telos, 1999.

[390] Robert Spence. *Information Visualization: Design for Interaction*, Second edition. Upper Saddle River, NJ: Prentice Hall, 2007.

[391] L. Spillmann. “The Hermann Grid Illusion: A Tool for Studying Human Perceptive Field Organization.” *Perception* 23 (1994), 691–708.

[392] SPSS Inc. “SPSS Home Page.” http://www.spss.com, accessed July 1, 2008.

[393] John Stasko and Eugene Zhang. "Focus+Context Display and Navigation Techniques for Enhancing Radial, Space-Filling Hierarchy Visualizations." In *Proceedings of the IEEE Symposium on Information Visualization*, pp. 57–65. Los Alamitos, CA: IEEE Computer Society, 2000.

[394] StatLib. "StatLib—Datasets Archive." http://lib.stat.cmu.edu/datasets/, accessed July 1, 2008.

[395] Peter Stearns. *The Encyclopedia of World History*. New York: Houghton-Mifflin, 2001.

[396] Daniel Steinbock. "TagCrowd Home Page." http://www.tagcrowd.com/, accessed August 31, 2009.

[397] Andreas Steiner. "A Generalisation Approach to Temporal Data Models and Their Implementations." Ph.D. thesis, Swiss Federal Institute of Technology, 1998.

[398] Debbie Stone, Caroline Jarrett, Mark Woodroffe, and Shailey Minocha. *User Interface Design and Evaluation*. The Morgan Kaufmann Series in Interactive Technologies, San Francisco: Morgan Kaufmann Publishers, Inc., 2005.

[399] Magnus Strengert, Marcelo Magallón, Daniel Weiskopf, Stefan Guthe, and Thomas Ertl. "Hierarchical Visualization and Compression of Large Volume Datasets Using GPU Clusters." In *Proceedings of the Eurographics Symposium on Parallel Graphics and Visualization*, pp. 41–48. Aire-la-Ville, Switzerland: Eurographics Association, 2004.

[400] H. Strobelt, D. Oelke, C. Rohrdantz, A. Stoffel, D. Keim, and O. Deussen. "Document Cards: A Top Trumps Visualization for Documents." *IEEE InfoVis 2009: IEEE Transactions on Visualization and Computer Graphics* 15:6 (2009), 1145–1152.

[401] Steven H. Strogatz. "Exploring Complex Networks." *Nature* 410:6825 (2001), 268–276.

[402] Steve Summit. "Data File Formats." http://www.eskimo.com/~scs/datafiles.html, accessed July 1, 2008.

[403] Tableau Software. "Tableau Home Page." http://www.tableausoftware.com, accessed July 1, 2008.

[404] H. Tamura, S. Mori, and T. Yamawaki. "Textural Features Corresponding to Visual Perception." *IEEE Transactions on Systems, Man, and Cybernetics* 8:6 (1978), 460–473.

[405] Alexandru Telea. *Data Visualization: Principles and Practice*. Wellesley, MA: A K Peters, 2008.

[406] T. Tenev and R. Rao. "Managing Multiple Focal Levels in Table Lens." In *Proceedings of the 1997 IEEE Symposium on Information Visualization*, pp. 59–63. Washington, DC: IEEE Computer Society, 1997.

[407] J. Thomas, P. Cowley, O. Kuchar, L. Nowell, J. Thomson, and P. Chung Wong. "Discovering Knowledge Through Visual Analysis." *Journal of Universal Computer Science* 7:6 (2001), 517–529. Available online (http://www.jucs.org/jucs_7_6/discovering_knowledge_through_visual).

[408] David Thompson, Jeff Braun, and Ray Ford. *OpenDX: Paths to Visualization.* Missoula, MT: VIS, Inc., 2004.

[409] TIBCO Software, Inc. "Spotfire Home Page." http://spotfire.tibco.com, accessed July 1, 2008.

[410] Vladimir Tikunov and Sabir Gusein-Zade. "A New Technique for Constructing Continuous Cartograms." *Cartography and Geographic Information Systems* 20:3 (1993), 66–85.

[411] Vladimir Tikunov and Sabir Gusein-Zade. "Map Transformations." *Geography Review* 9:1 (1995), 19–23.

[412] W. R. Tobler. "Cartograms and Cartosplines." In *Proceedings of the 1976 Workshop on Automated Cartography and Epidemiology*, pp. 53–58. Washington, DC: Department of Health Education and Welfare, 1976.

[413] W. R. Tobler. "Pseudo-Cartograms." *The American Cartographer* 13:1 (1986), 43–40.

[414] Tom Sawyer Software. "Tom Sawyer Home Page." http://www.tomsawyer.com, accessed July 1, 2008.

[415] Christian Tominski and Hans-Jörg Schulz. "The Great Wall of Space-Time." In *Proceedings of the Workshop on Vision, Modeling & Visualization (VMV)*, pp. 199–206. Eurographics Association, 2012. Available online (http://dx.doi.org/10.2312/PE/VMV/VMV12/199-206).

[416] Christian Tominski and Heidrun Schumann. "Enhanced Interactive Spiral Display." In *Proceedings of the Annual SIGRAD Conference, Special Theme: Interactivity*, pp. 53–56. Linköping, Sweden: Linköping University Electronic Press, 2008.

[417] Christian Tominski, James Abello, and Heidrun Schumann. "Axes-Based Visualizations with Radial Layouts." In *Proceedings of the ACM Symposium on Applied Computing (SAC)*, pp. 1242–1247. New York: ACM Press, 2004.

[418] Melanie Tory and Torsten Müller. "Evaluating Visualizations: Do Expert Reviews Work?" *IEEE Computer Graphics and Applications* 25:5 (2005), 8–11.

[419] Anne M. Treisman and Garry Gelade. "A Feature-Integration Theory of Attention." *Cognitive Psychology* 12:1 (1980), 97–136. Available online (http://dx.doi.org/10.1016/0010-0285(80)90005-5).

[420] Anne Treisman and S. Gormican. "Feature Analysis in Early Vision: Evidence from Search Asymmetries." *Psychological Review* 95:1 (1988), 15–48.

[421] Anne Treisman and J. Souther. "The Roles of Attention and Top-Down Constraints in Conjoining Letters to Form Words." *Journal of Experimental Psychology: Human Perception & Performance* 12 (1986), 107–141.

[422] Anne M. Treisman. "Preattentive Processing in Vision." *Computer Vision, Graphics, and Image Processing* 31:2 (1985), 156–177.

[423] Anne M. Treisman. "Search, Similarity, and Integration of Features between and within Dimensions." *Journal of Experimental Psychology: Human Perception & Performance* 17:3 (1991), 652–676.

[424] E. R. Tufte. *The Visual Display of Quantitative Information.* Cheshire, CT: Graphics Press, 1983.

[425] E. R. Tufte. *Envisioning Information.* Cheshire, CT: Graphics Press, 1990.

[426] E. R. Tufte. *Visual Explanations.* Cheshire, CT: Graphics Press, 1997.

[427] E. R. Tufte. *Beautiful Evidence.* Cheshire, CT: Graphics Press, 2006.

[428] P. D. Tynan and R. Sekuler. "Motion Processing in Peripheral Vision: Reaction Time and Perceived Velocity." *Vision Research* 22:1 (1982), 61–68.

[429] Fan-Yin Tzeng and Kwan-Liu Ma. "Intelligent Feature Extraction and Tracking for Visualizing Large-Scale 4D Flow Simulations." In *SC '05: Proceedings of the 2005 ACM/IEEE Conference on Supercomputing*, p. 6. Washington, DC: IEEE Computer Society Press, 2005.

[430] University of California, Irvine Department of Information and Computer Science. "UCI KDD Data Archive." http://kdd.ics.uci.edu/, accessed July 1, 2008.

[431] University of Maryland HCI Lab Data Repository. "SEMVAST: Scientific Evaluation Methods for Visual Analytics Science and Technology." http://www.cs.umd.edu/hcil/semvast/, accessed August 27, 2009.

[432] Eliane R. A. Valiati, Marcelo S. Pimenta, and Carla M. D. S. Freitas. "A Taxonomy of Tasks for Guiding the Evaluation of Multidimensional Visualizations." In *BELIV '06: Proceedings of the 2006 AVI Workshop on Beyond Time and Errors*, pp. 1–6. New York: ACM Press, 2006.

[433] A. van Doorn and J. Koenderink. "Spatial Properties of the Visual Detectability of Moving Spatial White Noise." *Experimental Brain Research* 45:1–2 (1982), 189–195. Available online (http://dx.doi.org/10.1007/BF00235778).

[434] A. van Doorn and J. Koenderink. "Temporal Properties of the Visual Detectability of Moving Spatial White Noise." *Experimental Brain Research* 45:1–2 (1982), 179–188.

[435] J. J. van Wijk and W. Nuij. "Smooth and Efficient Zooming and Panning." In *Proceedings of the IEEE Symposium on Information Visualization 2003*, pp. 15–23. Los Alamitos, CA: IEEE Computer Society Press, 2003.

[436] Andrew Vande Moere. "Time-Varying Data Visualization Using Information Flocking Boids." In *Proceedings of the IEEE Symposium on Information Visualization (InfoVis)*, pp. 97–104. Los Alamitos, CA: IEEE Computer Society, 2004.

[437] Vero Insight. "MineSet Home Page." http://www.vero-insight.com/, 2009.

[438] Fernanda B. Viégas, Danah Boyd, David H. Nguyen, Jeffrey Potter, and Judith Donath. "Digital Artifacts for Remembering and Storytelling: PostHistory and Social Network Fragments." In *Proceedings of the Annual Hawaii International Conference on System Sciences (HICSS)*, pp. 109–118. Los Alamitos, CA: IEEE Computer Society, 2004.

[439] VRVis. "High Quality Volume Rendering with 2D and 3D Textures." http://old.vrvis.at/via/resources/PR-CBerger-2/index.html, accessed August 1, 2008.

[440] F. Wanner, C. Rohrdantz, F. Mansmann, D. Oelke, and D. A. Keim. "Visual Sentiment Analysis of RSS News Feeds Featuring the US Presidential Election in 2008." Paper presented at the Workshop on Visual Interfaces to the Social and the Semantic Web, Sanibel Island, FL, February 8, 2009.

[441] M. O. Ward and B. N. Lipchak. "A Visualization Tool for Exploratory Analysis of Cyclic Multivariate Data." *Metrika* 51:1 (2000), 27–38.

[442] Matthew O. Ward and Kevin J. Theroux. "Perceptual Benchmarking for Multivariate Data Visualization." In *DAGSTUHL '97: Proceedings of the Conference on Scientific Visualization*, pp. 314–321. Washington, DC: IEEE Computer Society, 1997.

[443] Matthew O. Ward and Jing Yang. "Interaction Spaces in Data and Information Visualization." In *Eurographics Symposium on Visualization (VisSym)*, edited by Oliver Deussen, Charles D. Hansen, Daniel A. Keim, and Dietmar Saupe, pp. 137–145. Aire-la-Ville, Switzerland: Eurographics Association, 2004.

[444] Matthew O. Ward. "XmdvTool: Integrating Multiple Methods for Visualizing Multivariate Data." In *VIS '94: Proceedings of the Conference on Visualization '94*, pp. 326–333. Los Alamitos, CA: IEEE Computer Society Press, 1994.

[445] Matthew O. Ward. "A Taxonomy of Glyph Placement Strategies for Multidimensional Data Visualization." *Information Visualization* 1:3–4 (2002), 194–210.

[446] Colin Ware and William Knight. "Using Visual Texture for Information Display." *ACM Trans. Graph.* 14:1 (1995), 3–20.

[447] Colin Ware. "Color Sequences for Univariate Maps: Theory, Experiments and Principles." *IEEE Comput. Graph. Appl.* 8:5 (1988), 41–49.

[448] Colin Ware. *Information Visualization: Perception for Design.* San Francisco: Morgan Kaufmann Publishers Inc., 2000.

[449] A. Watt and M. Watt. *Advanced Rendering and Animation Techniques: Theory and Practice.* Reading, MA: Addison-Wesley, 1991.

[450] M. Wattenberg and F. B. Viégas. "The Word Tree, an Interactive Visual Concordance." *IEEE Transactions on Visualization and Computer Graphics* 14:6 (2008), 1221–1228.

[451] Martin Wattenberg. "Arc Diagrams: Visualizing Structure in Strings." In *Proceedings of the IEEE Symposium on Information Visualization (INFOVIS 2002)*, pp. 110–116. Washington, DC: IEEE Computer Society Press, 2002.

[452] Duncan J. Watts and Steven H. Strogatz. "Collective Dynamics of 'Small-World' Networks." *Nature* 393:6684 (1998), 440–442.

[453] Marc Weber, Marc Alexa, and Wolfgang Müller. "Visualizing Time-Series on Spirals." In *Proceedings of the IEEE Symposium on Information Visualization (InfoVis)*, pp. 7–14. Los Alamitos, CA: IEEE Computer Society, 2001.

[454] WEBSOM research group. "WEBSOM Map—Million Documents." http://websom.hut.fi/websom/milliondemo/html/root.html, accessed August 31, 2009.

[455] Edward J. Wegman and Jeffrey L. Solka. "On Some Mathematics for Visualizing High Dimensional Data." *Sankhya—The Indian Journal of Statistics, Series A* 64:2 (2002), 429–452.

[456] Stephen Wehrend and Clayton Lewis. "A Problem-Oriented Classification of Visualization Techniques." In *VIS '90: Proceedings of the First Conference on Visualization '90*, pp. 139–143. Los Alamitos, CA: IEEE Computer Society Press, 1990.

[457] C. Weigle, W. Emigh, G. Liu, R. Taylor, J. Enns, and C. Healey. "Oriented Sliver Textures: A Technique for Local Value Estimation of Multiple Scalar Fields." In *Proceedings Graphics Interface 2000*, pp. 163–170. Toronto: Canadian Information Processing Society, 2000.

[458] Scott D. Westrem. "Making a Mappamundi: The Hereford Map." http://www.sochistdisc.org/2002_articles/westrem.htm, 2008.

[459] Leland Wilkinson. *SYSTAT for DOS: Advanced Applications, Version 6.* Evanston, IL: SYSTAT, Inc., 1994.

[460] Leland Wilkinson. *The Grammar of Graphics.* Statistics and Computing, New York: Springer-Verlag, 2005.

[461] G. Wills. "Selection: 524,288 Ways to Say 'This Is Interesting'." In *Proceedings of the IEEE Symposium on Information Visualization '96*, pp. 54–60. Los Alamitos, CA: IEEE Computer Society Press, 1996.

[462] Craig M. Wittenbrink, Alex T. Pang, and Suresh K. Lodha. "Glyphs for Visualizing Uncertainty in Vector Fields." *IEEE Transactions on Visualization and Computer Graphics* 2:3 (1996), 266–279.

[463] J. M. Wolfe and K. R. Cave. "Deploying Visual Attention: The Guided Search Model." In *AI and the Eye*, edited by T. Troscianko and A. Blake, pp. 79–103. Chichester, UK: John Wiley & Sons, Inc., 1989.

[464] J. M. Wolfe and S. L. Franzel. "Binocularity and Visual Search." *Perception & Psychophysics* 44 (1988), 81–93.

[465] J. M. Wolfe, K. R. Cave, and S. L. Franzel. "Guided Search: An Alternative to the Feature Integration Model for Visual Search." *Journal of Experimental Psychology: Human Perception & Performance* 15:3 (1989), 419–433. Available online (http://view.ncbi.nlm.nih.gov/pubmed/2527952).

[466] J. M. Wolfe, K. P. Yu, M. I. Stewart, A. D. Shorter, S. R. Friedman-Hill, and K. R. Cave. "Limitations on the Parallel Guidance of Visual Search: Color × Color and Orientation × Orientation Conjunctions." *Journal of Experimental Psychology: Human Perception & Performance* 16:4 (1990), 879–892.

[467] J. M. Wolfe, S. R. Friedman-Hill, M. I. Stewart, and K. M. O'Connell. "The Role of Categorization in Visual Search for Orientation." *Journal of Experimental Psychology: Human Perception & Performance* 18:1 (1992), 34–49.

[468] J. M. Wolfe, N. Klempen, and K. Dahlen. "Postattentive Vision." *Journal of Experimental Psychology: Human Perception & Performance* 26:2 (2000), 693–716.

[469] J. M. Wolfe. "Guided Search 2.0: A Revised Model of Visual Search." *Psychonomic Bulletin & Review* 1:2 (1994), 202–238.

[470] P. Wong and R. Bergeron. "Multiresolution Multidimensional Wavelet Brushing." In *Proceedings of the 7th Conference on Visualization '96*, pp. 141–148. Los Alamitos, CA: IEEE Computer Society Press, 1996.

[471] Pak Chung Wong, Harlan Foote, Dan Adams, Wendy Cowley, and Jim Thomas. "Dynamic Visualization of Transient Data Streams." In *Proceedings of the IEEE Symposium on Information Visualization*, pp. 97–104. Los Alamitos, CA: IEEE Computer Society Press, 2003.

[472] Pak Chung Wong, Han-Wei Shen, and Chaomei Chen. "Top Ten Interaction Challenges in Extreme-Scale Visual Analytics." In *Expanding the Frontiers of Visual Analytics and Visualization*, edited by J. Dill, R. Earnshaw, D. Kasik, J. Vince, and P.C. Wong, pp. 197–207. New York: Springer, 2012.

[473] H. Wright. *Introduction to Scientific Visualization.* New York: Springer, 2007.

[474] Michael Wybrow, Niklas Elmqvist, Jean-Daniel Fekete, Tatiana von Landesberger, Jarke J van Wijk, and Björn Zimmer. "Interaction in the Visualization of Multivariate Networks." In *Multivariate Network Visualization*, Lecture Notes in Computer Science, 8380, edited by Andreas Kerren, Helen C. Purchase, and Matthew O. Ward, pp. 97–125. New York: Springer, 2014.

[475] G. Wyvill, C. McPheeters, and B. Wyvill. "Data Structure for Soft Objects." *The Visual Computer* 2 (1986), 227–234.

[476] Zaixian Xie, Shiping Huang, Matthew O. Ward, and Elke A. Rundensteiner. "Exploratory Visualization of Multivariate Data with Variable Quality." In *Proceedings of the IEEE Symposium on Visual Analysis Science and Technology*, pp. 183–190. Los Alamitos, CA: IEEE Computer Society Press, 2006.

[477] XmdvTool Project. "XmdvTool Home Page." http://davis.wpi.edu/~xmdv, accessed July 1, 2008.

[478] Jing Yang, Matthew O. Ward, and Elke A. Rundensteiner. "InterRing: An Interactive Tool for Visually Navigating and Manipulating Hierarchical Structures." In *Proceedings of the IEEE Symposium on Information Visualization '02*, pp. 77–84. Washington, DC: IEEE Computer Society, 2002.

[479] J. Yang, W. Peng, M. O. Ward, and E. A. Rundensteiner. "Interactive Hierarchical Dimension Ordering, Spacing and Filtering for Exploration of High Dimensional Datasets." In *Proceedings of the IEEE Symposium on Information Visualization*, pp. 105–112. Washington, DC: IEEE Computer Society, 2003.

[480] Jing Yang, Matthew O. Ward, Elke A. Rundensteiner, and S. Huang. "Visual Hierarchical Dimension Reduction for Exploration of High Dimensional Datasets." In *VISSYM '03: Proceedings of the Symposium on Data Visualisation 2003*, pp. 19–28. Aire-la-Ville, Switzerland: Eurographics Association, 2003.

[481] Jing Yang, Matthew O. Ward, Elke A. Rundensteiner, and Anilkumar Patro. "InterRing: A Visual Interface for Navigating and Manipulating Hierarchies." *Information Visualization* 2:1 (2003), 16–30.

[482] J. Yang, A. Patro, S. Huang, N. Mehta, M. O. Ward, and E. A. Rundensteiner. "Value and Relation Display for Interactive Exploration of High Dimensional Datasets." In *Proceedings of the IEEE Symposium on Information Visualization*, pp. 73–80. Washington, DC: IEEE Computer Society, 2004.

[483] Fanhai Yang, Howard Goodell, Ronald Pickett, Robert Bobrow, Alexander Baumann, Alexander Gee, and Georges Grinstein. "Data Exploration Combining Kinetic and Static Visualization Displays." In *Proceedings of the Fourth International Conference on Coordinated and Multiple Views in Exploratory Visualization*, pp. 21–30. Washington, DC: IEEE Computer Society, 2006.

[484] D. Yang, Elke A. Rundensteiner, and Matthew O. Ward. "Analysis Guided Visual Exploration of Multivariate Data." In *Proceedings of the IEEE Symposium on Visual Analytics Science and Technology*, pp. 83–90. Washington, DC: IEEE Computer Society, 2007.

[485] Jing Yang, Daniel Hubball, Matthew Ward, Elke Rundensteiner, and William Ribarsky. "Value and Relation Display: Interactive Visual Exploration of Large Data Sets with Hundreds of Dimensions." *IEEE Trans. Visualization and Computer Graphics* 13:3 (2007), 494–507.

[486] Li Yang. "Pruning and Visualizing Generalized Association Rules in Parallel Coordinates." *IEEE Transactions on Knowledge and Data Engineering* 17:1 (2005), 60–70.

[487] Ji Soo Yi, Youn ah Kang, John T. Stasko, and Julie A. Jacko. "Toward a Deeper Understanding of the Role of Interaction in Information Visualization." *IEEE Trans. Visualization and Computer Graphics* 13 (2007), 1224–1231.

[488] Jian Zhao, Fanny Chevalier, and Ravin Balakrishnan. "KronoMiner: Using Multi-Foci Navigation for the Visual Exploration of Time-Series Data." In *Proceedings of the 2011 Annual Conference on Human Factors in Computing Systems*, pp. 1737–1746. New York: ACM Press, 2011.

[489] J. Zhou, G. Grinstein, and K. Marx. "A New Gene Selection Method for Visual Analysis." Scientific Report No. 015, University of Massachusetts Lowell, 2007.

[490] G. K. Zipf. *Human Behavior and the Principle of Least Effort: An Introduction to Human Ecology.* Reading, MA: Addison-Wesley Press, 1949.

[491] Christian Zuchner. "Grotte Chauvet Archaeologically Dated." http://www.rupestre.net/tracce/12/chauv.html, 2000.

[492] Torre Zuk, Lothar Schlesier, Petra Neumann, Mark S. Hancock, and Sheelagh Carpendale. "Heuristics for Information Visualization Evaluation." In *BELIV '06: Proceedings of the 2006 AVI Workshop on Beyond Time and Errors*, pp. 1–6. New York: ACM Press, 2006.

[493] Zuse Institute Berlin. "LicFactory Home Page." http://www.zib.de/visual/software/LicFactory/, accessed August 1, 2008.