

References

- Aigner, W., Miksch, S., Müller, W., Schumann, H., and Tominski, C. (2007). Visualizing Time-Oriented Data – A Systematic View. *Computers & Graphics*, 31(3):401–409.
- Aigner, W., Miksch, S., Müller, W., Schumann, H., and Tominski, C. (2008). Visual Methods for Analyzing Time-Oriented Data. *IEEE Transactions on Visualization and Computer Graphics*, 14(1):47–60.
- Aigner, W., Miksch, S., Thurnher, B., and Biffl, S. (2005). PlanningLines: Novel Glyphs for Representing Temporal Uncertainties and their Evaluation. In *Proceedings of the International Conference Information Visualisation (IV)*, pages 457–463, Los Alamitos, CA, USA. IEEE Computer Society.
- Akaishi, M. and Okada, Y. (2004). Time-tunnel: Visual Analysis Tool for Time-series Numerical Data and its Aspects as Multimedia Presentation Tool. In *Proceedings of the International Conference Information Visualisation (IV)*, pages 456–461, Los Alamitos, CA, USA. IEEE Computer Society.
- Allen, J. F. (1983). Maintaining Knowledge about Temporal Intervals. *Communications of the ACM*, 26(11):832–843.
- André, P., Wilson, M. L., Russell, A., Smith, D. A., Owens, A., and schraefel, m.c. (2007). Continuum: Designing Timelines for Hierarchies, Relationships and Scale. In *Proceedings of the ACM Symposium on User Interface Software and Technology (UIST)*, pages 101–110, New York, NY, USA. ACM Press.
- Andrienko, N. and Andrienko, G. (2004). Interactive Visual Tools to Explore Spatio-Temporal Variation. In *Proceedings of the Working Conference on Advanced Visual Interfaces (AVI)*, pages 417–420, New York, NY, USA. ACM Press.
- Andrienko, N. and Andrienko, G. (2006). *Exploratory Analysis of Spatial and Temporal Data*. Springer, Berlin, Germany.
- Andrienko, N. and Andrienko, G. (2011). Spatial Generalization and Aggregation of Massive Movement Data. *IEEE Transactions on Visualization and Computer Graphics*, 17(2):205–219.
- Ankerst, M. (2001). Visual Data Mining with Pixel-oriented Visualization Techniques. In *Proceedings of ACM SIGKDD Workshop on Visual Data Mining*, New York, NY, USA. ACM Press.
- Ankerst, M., Kao, A., Tjoelker, R., and Wang, C. (2008). DataJewel: Integrating Visualization with Temporal Data Mining. In Simoff, S., Böhlen, M., and Mazeika, A., editors, *Visual Data Mining*, volume 4404 of *Lecture Notes in Computer Science*, pages 312–330. Springer, Berlin, Germany.
- Antunes, C. M. and Oliveira, A. L. (2001). Temporal Data Mining: An Overview. Workshop on Temporal Data Mining at the ACM SIGKDD International Conference on Knowledge Discovery and Data Mining (KDD).

- Bade, R., Schlechtweg, S., and Miksch, S. (2004). Connecting Time-oriented Data and Information to a Coherent Interactive Visualization. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI)*, pages 105–112, New York, NY, USA. ACM Press.
- Baldonado, M. Q. W., Woodruff, A., and Kuchinsky, A. (2000). Guidelines for Using Multiple Views in Information Visualization. In *Proceedings of the Working Conference on Advanced Visual Interfaces (AVI)*, pages 110–119, New York, NY, USA. ACM Press.
- Bale, K., Chapman, P., Barraclough, N., Purdy, J., Aydin, N., and Dark, P. (2007). Kaleidomaps: A New Technique for the Visualization of Multivariate Time-Series Data. *Information Visualization*, 6(2):155–167.
- Bale, K., Chapman, P., Purdy, J., Aydin, N., and Dark, P. (2006). Kaleidomap Visualizations of Cardiovascular Function in Critical Care Medicine. In *Proceedings of International Conference on Medical Information Visualisation - BioMedical Visualisation (MediVis)*, pages 51–58, Los Alamitos, CA, USA. IEEE Computer Society.
- Barbeau-Dubourg, J. (1753). Carte chronographique. Paper roll in scroll case, 40 cm x 16.5 m. Princeton University Library.
- Beard, K., Deese, H., and Pettigrew, N. R. (2008). A Framework for Visualization and Exploration of Events. *Information Visualization*, 7:133–151.
- Becker, R. A. and Cleveland, W. S. (1987). Brushing Scatterplots. *Technometrics*, 29:127–142.
- Bederson, B. B., Clamage, A., Czerwinski, M. P., and Robertson, G. G. (2004). DateLens: A Fisheye Calendar Interface for PDAs. *ACM Transactions on Computer-Human Interaction (TOCHI)*, 11(1):90–119.
- Been, K., Daiches, E., and Yap, C.-K. (2006). Dynamic Map Labeling. *IEEE Transactions on Visualization and Computer Graphics*, 12(5):773–780.
- Bergman, L., Rogowitz, B. E., and Treinish, L. A. (1995). A Rule-based Tool for Assisting Colormap Selection. In *Proceedings of IEEE Visualization (Vis)*, pages 118–125, Washington, DC, USA. IEEE Computer Society.
- Berry, L. and Munzner, T. (2004). BinX: Dynamic Exploration of Time Series Datasets Across Aggregation Levels. In *Poster Compendium of IEEE Symposium on Information Visualization (InfoVis)*, pages 5–6, Los Alamitos, CA, USA. IEEE Computer Society.
- Bertin, J. (1981). *Graphics and Graphic Information-Processing*. de Gruyter, Berlin, Germany. translated by William J. Berg and Paul Scott.
- Bertin, J. (1983). *Semiology of Graphics: Diagrams, Networks, Maps*. University of Wisconsin Press, Madison, WI, USA. translated by William J. Berg.
- Bettini, C., Jajodia, S., and Wang, X. S. (2000). *Time Granularities in Databases, Data Mining, and Temporal Reasoning*. Springer, Secaucus, NJ, USA, 1st edition.
- Borland, D. and Taylor, R. (2007). Rainbow Color Map (Still) Considered Harmful. *IEEE Computer Graphics and Applications*, 27(2):14–17.
- Brewer, C. A. (1999). Color Use Guidelines for Data Representation. In *Proceedings of the Section on Statistical Graphics*, pages 55–60, Baltimore, MD, USA. American Statistical Association.
- Brinton, W. C. (1914). *Graphic Methods for Presenting Facts*. The Engineering Magazine Company, New York, NY, USA.
- Brinton, W. C. (1939). *Graphic Presentation*. Brinton Associates, New York, NY, USA.
- Brockwell, P. J. and Davis, R. A. (2009). *Time Series: Theory and Methods*. Springer, New York, USA, 2nd edition.
- Brodbeck, D. and Girardin, L. (2003). Interactive Poster: Trend Analysis in Large Timeseries of High-Throughput Screening Data Using a Distortion-Oriented Lens with Semantic Zooming. In *Poster Compendium of IEEE Symposium on Information Visualization (InfoVis)*, pages 74–75, Los Alamitos, CA, USA. IEEE Computer Society.
- Buono, P., Aris, A., Plaisant, C., Khella, A., and Shneiderman, B. (2005). Interactive Pattern Search in Time Series. In *Proceedings of the Conference on Visualization and Data Analysis (VDA)*, pages 175–186, SPIE.
- Buono, P., Plaisant, C., Simeone, A., Aris, A., Shneiderman, B., Shmueli, G., and Jank, W. (2007). Similarity-Based Forecasting with Simultaneous Previews: A River Plot Interface for Time

- Series Forecasting. In *Proceedings of the International Conference Information Visualisation (IV)*, pages 191–196, Los Alamitos, CA, USA. IEEE Computer Society.
- Burch, M., Beck, F., and Diehl, S. (2008). Timeline Trees: Visualizing Sequences of Transactions in Information Hierarchies. In *Proceedings of the Working Conference on Advanced Visual Interfaces (AVI)*, pages 75–82, New York, NY, USA. ACM Press.
- Byron, L. and Wattenberg, M. (2008). Stacked Graphs – Geometry & Aesthetics. *IEEE Transactions on Visualization and Computer Graphics*, 14(6):1245–1252.
- Card, S., Mackinlay, J., and Shneiderman, B. (1999). *Readings in Information Visualization: Using Vision to Think*. Morgan Kaufmann Publishers, San Francisco, CA, USA.
- Card, S. K., Suh, B., Pendleton, B. A., Heer, J., and Bodnar, J. W. (2006). Time Tree: Exploring Time Changing Hierarchies. In *Proceedings of the IEEE Symposium on Visual Analytics Science and Technology (VAST)*, pages 3–10, Los Alamitos, CA, USA. IEEE Computer Society.
- Carlis, J. V. and Konstan, J. A. (1998). Interactive Visualization of Serial Periodic Data. In *Proceedings of the ACM Symposium on User Interface Software and Technology (UIST)*, pages 29–38, New York, NY, USA. ACM Press.
- Chapple, S. and Garofalo, R. (1977). *Rock 'N' Roll is Here to Pay: The History and Politics of the Music Industry*. Burnham Inc Pub, Chicago, IL, USA.
- Chen, C. (2006). CiteSpace II: Detecting and Visualizing Emerging Trends and Transient Patterns in Scientific Literature. *Journal of the American Society for Information Science and Technology*, 57(3):359–377.
- Chen, H. (2004). Compound Brushing Explained. *Information Visualization*, 3(2):96–108.
- Chi, E. H. (2000). A Taxonomy of Visualization Techniques Using the Data State Reference Model. In *Proceedings of the IEEE Symposium on Information Visualization (InfoVis)*, pages 69–76, Washington, DC, USA. IEEE Computer Society.
- Chittaro, L. and Combi, C. (2003). Visualizing Queries on Databases of Temporal Histories: New Metaphors and their Evaluation. *Data and Knowledge Engineering*, 44(2):239–264.
- Chittaro, L., Combi, C., and Trapasso, G. (2003). Data Mining on Temporal Data: A Visual Approach and its Clinical Application to Hemodialysis. *Journal of Visual Languages and Computing*, 14(6):591–620.
- Chuah, M. C. (1998). Dynamic Aggregation with Circular Visual Designs. In *Proceedings of the IEEE Symposium on Information Visualization (InfoVis)*, pages 35–43, Los Alamitos, CA, USA. IEEE Computer Society.
- Chuah, M. C. and Eick, S. G. (1998). Information Rich Glyphs for Software Management Data. *IEEE Computer Graphics and Applications*, 18(4):24–29.
- Clancey, W. J. (1985). Heuristic Classification. *Artificial Intelligence*, 27(3):289–350.
- Cleveland, W. (1993). *Visualizing Data*. Hobart Press, Summit, NJ, USA.
- Cockburn, A., Karlson, A., and Bederson, B. B. (2009). A Review of Overview+Detail, Zooming, and Focus+Context Interfaces. *ACM Computing Surveys*, 41(1):2:1–2:31.
- Combi, C., Keravnou-Papailiou, E., and Shahar, Y. (2010). *Temporal Information Systems in Medicine*. Springer, Berlin, Germany.
- Combi, C. and Pozzi, G. (2001). HMAP - A Temporal Data Model Managing Intervals with Different Granularities and Indeterminacy from Natural Language Sentences. *The VLDB Journal*, 9(4):294–311.
- Constantine, L. L. (2003). Canonical Abstract Prototypes for Abstract Visual and Interaction Design. In Jorge, J., Nunes, N. J., and e Cunha, J. F., editors, *Interactive Systems: Design, Specification, and Verification*, volume 2844 of *Lecture Notes in Computer Science*. Springer, Berlin, Germany.
- Cooper, A., Reimann, R., and Cronin, D. (2007). *About Face 3: The Essentials of Interaction Design*. Wiley Publishing, Inc., Indianapolis, Indiana, USA.
- Courage, C. and Baxter, K. (2005). *Understanding Your Users*. Morgan Kaufmann, San Francisco, CA, USA.
- Cousins, S. B. and Kahn, M. G. (1991). The Visual Display of Temporal Information. *Artificial Intelligence in Medicine*, 3(6):341–357.

- Crabbe, A. (2003). Different Pictures of Time. URL, <http://davinci.ntu.ac.uk/rws/researchers/design/tonycrabbe/different.htm>. Retrieved Nov. 12, 2003.
- Dachselt, R., Frisch, M., and Weiland, M. (2008). FacetZoom: A Continuous Multi-Scale Widget for Navigating Hierarchical Metadata. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI)*, pages 1353–1356, New York, NY, USA. ACM Press.
- Dachselt, R. and Weiland, M. (2006). TimeZoom: A Flexible Detail and Context Timeline. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI)*, pages 682–687, New York, NY, USA. ACM Press. Extended Abstracts.
- Doleisch, H. and Hauser, H. (2002). Smooth Brushing for Focus+Context Visualization of Simulation Data in 3D. In *Proceedings of the International Conference in Central Europe on Computer Graphics, Visualization and Computer Vision (WSCG)*, pages 147–154, Plzen, Czech Republic. University of West Bohemia.
- dos Santos, S. and Brodlie, K. (2004). Gaining Understanding of Multivariate and Multidimensional Data through Visualization. *Computers & Graphics*, 28:311–325.
- Dragiccevic, P. and Huot, S. (2002). SpiraClock: A Continuous and Non-Intrusive Display for Upcoming Events. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI)*, pages 604–605, New York, NY, USA. ACM Press. Extended Abstracts.
- Dyreson, C. E., Evans, W. S., Lin, H., and Snodgrass, R. T. (2000). Efficiently Supporting Temporal Granularities. *IEEE Transactions on Knowledge and Data Engineering*, 12(4):568–587.
- Eccles, R., Kapler, T., Harper, R., and Wright, W. (2008). Stories in GeoTime. *Information Visualization*, 7(1):3–17.
- Elmqvist, N. and Tsigas, P. (2007). A Taxonomy of 3D Occlusion Management Techniques. In *Proceedings of the IEEE Conference on Virtual Reality (VR)*, pages 51–58, Los Alamitos, CA, USA. IEEE Computer Society.
- Erbacher, R. F., Walker, K. L., and Frincke, D. A. (2002). Intrusion and Misuse Detection in Large-Scale Systems. *IEEE Computer Graphics and Applications*, 22(1):38–48.
- Fails, J., Karlson, A., Shahamat, L., and Shneiderman, B. (2006). A Visual Interface for Multivariate Temporal Data: Finding Patterns of Events across Multiple Histories. In *Proceedings of the IEEE Symposium on Visual Analytics Science and Technology (VAST)*, pages 167–174, Los Alamitos, CA, USA. IEEE Computer Society.
- Fanea, E., Carpendale, M. S. T., and Isenberg, T. (2005). An Interactive 3D Integration of Parallel Coordinates and Star Glyphs. In *Proceedings of the IEEE Symposium on Information Visualization (InfoVis)*, pages 149–156, Los Alamitos, CA, USA. IEEE Computer Society.
- Farquhar, A. B. and Farquhar, H. (1891). *Economic and Industrial Solutions*. G. B. Putnam’s Sons, New York, NY.
- Fayyad, U., Grinstein, G. G., and Wierse, A. (2001). *Information Visualization in Data Mining and Knowledge Discovery*. Morgan Kaufmann, San Francisco, CA, USA.
- Fayyad, U., Piatetsky-Shapiro, G., and Smyth, P. (1996). From Data Mining to Knowledge Discovery in Databases. *AI Magazine*, 17(3):37–54.
- Ferguson, S. (1991). The 1753 Carte chronographique of Jacques Barbeu-Dubourg. *Princeton University Library Chronicle*, 52(2):190–230.
- Forlines, C. and Wittenburg, K. (2010). Wakame: Sense Making of Multi-Dimensional Spatial-Temporal Data. In *Proceedings of the International Conference on Advanced Visual Interfaces (AVI)*, pages 33–40, New York, NY, USA. ACM Press.
- Frank, A. U. (1998). Different Types of “Times” in GIS. In Egenhofer, M. J. and Golledge, R. G., editors, *Spatial and Temporal Reasoning in Geographic Information Systems*, pages 40–62. Oxford University Press, New York, NY, USA.
- Friendly, M. (2008). A Brief History of Data Visualization. In Chen, C.-h., Härdle, W., and Unwin, A., editors, *Handbook of Data Visualization*, pages 15–56. Springer, Berlin, Heidelberg, Germany.
- Fry, B. (2000). Organic Information Design, Master’s thesis, Massachusetts Institute of Technology.

- Fuchs, G. and Schumann, H. (2004a). Intelligent Icon Positioning for Interactive Map-Based Information Systems. In *Proceedings of the International Conference of the Information Resources Management Association (IRMA)*, pages 261–264, Hershey, PA, USA. Idea Group Inc.
- Fuchs, G. and Schumann, H. (2004b). Visualizing Abstract Data on Maps. In *Proceedings of the International Conference Information Visualisation (IV)*, pages 139–144, Los Alamitos, CA, USA. IEEE Computer Society.
- Funkhouser, H. G. (1936). A Note on a Tenth Century Graph. *Osiris*, 1(1):260–262.
- Furia, C. A., Mandrioli, D., Morzenti, A., and Rossi, M. (2010). Modeling Time in Computing: A Taxonomy and a Comparative Survey. *ACM Computing Surveys*, 42:6:1–6:59.
- Gajos, K. Z., Czerwinski, M., Tan, D. S., and Weld, D. S. (2006). Exploring the Design Space for Adaptive Graphical User Interfaces. In *Proceedings of the Working Conference on Advanced Visual Interfaces (AVI)*, pages 201–208, New York, NY, USA. ACM Press.
- Gall, H., Jazayeri, M., and Riva, C. (1999). Visualizing Software Release Histories: The Use of Color and Third Dimension. In *Proceedings of the International Conference on Software Maintenance (ICSM)*, pages 99–108, Los Alamitos, CA, USA. IEEE Computer Society.
- Gan, G., Ma, C., and Wu, J. (2007). *Data Clustering: Theory, Algorithms, and Applications*, ASA-SIAM Series on Statistics and Applied Probability. SIAM, Philadelphia, PA, USA.
- Gantt, H. L. (1913). *Work, Wages, and Profits*. Engineering Magazine Co., New York, NY, USA.
- Gapminder Foundation (2010). Gapminder Trendalyzer. URL, <http://www.gapminder.org/world/>. Retrieved Feb., 2011.
- Gatalaky, P., Andrienko, N., and Andrienko, G. (2004). Interactive Analysis of Event Data Using Space-Time Cube. In *Proceedings of the International Conference Information Visualisation (IV)*, pages 145–152, Los Alamitos, CA, USA. IEEE Computer Society.
- Gershon, N. and Page, W. (2001). What Storytelling Can Do for Information Visualization. *Communications of the ACM*, 44(8):31–37.
- Goralwalla, I. A., Özsü, M. T., and Szafron, D. (1998). An Object-Oriented Framework for Temporal Data Models. In Etzion, O. et al., editors, *Temporal Databases: Research and Practice*, pages 1–35. Springer, Berlin, Germany.
- Gschwandtner, T., Aigner, W., Kaiser, K., Miksch, S., and Seyfang, A. (2011). CareCruiser: Exploring and Visualizing Plans, Events, and Effects Interactively. In *Proceedings of the IEEE Pacific Visualization Symposium (PacificVis 2011)*, pages 43–50, Los Alamitos, CA, USA. IEEE Computer Society.
- Guo, D., Chen, J., MacEachren, A. M., and Liao, K. (2006). A Visualization System for Space-Time and Multivariate Patterns (VIS-STAMP). *IEEE Transactions on Visualization and Computer Graphics*, 12(6):1461–1474.
- Haber, R. B. and McNabb, D. A. (1990). Visualization Idioms: A Conceptual Model for Scientific Visualization Systems. In *Visualization in Scientific Computing*, pages 74–93. IEEE Computer Society, Los Alamitos, CA, USA.
- Hackos, J. T. and Redish, J. C. (1998). *User and Task Analysis for Interface Design*. John Wiley & Sons, Inc., New York, NY, USA.
- Hadlak, S., Tominski, C., and Schumann, H. (2010). Visualization of Attributed Hierarchical Structures in a Spatio-Temporal Context. *International Journal of Geographical Information Science*, 24(10):1497–1513.
- Hajnicz, E. (1996). *Time Structures: Formal Description and Algorithmic Representation*, volume 1047 of *Lecture Notes in Computer Science*. Springer, Berlin.
- Han, J. and Kamber, M. (2005). *Data Mining: Concepts and Techniques*. Morgan Kaufmann, San Francisco, CA, USA.
- Harris, R. L. (1999). *Information Graphics: A Comprehensive Illustrated Reference*. Oxford University Press, New York, NY, USA.
- Harrower, M. A. and Brewer, C. A. (2003). ColorBrewer.org: An Online Tool for Selecting Color Schemes for Maps. *The Cartographic Journal*, 40(1):27–37.
- Hauser, H., Ledermann, F., and Doleisch, H. (2002). Angular Brushing of Extended Parallel Coordinates. In *Proceedings of the IEEE Symposium on Information Visualization (InfoVis)*, pages 127–130, Los Alamitos, CA, USA. IEEE Computer Society.

- Havre, S., Hetzler, E., and Nowell, L. (2000). ThemeRiver: Visualizing Theme Changes Over Time. In *Proceedings of the IEEE Symposium on Information Visualization (InfoVis)*, pages 115–124, Los Alamitos, CA, USA. IEEE Computer Society.
- Havre, S., Hetzler, E., Whitney, P., and Nowell, L. (2002). ThemeRiver: Visualizing Thematic Changes in Large Document Collections. *IEEE Transactions on Visualization and Computer Graphics*, 8(1):9–20.
- Heer, J., Kong, N., and Agrawala, M. (2009). Sizing the Horizon: The Effects of Chart Size and Layering on the Graphical Perception of Time Series Visualizations. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI)*, pages 1303–1312, New York, NY, USA. ACM Press.
- Heer, J. and Robertson, G. (2007). Animated Transitions in Statistical Data Graphics. *IEEE Transactions on Visualization and Computer Graphics*, 13(6):1240–1247.
- Henriksen, K., Sporning, J., and Hornbaek, K. (2004). Virtual Trackballs Revisited. *IEEE Transactions on Visualization and Computer Graphics*, 10(2):206–216.
- Hinun, K., Miksch, S., Aigner, W., Ohmann, S., Popow, C., Pohl, M., and Rester, M. (2005). Gravi++: Interactive Information Visualization to Explore Highly Structured Temporal Data. *Journal of Universal Computer Science*, 11(11):1792–1805.
- Hochheiser, H. and Shneiderman, B. (2004). Dynamic Query Tools for Time Series Data Sets: Timebox Widgets for Interactive Exploration. *Information Visualization*, 3(1):1–18.
- Holz, C. and Feiner, S. (2009). Relaxed Selection Techniques for Querying Time-Series Graphs. In *Proceedings of the ACM Symposium on User Interface Software and Technology (UIST)*, pages 213–222, New York, NY, USA. ACM Press.
- Horn, W., Popow, C., and Unterasinger, L. (2001). Support for Fast Comprehension of ICU Data: Visualization using Metaphor Graphics. *Methods of Information in Medicine*, 40(5):421–424.
- Hsu, W., Lee, M. L., and Wang, J. (2008). *Temporal and Spatio-Temporal Data Mining*. IGI Global, Hershey, PA, USA.
- Huang, G., Govoni, S., Choi, J., Hartley, D. M., and Wilson, J. M. (2008). Geovisualizing Data With Ring Maps. *ArcUser*, Winter 2008.
- Hägerstrand, T. (1970). What About People in Regional Science? *Papers of the Regional Science Association*, 24:7–21.
- Imrich, P., Mueller, K., Imre, D., Zelenyuk, D., and Zhu, W. (2003). Interactive Poster: 3D ThemeRiver. In *Poster Compendium of IEEE Symposium on Information Visualization (InfoVis)*, Los Alamitos, CA, USA. IEEE Computer Society.
- Inselberg, A. and Dimsdale, B. (1990). Parallel Coordinates: A Tool for Visualizing Multi-Dimensional Geometry. In *Proceedings of IEEE Visualization (Vis)*, pages 361–378, Los Alamitos, CA, USA. IEEE Computer Society.
- Jackson, J. E. (2003). *A User's Guide to Principal Components*, Wiley Series in Probability and Statistics. John Wiley & Sons, Inc., New York, NY, USA.
- Jain, A. K., Murty, M. N., and Flynn, P. J. (1999). Data Clustering: A Review. *ACM Computing Surveys*, 31:264–323.
- Jankun-Kelly, T., Ma, K.-L., and Gertz, M. (2007). A Model and Framework for Visualization Exploration. *IEEE Transactions on Visualization and Computer Graphics*, 13(2):357–369.
- Javed, W., McDonnell, B., and Elmqvist, N. (2010). Graphical Perception of Multiple Time Series. *IEEE Transactions on Visualization and Computer Graphics*, 16(6):927–34.
- Jensen, C. S., Dyreson, C. E., Böhlen, M. H., Clifford, J., Elmasri, R., Gadia, S. K., Grandi, F., Hayes, P. J., Jajodia, S., Käfer, W., Kline, N., Lorentzos, N. A., Mitsopoulos, Y. G., Montanari, A., Nonen, D. A., Peressi, E., Pernici, B., Roddick, J. F., Sarda, N. L., Scalas, M. R., Segev, A., Snodgrass, R. T., Soo, M. D., Tansel, A. U., Tiberio, P., and Wiederhold, G. (1998). The Consensus Glossary of Temporal Database Concepts – February 1998 Version. In Etzion, O., Jajodia, S., and Sripada, S., editors, *Temporal Databases: Research and Practice*, volume 1399 of *Lecture Notes in Computer Science*, pages 367–405. Springer, Berlin, Germany.
- Jeong, D. H., Ziemkiewicz, C., Fisher, B., Ribarsky, W., and Chang, R. (2009). iPCA: An Interactive System for PCA-based Visual Analytics. *Computer Graphics Forum*, 28(3):767–774.

- Jolliffe, I. T. (2002). *Principal Component Analysis*, Springer Series in Statistics. Springer, New York, NY, USA, 2nd edition.
- Kapler, T., Eccles, R., Harper, R., and Wright, W. (2008). Configurable Spaces: Temporal Analysis in Diagrammatic Contexts. In *Proceedings of the IEEE Symposium on Visual Analytics Science and Technology (VAST)*, pages 43–50, Los Alamitos, CA, USA. IEEE Computer Society.
- Kapler, T. and Wright, W. (2005). GeoTime Information Visualization. *Information Visualization*, 4(2):136–146.
- Keim, D., Kohlhammer, J., Ellis, G., and Mansmann, F., editors (2010). *Mastering the Information Age – Solving Problems with Visual Analytics*. Eurographics Association, Geneva, Switzerland.
- Keim, D., Kriegel, H.-P., and Ankerst, M. (1995). Recursive Pattern: A Technique for Visualizing Very Large Amounts of Data. In *Proceedings of IEEE Visualization (Vis)*, pages 279–286, Los Alamitos, CA, USA. IEEE Computer Society.
- Keim, D. A., Mansmann, F., Schneidewind, J., and Ziegler, H. (2006). Challenges in Visual Data Analysis. In *Proceedings of the International Conference Information Visualisation (IV)*, pages 9–16, Los Alamitos, CA, USA. IEEE Computer Society.
- Keim, D. A. and Schneidewind, J. (2005). Scalable Visual Data Exploration of Large Data Sets via MultiResolution. *Journal of Universal Computer Science*, 11(11):1766–1779.
- Keim, D. A., Schneidewind, J., and Sips, M. (2004). CircleView: A New Approach for Visualizing Time-Related Multidimensional Data Sets. In *Proceedings of the Working Conference on Advanced Visual Interfaces (AVI)*, pages 179–182, New York, NY, USA. ACM Press.
- Kerren, A., Ebert, A., and Meyer, J., editors (2007). *Human-Centered Visualization Environments*, volume 4417 of *Lecture Notes in Computer Science*. Springer, Berlin, Germany.
- Kim, N. W., Card, S. K., and Heer, J. (2010). Tracing Genealogical Data with TimeNets. In *Proceedings of the International Conference on Advanced Visual Interfaces (AVI)*, pages 241–248, New York, NY, USA. ACM Press.
- Kolence, K. W. and Kiviat, P. J. (1973). Software Unit Profiles & Kiviat Figures. *SIGMETRICS Performance Evaluation Review*, 2:2–12.
- Kolojejchick, J., Roth, S. F., and Lucas, P. (1997). Information Appliances and Tools in Visage. *IEEE Computer Graphics and Applications*, 17(4):32–41.
- Kosara, R., Bendix, F., and Hauser, H. (2004). TimeHistograms for Large, Time-Dependent Data. In *Proceedings of the Joint Eurographics - IEEE TCVG Symposium on Visualization (VisSym)*, pages 45–54, Los Alamitos, CA, USA. IEEE Computer Society.
- Kosara, R. and Miksch, S. (2001). Metaphors of Movement - A Visualization and User Interface for Time-Oriented, Skeletal Plans. *Artificial Intelligence in Medicine, Special Issue: Information Visualization in Medicine*, 22(2):111–131.
- Kosara, R. and Miksch, S. (2002). Visualization Methods for Data Analysis and Planning. *International Journal of Medical Informatics*, 68(1–3):141–153.
- Kraak, M.-J. (2003). The Space-Time Cube Revisited from a Geovisualization Perspective. In *Proceedings of the 21st International Cartographic Conference (ICC)*, pages 1988–1995, Newcastle, UK. The International Cartographic Association (ICA).
- Kraak, M.-J. and Ormeling, F. (2003). *Cartography: Visualization of Geospatial Data*. Pearson Education, Harlow, England, 2nd edition.
- Krasner, G. E. and Pope, S. T. (1988). A Cookbook for Using the Model-View-Controller User Interface Paradigm in Smalltalk-80. *Journal of Object-Oriented Programming*, 1(3):26–49.
- Kristensson, P., Dahlback, N., Anundi, D., Bjornstad, M., Gillberg, H., Haraldsson, J., Martensson, I., Nordvall, M., and Stahl, J. (2009). An Evaluation of Space Time Cube Representation of Spatiotemporal Patterns. *IEEE Transactions on Visualization and Computer Graphics*, 15(4):696–702.
- Krzywinski, M., Schein, J., Birol, I., Connors, J., Gascoyne, R., Horsman, D., Jones, S. J., and Marra, M. A. (2009). Circos: An Information Aesthetic for Comparative Genomics. *Genome Research*, 19(9):1639–1645.
- Kwan, M.-P. (2009). Space-Time Paths. In Madden, M., editor, *Manual of Geographic Information Systems*, chapter 25, pages 427–442. American Society for Photogrammetry and Remote Sensing, Bethesda, MD, USA.

- La maison du cinema and Cinematheque Francaise (2000). Étienne-Jules Marey: Movement in Light. URL, <http://www.expo-marey.com/ANGLAIS/home.html>. Retrieved Nov. 18, 2004.
- Lammarsch, T., Aigier, W., Bertone, A., Gärtner, J., Mayr, E., Miksch, S., and Smuc, M. (2009). Hierarchical Temporal Patterns and Interactive Aggregated Views for Pixel-based Visualizations. In *Proceedings of the International Conference Information Visualisation (IV)*, pages 44–49, Los Alamitos, CA, USA. IEEE Computer Society.
- Laxman, S. and Sastry, P. (2006). A Survey of Temporal Data Mining. *Sādhanā*, 31:173–198.
- Lazar, J., Feng, J. H., and Hochheiser, H. (2010). *Research Methods in Human-Computer Interaction*. John Wiley & Sons, Ltd., London, UK.
- Lee, B., Riche, N., Karlson, A., and Carpendale, S. (2010). SparkClouds: Visualizing Trends in Tag Clouds. *IEEE Transactions on Visualization and Computer Graphics*, 16(6):1182–1189.
- Lee, J. Y., Elmasri, R., and Won, J. (1998). An Integrated Temporal Data Model Incorporating Time Series Concept. *Data and Knowledge Engineering*, 24(3):257–276.
- Lenntorp, B. (1976). Paths in Space-Time Environments: A Time Geographic Study of Movement Possibilities of Individuals. In *Lund Studies in Geography*, number 44 in *Series B: Human Geography*. Royal University of Lund, Lund, Sweden.
- Lenz, H. (2005). *Universalgeschichte der Zeit*. Marixverlag, Wiesbaden, Germany.
- Lin, J., Keogh, E. J., and Lonardi, S. (2005). Visualizing and Discovering Non-Trivial Patterns in Large Time Series Databases. *Information Visualization*, 4(2):61–82.
- Lin, J., Keogh, E. J., Wei, L., and Lonardi, S. (2007). Experiencing SAX: A Novel Symbolic Representation of Time Series. *Data Mining and Knowledge Discovery*, 15(2):107–144.
- Liu, L. and Özsu, M. (2009). *Encyclopedia of Database Systems*. Springer, Berlin, Heidelberg, Germany.
- Luboschik, M., Schumann, H., and Cords, H. (2008). Particle-Based Labeling: Fast Point-feature Labeling Without Obscuring Other Visual Features. *IEEE Transactions on Visualization and Computer Graphics*, 14(6):1237–1244.
- Luo, D., Yang, J., Krstajic, M., Ribarsky, W., and Keim, D. (2011). EventRiver: Visually Exploring Text Collections With Temporal References. *IEEE Transactions on Visualization and Computer Graphics*. To appear.
- Mackay, W. E., Van Kleek, M. G., and Tabard, A. (2009). Interacting with Temporal Data. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI)*, pages 4783–4786, New York, NY, USA. ACM Press. Extended Abstracts.
- Mackinlay, J. (1986). Automating the Design of Graphical Presentations of Relational Information. *ACM Transactions on Graphics*, 5(2):110–141.
- Mackinlay, J. D., Robertson, G. G., and Card, S. K. (1991). The Perspective Wall: Detail and Context Smoothly Integrated. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI)*, pages 173–179, New York, NY, USA. ACM Press.
- Marey, E.-J. (1875). *La Méthode Graphique dans les Sciences Expérimentales (Suite)*, volume 1, pages 255–278. Masson, G., Paris, France.
- Marey, E.-J. (1894). *Le mouvement*. Masson, G., Paris, France.
- Markovic, D. and Gelautz, M. (2006). Comics-Like Motion Depiction from Stereo. In *Proceedings of the International Conference in Central Europe on Computer Graphics, Visualization and Computer Vision (WSCG)*, pages 155–160, Plzen, Czech Republic. University of West Bohemia.
- Matković, K., Hauser, H., Sainitzer, R., and Gröller, E. (2002). Process Visualization with Levels of Detail. In *Proceedings of the IEEE Symposium on Information Visualization (InfoVis)*, pages 67–70, Los Alamitos, CA, USA. IEEE Computer Society.
- Matthews, G. and Roze, M. (1997). Worm Plots. *IEEE Computer Graphics and Applications*, 17(6):17–20.
- McCloud, S. (1994). *Understanding Comics*. HarperPerennial, New York, NY, USA.
- McCormick, B. H., DeFanti, T. A., and Brown, M. D. (1987). Visualization in Scientific Computing. *Computer Graphics*, 21(6).
- McEachren, A. M. (1995). *How Maps Work: Representation, Visualization, and Design*. Guilford Press, New York, NY, USA.

- McLachlan, P., Munzner, T., Koutsofios, E., and North, S. (2008). LiveRAC: Interactive Visual Exploration of System Management Time-Series Data. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI)*, CHI '08, pages 1483–1492, New York, NY, USA. ACM Press.
- Mennis, J. L., Peuquet, D., and Qian, L. (2000). A Conceptual Framework for Incorporating Cognitive Principles into Geographical Database Representation. *International Journal of Geographical Information Science*, 14(6):501–520.
- Miksch, S., Horn, W., Popow, C., and Paky, F. (1996). Utilizing Temporal Data Abstraction for Data Validation and Therapy Planning for Artificially Ventilated Newborn Infants. *Artificial Intelligence in Medicine*, 8(6):543–576.
- Miksch, S., Seyfang, A., Horn, W., and Popow, C. (1999). Abstracting Steady Qualitative Descriptions over Time from Noisy, High-Frequency Data. In *Proceedings of the Joint European Conference on Artificial Intelligence in Medicine and Medical Decision Making (AIMDM)*, pages 281–290, Berlin, Germany. Springer.
- Mintz, D., Fitz-Simons, T., and Wayland, M. (1997). Tracking Air Quality Trends with SAS/GRAPH. In *Proceedings of the 22nd Annual SAS User Group International Conference (SUGI97)*, pages 807–812, Cary, NC, USA. SAS.
- Mitsa, T. (2010). *Temporal Data Mining*. Chapman & Hall/CRC Data Mining and Knowledge Discovery Series, Boca Raton, FL, USA.
- Muniandy, K. (2001). Visualizing Time-Related Events for Intrusion Detection. In *Proceedings of the IEEE Symposium on Information Visualization (InfoVis)*, Los Alamitos, CA, USA. IEEE Computer Society. Late Breaking Hot Topics.
- Munzner, T. (2009). A Nested Process Model for Visualization Design and Validation. *IEEE Transactions on Visualization and Computer Graphics*, 15(6):921–928.
- Müller, W. and Schumann, H. (2003). Visualization Methods for Time-Dependent Data - An Overview. In *Proceedings of Winter Simulation Conference (WSC)*, pages 737–745, Los Alamitos, CA, USA. IEEE Computer Society.
- Nelson, A. (2008). Travel Time to Major Cities: A Global Map of Accessibility. Office for Official Publications of the European Communities, Luxembourg.
- Newman, L. H. (1965). *Man and Insects*. Aldus Books, London, UK.
- Nocke, T., Schumann, H., and Böhm, U. (2004). Methods for the Visualization of Clustered Climate Data. *Computational Statistics*, 19(1):75–94.
- Noirhomme-Fraiture, M. (2002). Visualization of Large Data Sets: The Zoom Star Solution. *Journal of Symbolic Data Analysis*, 0(0).
- Norman, D. A. (1993). *Things That Make Us Smart: Defending Human Attributes in the Age of the Machine*. Addison-Wesley Longman Publishing Co., Inc., Boston, MA, USA.
- Norman, D. A. (2002). *The Design of Everyday Things*. Basic Books (Perseus), New York, NY, USA.
- Paternò, F., Mancini, C., and Meniconi, S. (1997). ConcurTaskTrees: A Diagrammatic Notation for Specifying Task Models. In *Proceedings of IFIP TC13 International Conference on Human-Computer Interaction (INTERACT)*, pages 362–369, Boston, MA, USA. Kluwer Academic Publishers.
- Paternò, F. and Santoro, C. (2002). One Model, Many Interfaces. In *Proceedings of the Fourth International Conference on Computer-Aided Design of User Interfaces (CADUI)*, pages 143–154, Boston, MA, USA. Kluwer Academic Publishers.
- Petzold, I. (2003). *Beschriftung von Bildschirmkarten in Echtzeit*, PhD thesis, Rheinische Friedrich-Wilhelms-Universität Bonn.
- Peuquet, D. J. (1994). It's about Time: A Conceptual Framework for the Representation of Temporal Dynamics in Geographic Information Systems. *Annals of the Association of American Geographers*, 84(3):441–461.
- Peuquet, D. J. (2002). *Representations of Space and Time*. The Guilford Press, New York, NY, USA.

- Piringer, H., Tominski, C., Muigg, P., and Berger, W. (2009). A Multi-Threading Architecture to Support Interactive Visual Exploration. *IEEE Transactions on Visualization and Computer Graphics*, 15(6):1113–1120.
- Plaisant, C. (2004). The Challenge of Information Visualization Evaluation. In *Proceedings of the Working Conference on Advanced Visual Interfaces (AVI)*, pages 106–119, New York, NY, USA. ACM Press.
- Plaisant, C., Mushlin, R., Snyder, A., Li, J., Heller, D., and Shneiderman, B. (1998). LifeLines: Using Visualization to Enhance Navigation and Analysis of Patient Records. In *Proceedings of the American Medical Informatics Association Annual Fall Symposium*, pages 76–80, Bethesda, MD, USA. American Medical Informatic Association (AMIA).
- Playfair, W. (1805). *An Inquiry into the Permanent Causes of the Decline and Fall of Powerful and Wealthy Nations*. Greenland and Norris, London, UK.
- Playfair, W. (1821). *A Letter on our Agricultural Distresses, their Causes and Remedies*. William Sams, London, UK.
- Playfair, W. and Corry, J. (1786). *The Commercial and Political Atlas: Representing, by Means of Stained Copper-Plate Charts, the Progress of the Commerce, Revenues, Expenditure and Debts of England during the Whole of the Eighteenth Century*. printed for J. Debrett; G. G. and J. Robinson; J. Sewell; the engraver, S. J. Neele; W. Creech and C. Elliot, Edinburgh; and L. White, London, UK.
- Powsner, S. M. and Tufté, E. R. (1994). Graphical Summary of Patient Status. *The Lancet*, 344(8919):386–389.
- Priestley, J. (1765). *A Chart of Biography*. Johnson, J., London, UK.
- Pulo, K. (2007). Navani: Navigating Large-Scale Visualisations with Animated Transitions. In *Proceedings of the International Conference Information Visualisation (IV)*, Los Alamitos, CA, USA. IEEE Computer Society.
- Reijner, H. (2008). The Development of the Horizon Graph. In *Electronic Proceedings of the VisWeek Workshop From Theory to Practice: Design, Vision and Visualization*.
- Reinders, F., Post, F. H., and Spoelder, H. J. (2001). Visualization of Time-Dependent Data with Feature Tracking and Event Detection. *The Visual Computer*, 17(1):55–71.
- Rind, A., Aigner, W., Miksch, S., Wiltner, S., Pohl, M., Drexler, F., Neubauer, B., and Suchy, N. (2011). Visually Exploring Multivariate Trends in Patient Cohorts using Animated Scatter Plots. In *Proceedings of the International Conference on Human-Computer Interaction (HCI-I)*, Berlin, Germany. Springer. To appear.
- Rind, A., Miksch, S., Aigner, W., Turic, T., and Pohl, M. (2010). VisuExplore: Gaining New Medical Insights from Visual Exploration. In Hayes, G. R. and Tan, D. S., editors, *Proceedings of the 1st International Workshop on Interactive Systems in Healthcare (WISH@CHI2010)*, pages 149–152, New York, NY, USA. ACM Press.
- Rit, J.-F. (1986). Propagating Temporal Constraints for Scheduling. In *Proceedings of the National Conference on Artificial Intelligence (AAAI)*, pages 383–388, Los Altos, CA, USA. Morgan Kaufmann.
- Robertson, G., Fernandez, R., Fisher, D., Lee, B., and Stasko, J. (2008). Effectiveness of Animation in Trend Visualization. *IEEE Transactions on Visualization and Computer Graphics*, 14:1325–1332.
- Robertson, P. K. (1991). A Methodology for Choosing Data Representations. *IEEE Computer Graphics and Applications*, 11(3):56–67.
- Rosenberg, D. and Grafton, A. (2010). *Cartographies of Time: A History of the Timeline*. Princeton Architectural Press, New York, NY, USA.
- Sadri, R., Zaniolo, C., Zarkesh, A., and Adibi, J. (2004). Expressing and Optimizing Sequence Queries in Database Systems. *ACM Transactions on Database Systems*, 29(2):282–318.
- Saito, T., Miyamura, H., Yamamoto, M., Saito, H., Hoshiya, Y., and Kaseda, T. (2005). Two-Tone Pseudo Coloring: Compact Visualization for One-Dimensional Data. In *Proceedings of the IEEE Symposium on Information Visualization (InfoVis)*, pages 173–180, Los Alamitos, CA, USA. IEEE Computer Society.

- Schulze-Wollgast, P., Tominski, C., and Schumann, H. (2005). Enhancing Visual Exploration by Appropriate Color Coding. In *Proceedings of the International Conference in Central Europe on Computer Graphics, Visualization and Computer Vision (WSCG)*, pages 203–210, Plzen, Czech Republic. University of West Bohemia.
- Schumann, H. and Müller, W. (2000). *Visualisierung – Grundlagen und allgemeine Methoden*. Springer, Berlin, Germany.
- Senay, H. and Ignatius, E. (1994). A Knowledge-Based System for Visualization Design. *Computer Graphics and Applications*, 14(6):36–47.
- Shahar, Y., Goren-Bar, D., Boaz, D., and Tahan, G. (2006). Distributed, Intelligent, Interactive Visualization and Exploration of Time-Oriented Clinical Data and their Abstractions. *Artificial Intelligence in Medicine*, 38(2):115–135.
- Shahar, Y., Miksch, S., and Johnson, P. (1998). The Asgaard Project: A Task-Specific Framework for the Application and Critiquing of Time-Oriented Clinical Guidelines. *Artificial Intelligence in Medicine*, 14(1-2):29–51.
- Shanbhag, P., Rheingans, P., and desJardins, M. (2005). Temporal Visualization of Planning Polygons for Efficient Partitioning of Geo-Spatial Data. In *Proceedings of the IEEE Symposium on Information Visualization (InfoVis)*, pages 211–218, Los Alamitos, CA, USA. IEEE Computer Society.
- Shimabukuro, M., Flores, E., de Oliveira, M., and Levkowitz, H. (2004). Coordinated Views to Assist Exploration of Spatio-Temporal Data: A Case Study. In *Proceedings of the International Conference on Coordinated and Multiple Views in Exploratory Visualization (CMV)*, pages 107–117, Los Alamitos, CA, USA. IEEE Computer Society.
- Shneiderman, B. (1983). Direct Manipulation: A Step Beyond Programming Languages. *IEEE Computer*, 16(8):57–69.
- Shneiderman, B. (1994). Dynamic Queries for Visual Information Seeking. *IEEE Software*, 11(6):70–77.
- Shneiderman, B. (1996). The Eyes Have It: A Task by Data Type Taxonomy for Information Visualizations. In *Proceedings of the IEEE Symposium on Visual Languages*, pages 336–343, Los Alamitos, CA, USA. IEEE Computer Society.
- Silva, S., Madeira, J., and Santos, B. S. (2007). There is More to Color Scales than Meets the Eye: A Review on the Use of Color in Visualization. In *Proceedings of the International Conference Information Visualisation (IV)*, pages 943–950, Los Alamitos, CA, USA. IEEE Computer Society.
- Silva, S. F. and Catarci, T. (2000). Visualization of Linear Time-Oriented Data: A Survey. In *Proceedings of the International Conference on Web Information Systems Engineering (WISE)*, pages 310–319, Los Alamitos, CA, USA. IEEE Computer Society.
- Simons, D. J. and Rensink, R. A. (2005). Change Blindness: Past, Present, and Future. *Trends in Cognitive Sciences*, 9(1):16–20.
- Speeth, S. D. (1961). Seismometer Sounds. *The Journal of the Acoustical Society of America*, 33(7):909–916.
- Spence, R. (2007). *Information Visualization: Design for Interaction*. Prentice-Hall, Inc., Upper Saddle River, NJ, USA, 2nd edition.
- Stacey, M. and McGregor, C. (2007). Temporal Abstraction in Intelligent Clinical Data Analysis: A Survey. *Artificial Intelligence in Medicine*, 39(1):1–24.
- Stein, K., Wegener, R., and Schlieder, C. (2010). Pixel-Oriented Visualization of Change in Social Networks. In *Proceedings of the International Conference on Advances in Social Networks Analysis and Mining (ASONAM)*, pages 233–240, Los Alamitos, CA, USA. IEEE Computer Society.
- Steiner, A. (1998). *A Generalisation Approach to Temporal Data Models and their Implementations*, PhD thesis, Swiss Federal Institute of Technology.
- Stolte, C., Tang, D., and Hanrahan, P. (2002). Polaris: A System for Query, Analysis, and Visualization of Multidimensional Relational Databases. *IEEE Transactions on Visualization and Computer Graphics*, 8(1):52–65.

- Telea, A. C. (2007). *Data Visualization: Principles and Practice*. A K Peters, Ltd., Natick, MA, USA.
- Thakur, S. and Hanson, A. J. (2010). A 3D Visualization of Multiple Time Series on Maps. In *Proceedings of the International Conference Information Visualisation (IV)*, pages 336–343, Los Alamitos, CA, USA. IEEE Computer Society.
- Thakur, S. and Rhyne, T.-M. (2009). Data Vases: 2D and 3D Plots for Visualizing Multiple Time Series. In *Proceedings of the International Symposium on Visual Computing (ISVC)*, pages 929–938, Berlin, Germany. Springer.
- Third Millennium Press (2001). *Zeittafel der Weltgeschichte. Den letzten 6000 Jahren auf der Spur*. Könnemann Verlagsgesellschaft mbH, Cologne, Germany.
- Thomas, J. J. and Cook, K. A. (2005). *Illuminating the Path: The Research and Development Agenda for Visual Analytics*. IEEE Computer Society, Los Alamitos, CA, USA.
- Tominski, C. (2011). Event-Based Concepts for User-Driven Visualization. *Information Visualization*, 10(1):65–81.
- Tominski, C., Abello, J., and Schumann, H. (2004). Axes-Based Visualizations with Radial Layouts. In *Proceedings of the ACM Symposium on Applied Computing (SAC)*, pages 1242–1247, New York, NY, USA. ACM Press.
- Tominski, C., Abello, J., and Schumann, H. (2005a). Interactive Poster: 3D Axes-Based Visualizations for Time Series Data. In *Poster Compendium of IEEE Symposium on Information Visualization (InfoVis)*, pages 49–50, Los Alamitos, CA, USA. IEEE Computer Society.
- Tominski, C., Fuchs, G., and Schumann, H. (2008). Task-Driven Color Coding. In *Proceedings of the International Conference Information Visualisation (IV)*, pages 373–380, Los Alamitos, CA, USA. IEEE Computer Society.
- Tominski, C., Schulze-Wollgast, P., and Schumann, H. (2003). Visualisierung zeitlicher Verläufe auf geografischen Karten. In *Kartographische Schriften, Band 7: Visualisierung und Erschließung von Geodaten*, pages 47–57. Kirschbaum Verlag, Bonn, Germany.
- Tominski, C., Schulze-Wollgast, P., and Schumann, H. (2005b). 3D Information Visualization for Time Dependent Data on Maps. In *Proceedings of the International Conference Information Visualisation (IV)*, pages 175–181, Los Alamitos, CA, USA. IEEE Computer Society.
- Tominski, C. and Schumann, H. (2008). Enhanced Interactive Spiral Display. In *Proceedings of the Annual SIGRAD Conference, Special Theme: Interactivity*, pages 53–56, Linköping, Sweden. Linköping University Electronic Press.
- Tomitsch, M., Aigner, W., and Grechenig, T. (2007). A Concept to Support Seamless Spectator Participation in Sports Events Based on Wearable Motion Sensors. In *Proceedings of the 2nd International Conference on Pervasive Computing and Applications (ICPCA07)*, pages 209–214, Los Alamitos, CA, USA. IEEE Computer Society.
- Tory, M. and Möller, T. (2004). Rethinking Visualization: A High-Level Taxonomy. In *Proceedings of the IEEE Symposium on Information Visualization (InfoVis)*, pages 151–158, Los Alamitos, CA, USA. IEEE Computer Society.
- Tufte, E. R. (1983). *The Visual Display of Quantitative Information*. Graphics Press, Cheshire, CT.
- Tufte, E. R. (1990). *Envisioning Information*. Graphics Press, Cheshire, CT.
- Tufte, E. R. (1997). *Visual Explanations*. Graphics Press, Cheshire, CT.
- Tufte, E. R. (2006). *Beautiful Evidence*. Graphics Press, Cheshire, CT.
- Turdukulov, U. D., Kraak, M.-J., and Blok, C. A. (2007). Designing a Visual Environment for Exploration of Time Series of Remote Sensing Data: In Search for Convective Clouds. *Computers & Graphics*, 31(3):370–379.
- Tversky, B., Morrison, J. B., and Betrancourt, M. (2002). Animation: Can It Facilitate? *International Journal of Human-Computer Studies*, 57(4):247–262.
- Udell, J. (2004). Space, Time, and Data. *InfoWorld*, 26(26):32.
- Unger, A. and Schumann, H. (2009). Visual Support for the Understanding of Simulation Processes. In *Proceedings of the IEEE Pacific Visualization Symposium (PacificVis)*, pages 57–64, Los Alamitos, CA, USA. IEEE Computer Society.
- Van Wijk, J. J. (2006). Views on Visualization. *IEEE Transactions on Visualization and Computer Graphics*, 12(4):421–433.

- Van Wijk, J. J. and Van Selow, E. R. (1999). Cluster and Calendar Based Visualization of Time Series Data. In *Proceedings of the IEEE Symposium on Information Visualization (InfoVis)*, pages 4–9, Los Alamitos, CA, USA. IEEE Computer Society.
- Vande Moere, A. (2004). Time-Varying Data Visualization Using Information Flocking Boids. In *Proceedings of the IEEE Symposium on Information Visualization (InfoVis)*, pages 97–104, Los Alamitos, CA, USA. IEEE Computer Society.
- Viégas, F., Boyd, D., Nguyen, D., Potter, J., and Donath, J. (2004a). Digital Artifacts for Remembering and Storytelling: PostHistory and Social Network Fragments. In *Proceedings of the Annual Hawaii International Conference on System Sciences (HICSS)*, pages 109–118, Los Alamitos, CA, USA. IEEE Computer Society.
- Viégas, F. B., Wattenberg, M., and Dave, K. (2004b). Studying Cooperation and Conflict between Authors with history flow Visualizations. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI)*, pages 575–582, New York, NY, USA. ACM Press.
- Volaric, A. (2003). Four-Dimensional Art. URL, <http://www.mathsci.appstate.edu/~sjg/class/3510/final/geoartws.pdf>. Retrieved Feb., 2011.
- Wainer, H. (1997). *Visual Revelations: Graphical Tales of Fate and Deception from Napoleon Bonaparte to Ross Perot*. Copernicus, New York, NY, USA.
- Wainer, H. (2005). *Graphic Discovery: A Trout in the Milk and Other Visual Adventures*. Princeton University Press, Princeton, NJ, USA.
- Wang, T. D., Plaisant, C., Shneiderman, B., Spring, N., Roseman, D., Marchand, G., Mukherjee, V., and Smith, M. (2009). Temporal Summaries: Supporting Temporal Categorical Searching, Aggregation and Comparison. *IEEE Transactions on Visualization and Computer Graphics*, 15:1049–1056.
- Ward, M., Grinstein, G., and Keim, D. (2010). *Interactive Data Visualization: Foundations, Techniques, and Applications*. A K Peters Ltd, Natick, MA, USA.
- Ward, M. O. (1994). XmdvTool: Integrating Multiple Methods for Visualizing Multivariate Data. In *Proceedings of IEEE Visualization (Vis)*, pages 326–333, Los Alamitos, CA, USA. IEEE Computer Society.
- Ware, C. (2008). *Visual Thinking for Design*. Morgan Kaufmann, Burlington, MA, USA.
- Wattenberg, M. (2002). Arc Diagrams: Visualizing Structure in Strings. In *Proceedings of the IEEE Symposium on Information Visualization (InfoVis)*, pages 110–116, Los Alamitos, CA, USA. IEEE Computer Society.
- Weber, M., Alexa, M., and Müller, W. (2001). Visualizing Time-Series on Spirals. In *Proceedings of the IEEE Symposium on Information Visualization (InfoVis)*, pages 7–14, Los Alamitos, CA, USA. IEEE Computer Society.
- Wegner, P. (1997). Why Interaction Is More Powerful Than Algorithms. *Communications of the ACM*, 40(5):80–91.
- Wehrend, S. and Lewis, C. (1990). A Problem-Oriented Classification of Visualization Techniques. In *Proceedings of IEEE Visualization (Vis)*, pages 139–143, Los Alamitos, CA, USA. IEEE Computer Society.
- Whitrow, G. J., Fraser, J. T., and Soulsby, M. P. (2003). *What is Time?: The Classic Account of the Nature of Time*. Oxford University Press, New York, NY, USA.
- Wills, G. and Wilkinson, L. (2010). AutoVis: Automatic Visualization. *Information Visualization*, 9(1):47–69.
- Winckler, M. A., Palanque, P., and Freitas, C. M. D. S. (2004). Tasks and Scenario-Based Evaluation of Information Visualization Techniques. In *Proceedings of the Annual Conference on Task Models and Diagrams (TAMODIA)*, pages 165–172, New York, NY, USA. ACM Press.
- Wolter, M., Assenmacher, I., Hentschel, B., Schirski, M., and Kuhlen, T. (2009). A Time Model for Time-Varying Visualization. *Computer Graphics Forum*, 28(6):1561–1571.
- Wong, P. C. and Bergeron, R. (1997). 30 Years of Multidimensional Multivariate Visualization. In Nielson, G. M., Hagen, H., and Müller, H., editors, *Scientific Visualization*, pages 40–62. IEEE Computer Society, Los Alamitos, CA, USA.
- Wongsuphasawat, K. and Shneiderman, B. (2009). Finding Comparable Temporal Categorical Records: A Similarity Measure with an Interactive Visualization. In *Proceedings of the IEEE*

- Symposium on Visual Analytics Science and Technology (VAST)*, pages 27–34, Los Alamitos, CA, USA. IEEE Computer Society.
- Wright, H. (2007). *Introduction to Scientific Visualization*. Springer, Berlin, Germany.
- Wunderlich, C. A. (1870). *Das Verhalten der Eigenwärme in Krankheiten*. Otto Wigand, Leipzig, Germany, 2nd edition.
- Xiong, R. and Donath, J. (1999). PeopleGarden: Creating Data Portraits for Users. In *Proceedings of the ACM Symposium on User Interface Software and Technology (UIST)*, pages 37–44, New York, NY, USA. ACM Press.
- Xu, R. and Wunsch II, D. C. (2009). *Clustering*. John Wiley & Sons, Inc., Hoboken, NJ, USA.
- Yang, J., Wang, W., and Yu, P. S. (2000). Mining Asynchronous Periodic Patterns in Time Series Data. In *Proceedings of the ACM SIGKDD International Conference on Knowledge Discovery and Data Mining (KDD)*, pages 275–279, New York, NY, USA. ACM Press.
- Yi, J. S., Kang, Y., Stasko, J., and Jacko, J. (2007). Toward a Deeper Understanding of the Role of Interaction in Information Visualization. *IEEE Transactions on Visualization and Computer Graphics*, 13(6):1224–1231.
- Zhao, H., Plaisant, C., Shneiderman, B., and Lazar, J. (2008a). Data Sonification for Users with Visual Impairment: A Case Study with Georeferenced Data. *ACM Transactions on Computer-Human Interaction*, 15(1):4:1–4:28.
- Zhao, J., Forer, P., and Harvey, A. S. (2008b). Activities, Ringmaps and Geovisualization of Large Human Movement Fields. *Information Visualization*, 7(3):198–209.
- Zhu, Y. (2007). Measuring Effective Data Visualization. In *Proceedings of the International Symposium on Visual Computing (ISVC)*, pages 652–661, Berlin, Germany. Springer.

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