
Contents

Preface	viii	3.3 Methods for Analyzing Spatial Data, Ignoring Location 35
Part I Introduction		3.4 Numerical Summaries in Which Location Is an Integral Component 48
Chapter 1 Thematic Cartography and Geovisualization	1	Part II Principles of Cartography
1.1 What Is a Thematic Map? 2		Chapter 4 Data Classification 57
1.2 How Are Thematic Maps Used? 2		4.1 Common Methods of Data Classification 58
1.3 Basic Steps for Communicating Map Information 3		4.2 Using Spatial Context to Simplify Choropleth Maps 69
1.4 Consequences of Technological Change in Cartography 8		4.3 Using Multiple Criteria to Determine Class Intervals 70
1.5 Geovisualization 12		Chapter 5 Principles of Symbolization 76
1.6 Related Techniques 14		5.1 Nature of Geographic Phenomena 77
1.7 Cognitive Issues in Cartography 15		5.2 Levels of Measurement 79
1.8 Social and Ethical Issues in Cartography 16		5.3 Visual Variables 81
Chapter 2 A Historical Perspective on Thematic Cartography	19	5.4 Comparison of Choropleth, Proportional Symbol, Isopleth, and Dot Mapping 85
2.1 A Brief History of Cartography 20		5.5 Selecting Visual Variables for Choropleth Maps 91
2.2 History of Thematic Cartography 21		Chapter 6 Scale and Generalization 96
2.3 History of U.S. Academic Cartography 23		6.1 Geographic and Cartographic Scale 96
2.4 The Paradigms of American Cartography 31		6.2 Definitions of Generalization 97
Chapter 3 Statistical and Graphical Foundation	34	6.3 Models of Generalization 98
3.1 Population and Sample 35		6.4 The Fundamental Operations of Generalization 101
3.2 Descriptive Versus Inferential Statistics 35		6.5 An Example of Generalization 107
		6.6 MapShaper: A Free Web-Based Generalization Service 108

Chapter 7	The Earth and Its Coordinate System	113		
7.1	Basic Characteristics of the Earth's Graticule	113		
7.2	A Brief History of Latitude and Longitude	118		
7.3	Determining the Earth's Size and Shape	119		
Chapter 8	Elements of Map Projections	130		
8.1	The Map Projection Concept	131		
8.2	The Reference Globe and Developable Surfaces	131		
8.3	The Mathematics of Map Projections	132		
8.4	Map Projection Characteristics	135		
8.5	Distortion on Map Projections	139		
8.6	Projection Properties	145		
Chapter 9	Selecting an Appropriate Map Projection	153		
9.1	Potential Selection Guidelines	154		
9.2	Examples of Selecting Projections	159		
Chapter 10	Principles of Color	173		
10.1	How Color Is Processed by the Human Visual System	173		
10.2	Hardware Considerations in Producing Color Maps for Graphics Displays	179		
10.3	Models for Specifying Color	181		
Chapter 11	Map Elements and Typography	188		
11.1	Alignment and Centering	189		
11.2	Map Elements	189		
11.3	Typography	202		
Chapter 12	Cartographic Design	211		
12.1	Cartographic Design	212		
12.2	Case Study: Real Estate Site Suitability Map	221		
Chapter 13	Map Reproduction	232		
13.1	Reproduction Versus Dissemination	233		
13.2	Planning Ahead	233		
13.3	Map Editing	233		
13.4	Raster Image Processing for Print Reproduction	234		
13.5	Screening for Print Reproduction	235		
13.6	Aspects of Color Printing	238		
13.7	High-Volume Print Reproduction	240		
13.8	Nonprint Reproduction and Dissemination	246		
Part III	Mapping Techniques			
Chapter 14	Choropleth Mapping	251		
14.1	Selecting Appropriate Data	252		
14.2	Data Classification	253		
14.3	Factors for Selecting a Color Scheme	254		
14.4	Details of Color Specification	259		
14.5	Legend Design	262		
14.6	Classed Versus Unclassed Mapping	264		
Chapter 15	Dasymetric Mapping	271		
15.1	Selecting Appropriate Data and Ancillary Information	272		
15.2	Eicher and Brewer's Work	272		
15.3	Mennis and Hultgren's Intelligent Dasymetric Mapping (IDM)	274		
15.4	LandScan	276		
15.5	Langford and Unwin's Generalized Dasymetric Approach	277		
Chapter 16	Isarithmic Mapping	281		
16.1	Selecting Appropriate Data	282		
16.2	Manual Interpolation	282		
16.3	Automated Interpolation for True Point Data	283		
16.4	Criteria for Selecting an Interpolation Method for True Point Data	292		
16.5	Limitations of Automated Interpolation Approaches	293		
16.6	Tobler's Pycnophylactic Approach: An Interpolation Method for Conceptual Point Data	294		
16.7	Symbolization	296		
Chapter 17	Proportional Symbol and Dot Mapping	302		
17.1	Selecting Appropriate Data for Proportional Symbol Maps	303		
17.2	Kinds of Proportional Symbols	303		
17.3	Scaling Proportional Symbols	305		

17.4 Legend Design for Proportional Symbol Maps	314	23.3 Visual Variables for Depicting Uncertainty	427
17.5 Handling Overlap on Proportional Symbol Maps	315	23.4 Applications of Visualizing Uncertainty	429
17.6 Redundant Symbols	318	23.5 Studies of the Effectiveness of Methods for Visualizing Uncertainty	436
17.7 Selecting Appropriate Data for Dot Maps	318		
17.8 Creating a Dot Map	319		
Chapter 18 Multivariate Mapping	327	Chapter 24 Web Mapping	441
18.1 Bivariate Mapping	328	24.1 A Brief History of Web Mapping	442
18.2 Multivariate Mapping Involving Three or More Attributes	335	24.2 Cartographic Web Sites: A Classification	444
18.3 Cluster Analysis	344	24.3 Tying Together the Five Continua	456
Chapter 19 Cartograms and Flow Maps	355		
19.1 Cartograms	355	Chapter 25 Virtual Environments	460
19.2 Flow Mapping	360	25.1 Defining Virtual and Mixed Environments	460
Part IV Geovisualization		25.2 Technologies for Creating Virtual Environments	462
Chapter 20 Visualizing Terrain	371	25.3 The Four “I” Factors of Virtual Environments	465
20.1 Nature of the Data	371	25.4 Applications of Geospatial Virtual Environments	467
20.2 Vertical Views	372	25.5 Research Issues in Geospatial Virtual Environments	471
20.3 Oblique Views	384	25.6 Developments in Mixed Environments	473
20.4 Physical Models	387	25.7 Health, Safety, and Social Issues	475
Chapter 21 Map Animation	389	Chapter 26 Trends in Research and Development	478
21.1 Early Developments	390	26.1 Linked Micromap Plots and Conditioned Choropleth Maps	479
21.2 Visual Variables and Categories of Animation	390	26.2 Using Senses Other Than Vision to Interpret Spatial Patterns	481
21.3 Examples of Animations	392	26.3 Collaborative Geovisualization	485
21.4 Using 3-D Space to Display Temporal Data	402	26.4 Multimodal Interfaces	487
21.5 Does Animation Work?	403	26.5 Information Visualization and Spatialization	489
Chapter 22 Data Exploration	408	26.6 Spatial Data Mining	491
22.1 Goals of Data Exploration	408	26.7 Visual Analytics	493
22.2 Methods of Data Exploration	409	26.8 Mobile Mapping and Location-Based Services	494
22.3 Examples of Data Exploration Software	411	26.9 Keeping Pace with Recent Developments	494
Chapter 23 Visualizing Uncertainty	425	Appendix Lengths of One Degree Latitude and Longitude	498
23.1 Basic Elements of Uncertainty	425	Glossary	501
23.2 General Methods for Depicting Uncertainty	426	References	519
		Index	546