

Map Analysis: *Understanding Spatial Patterns and Relationships*

by [Joseph K. Berry](#)

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This book is a collection of selected works from of Joseph K. Berry's popular "Beyond Mapping" columns published in GeoWorld magazine from 1996 through 2006. In this compilation Berry develops a structured view of the important concepts, considerations and procedures involved in grid-based map analysis. The companion CD contains further readings and software for hands-on experience with the material presented.

While numerous books focus on Geographic Information Systems (GIS) capabilities of computer mapping and spatial database management, few provide an understanding of its analytical potential and practical realities in a non-technical manner. The unique character of this book draws from the author's ability to convey seemingly complex concepts of spatial data and GIS operations in words that resonant with others less technically versed. The result is a book that engages the reader to "think spatially" and formulate new and innovative solutions to complex spatial problems. Key to this process is a paradigm shift that extends the traditional paper map perspective of "*where is what*" to the modern perspective of "*why and so what*." Within this context, maps become data and map analysis becomes the means to derive information about spatial patterns and relationships within and among map layers. This new perspective is moving us beyond mapping as a descriptive image to spatial reasoning and dialog as a mechanism for communication and decision-making based on location-dependent relationships.

Note: the online links access <http://www.innovativegis.com/basis/MapAnalysis/>, select Topic and Section as indicated

Table of Contents

Foreword (to be determined)

Preface

Sub-headings of **Map Analysis, Intended Readership, Book Organization, Case Study Data Sets, Companion CD, Book Website, and Acknowledgements**

Introduction — *As GIS moves from graphical inventories and spatial databases to map analysis, an entirely new paradigm of mapping is emerging. This section discusses the relatively short history, evolutionary trajectory and probable future of geotechnology.*

1 Early GIS Technology and Its Expressions (GW, in press for October 2006) — traces the early phases of GIS technology of Computer Mapping, Spatial Database Management and Map Analysis/Modeling.

...current online link T27, select "[Early GIS Technology and Its Expressions](#)"

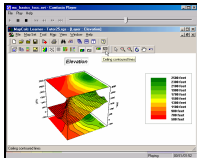
2 Contemporary GIS and Future Directions (GW, in press for November 2006) — discusses the contemporary GIS focus and probable future directions of Multimedia Mapping and Spatial Reasoning/Dialog.

...current online link T27, select "[Contemporary GIS and Future Directions](#)"

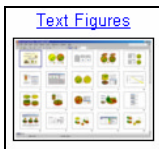
Further Reading (companion CD)

- **Keywords for Online Search** — listing of several keywords that can be used in online searches for additional material related to the discussion of GIS history and trends.
- **Companion Software** — link to MapCalc Learner Quick-take Review describing system requirements, capabilities, analytical operations, statistical operations, documentation, limitations and legacy.
- **Multimedia Mapping** — four references describing how photos and streaming video can be geographically referenced and used in multimedia applications.
- **Virtual Reality and GIS** — four references describing the underlying concepts, procedures and potential applications of linking GIS with virtual reality displays.
- **Software Design** — four references discussing the evolution of GIS software and basic concepts in object-oriented technology.

Hands-on Experience (companion CD)



Exercise I.1 Examples of Analysis Capabilities — in this exercise you will access two short video demos on MapCalc Basics and on Calculating Slope and Surface Flow. The first video demonstrates basic use including interactive 2D/3D plotting, display types, display navigation, accessing maps for display and graphical overlay. The second video illustrates some of the basic map analysis capabilities.



Exercise I.2 Viewing Full Color Figures — this exercise demonstrates how to access the full color versions of the B&W figures in the Map Analysis book. The figures are in standard PowerPoint files by Topic for easy access and printing in a variety of formats.



Exercise I.3 Installing Companion Software — this exercise includes guidelines for installing and testing the MapCalc Learner, Surfer Demo and SnagIt Evaluation software included on the companion CD.



Exercise 1.4 Software Tutorials — *this exercise describes how to access the companion software standard tutorials. The optional MapCalc and Surfer tutorials provide an overview of procedures and capabilities of the software that are covered in greater detail in the individual exercises for each of the Topics in this book. You are encouraged to complete the SnagIt tutorial as general familiarity with this software is assumed in the exercises.*

Topic 1. Data Structure Implications — *GIS technology is as different as it is similar to traditional mapping. These differences are due in large part to the structure and nature of digital mapped data. This section describes the various data and display types and their impacts on the appropriate characterization of discrete and continuous geographic distributions/patterns.*

3 Grids and Lattices Build Visualizations (GW, July 2002) — *describes Lattice and Grid graphic forms for displaying continuous surface data.*

...current online link T18, select "[Visualizing Grid-Based Data](#)"

4 Maps Are Numbers First, Pictures Later (GW, August 2002) — *discusses the numeric and geographic characteristics of data values used in representing discrete and continuous maps.*

...current online link T18, select "[Maps Are Numbers First, Pictures Later](#)"

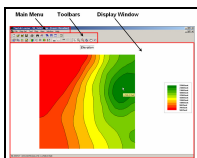
5 Normalize Maps for Data Analysis (GW, September, 2002) — *describes map normalization procedures and data exchange among grid-based software packages.*

...current online link T18, select "[Framing Maps for Data Analysis](#)"

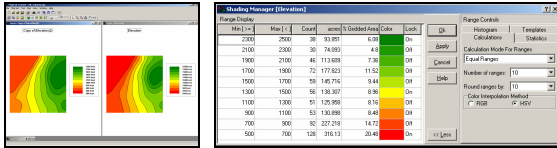
Further Reading (companion CD)

- **Keywords for Online Search** — *listing of several keywords that can be used in online searches for additional material related to grid-based data structure and display.*
- **Data Structure/Display Concepts** — *two references describing different approaches to storing raster data and generating contour map displays.*
- **Data Structure/Display Examples** — *five references providing annotated examples of grid-based map data/display types, continuous/discrete data values and data summary/display considerations.*

Hands-on Experience (companion CD)

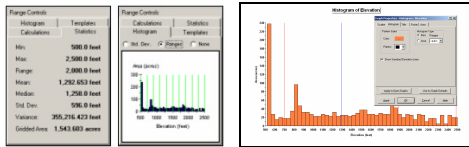


Exercise 1.1 Interacting with Grid Maps — *in this exercise you will become familiar with the basic layout and procedures for interacting with grid map displays.*



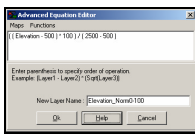
Exercise 1.2 Grid-based Thematic Mapping — this

exercise provides experience with the Shading Manager for setting contour intervals of 2D contour map representations of continuous surface data.



Exercise 1.3 Map Summary Statistics and Charts — this

exercise investigates various mechanisms for generating statistical summaries and charts continuous map surfaces.



Exercise 1.4 Map Normalization — this exercise demonstrates various techniques

for normalizing mapped data.

Topic 2. Fundamental Map Analysis Approaches — Map Analysis exploits the digital nature of modern maps to investigate the patterns and relationships within and among mapped data. This section uses a series of examples to introduce the concept of a map-ematics and the similarities/differences in Spatial Analysis and Spatial Statistics that form the two primary compartments of the map analysis toolbox.

6 Moving Mapping to Analysis of Mapped Data (GW, December 2004) — describes Spatial Analysis and Spatial Statistics as extensions to traditional mapping and statistics.

...current online link T24 select "[Moving Mapping to Analysis of Mapped Data](#)"

7 Bending Our Understanding of Distance (GW, January, 2005) — uses effective distance to establish an erosion setback to demonstrate the advanced nature of Spatial Analysis.

...current online link T24, select "[Bending Our Understanding of Distance](#)"

8 Use Spatial Statistics to Map Abnormal Averages (GW, February 2005) — discusses surface modeling to demonstrate the advanced nature Spatial Statistics.

...current online link T24, select "[Beyond Mapping Abnormal Averages](#)"

9 Making Space for Mapped Data (GW, March 2005) — investigates the link between Geographic Space and Data Space for mapping data distributions.

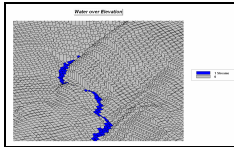
...current online link T24, select "[Making Space for Mapped Data](#)"

Further Reading (companion CD)

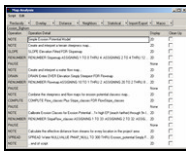
- **Keywords for Online Search** — listing of several keywords that can be used in online searches for additional material related to the overview discussion of Map Analysis capabilities and applications.

- **General Overview** — one reference discussing the important distinctions among discrete mapping, continuous map surfaces and map analysis.
- **General Application Examples** — three references containing annotated examples demonstrating important concepts in visualizing mapped data, comparing discrete maps and modeling campground suitability.

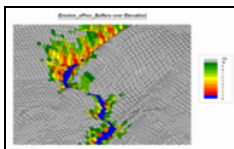
Hands-on Experience (companion CD)



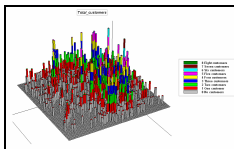
Exercise 2.1 Viewing Base Maps — in this exercise you will become familiar with the base maps used in the effective proximity buffer model.



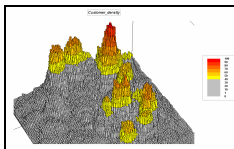
Exercise 2.2 Interacting with a Stored Script — this exercise introduces the procedures for interacting with a stored script of spatial analysis commands.



Exercise 2.3 Implementing a Script for Effective Erosion Buffers — this spatial analysis exercise evaluates step-by-step a model for generating a variable-width buffer around streams respecting the erosion potential of the intervening terrain (slope and surface flow).



Exercise 2.4 Investigating Customer Location — this exercise investigates the base maps used in the customer density model.



Exercise 2.5 Characterizing Customer Density — this spatial statistics exercise generates a customer density surface from customer locations and identifies areas of high density as being more than one standard deviation above the mean.



Exercise 2.6 Identifying Unusually High Customer Density — this exercise isolates the areas of statistically high customer density and identifies customer locations within this unusual region.

Topic 3. Basic Techniques in Spatial Analysis — *Spatial Analysis investigates the geographic context of mapped data resulting from the relative positioning and coincidence of the map values. This section discusses the Reclassify and Overlay grouping of operators that form the basic techniques used in most spatial models.*

10 Use a Map-ematical Framework for GIS Modeling (GW, March 2004) — describes a conceptual structure for categorizing Spatial Analysis operations.
...current online link T22, select "[A Map-ematical Framework for GIS Modeling](#)"

11 Options Seem Endless When Reclassifying Maps (GW, April 2004) — discusses basic map reclassify operations involving changing map values as a function of initial value, position, contiguity, size, or shape of the spatial configuration of the values on a single map layer.
...current online at T22, select "[Reclassifying Maps](#)"

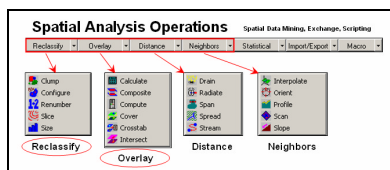
12 Overlay Operations Feature a Variety of Options (GW, May 2004) — discusses basic map overlay operations involving changing map values as a function of the point-by-point or region-wide alignment of the values associated with two or more existing map layers.
...current online link T22, select "[Overlaying Maps](#)"

13 Computers Quickly Characterize Spatial Coincidence (GW, June 2004) — describes the similarities and differences in how humans and computers characterize, assess and summarize spatial coincidence.
...current online at T22, select "[Characterizing Spatial Coincidence](#)"

Further Reading (companion CD)

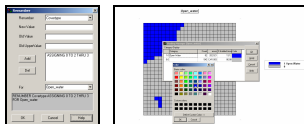
- **Keywords for Online Search** — listing of several keywords that can be used in online searches for additional material related to the discussion of grid-based Reclassify and Overlay operations.
- **Spatial Coincidence** — two references describing a technique for handling unique combinations of map layers and shadow maps of certainty can be used to estimate error and its propagation.
- **Micro-Terrain Analysis** — one reference describing the application of spatial analysis and surface modeling in decision-making contexts.

Hands-on Experience (companion CD)

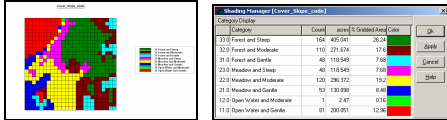


Exercise 3.1 Spatial Analysis Operations — in this exercise you

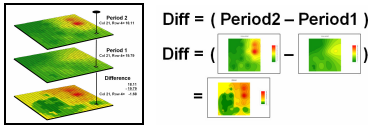
will be introduced to the basic classes of map analysis operations and how to access them when creating spatial models.



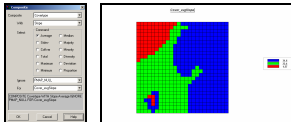
Exercise 3.2 Reclassifying Map Features — this exercise demonstrates the most basic class of map analysis operations within a logical processing sequence.



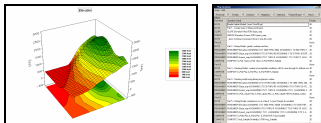
Exercise 3.3 Characterizing Map Coincidence — *this exercise identifies several ways to represent and statistically summarize the spatial coincidence between two discrete maps.*



Exercise 3.4 Calculating Change — *this exercise identifies the grid math procedures for generating a map depicting the amount of change in a continuous map variable between two periods.*



Exercise 3.5 Summarizing Map Regions — *this exercise demonstrates the procedure for determining the average condition of one map variable (Slope) occurring within the regions identified on another map (Districts).*



Exercise 3.6 Evaluating a Simple Habitat Model — *this exercise uses a stored script to demonstrate the derivation of a Binary, a Ranking and a Rating Suitability Model of Hugag habitat considering slope, aspect and elevation preferences.*

Topic 4. Calculating Effective Distance — *Traditional “as the crow flies” distance measured with a ruler is rarely an effective in establishing separation between two points as the reality of intervening barriers play a significant role that bends and twists actual movement. This section discusses the advanced Distance grouping of operators and expands the concept of simple distance to effective proximity considering relative and absolute barriers to movement.*

14 Extending GIS Procedures with Variable-Width Buffers (GW, November 2000) — *discusses the basic considerations in establishing variable-width buffers that respond to both intervening conditions and the type of connectivity.*

...current online link T13, select “[Creating Variable-Width Buffers](#)”

15 Create Effective Distance Buffers to Improve Map Accuracy (GW, January 2001) — *develops procedures for creating buffers that respond to the relative ease of movement.*

...current online link T13, select “[Creating Effective-Distance Buffers](#)”

16 Measuring Distance Is Neither Here nor There (GW, April 2005) — *discusses the basic concepts of distance and proximity used in generating simple proximity surfaces.*

...current online link T25, select “[Neither Here nor There](#)”

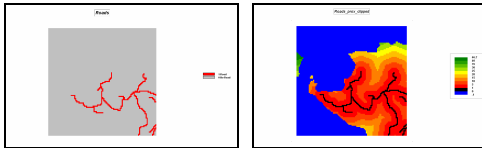
17 Extend Simple Proximity to Effective Movement (GW, June 2005) — *discusses the basic concepts used in generating effective proximity surfaces supporting that respond to relative and absolute barriers to movement.*

...current online link T25, select “[Extending Simple Proximity to Effective Movement](#)”

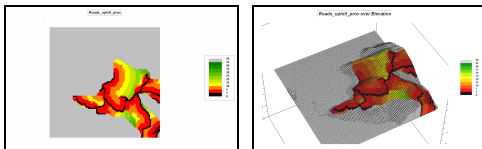
Further Reading (companion CD)

- **Keywords for Online Search** — listing of several keywords that can be used in online searches for additional material related to calculating and using effective proximity.
- **Calculating Simple and Effective Proximity** — four references describing how simple and effective proximity are calculated, as well as discussion about advanced distance operations.
- **Deriving and Analyzing Travel-Time** — five references on the use of effective proximity for assessing travel-time using examples from customer travel, hiking-time and connecting bus riders with their optimal stops.
- **Use of Travel-Time in Geo-Business** — seven references on the use of effective proximity for generating travel-time maps and procedures used in analyzing travel-time advantage between competing stores, competition zones, customer loyalty, as well as assessing in-store shopper movement patterns and sales.
- **Micro-Terrain Considerations and Techniques** — three references describing procedures for modeling surface flows to characterize erosion potential and determining uphill proximity as a function of slope to identify valley bottoms.
- **Surface Flow Considerations and Techniques** — four references discussing basic concepts, approaches and considerations in advanced surface flow modeling to include path, sheet, horizontal and fill flows in tracking flow time and quantity.
- **Proximity-based Application Examples** — three references containing annotated examples using effective proximity to model off-road emergency response, uphill terrain steepness for landslide potential and micro-terrain flows and pooling in an agricultural field.

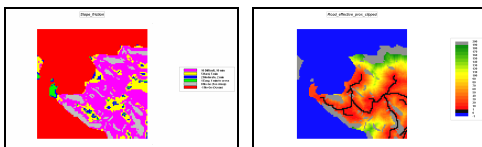
Hands-on Experience (companion CD)



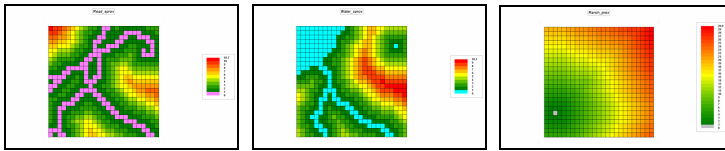
Exercise 4.1 Calculating Simple Proximity — in this exercise you will first create a map of the simple proximity to roads (as the crow flies) then mask the result for just the areas on the island.



Exercise 4.2 Calculating Uphill Proximity — this exercise describes generating proximity maps that respect a “guiding surface,” such as identifying distances to only uphill locations.

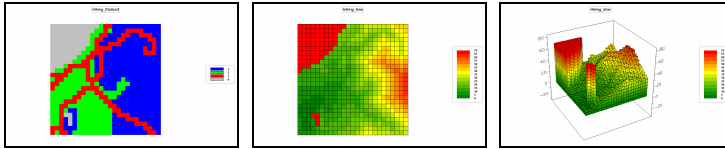


Exercise 4.3 Calculating Effective Proximity — this exercise demonstrates creating an effective proximity surface that respects intervening slope conditions as impediments (relative and absolute barriers) to movement off the road network.



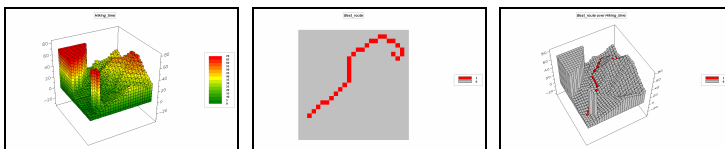
[Exercise 4.4 Simple Proximity](#)

Review — this exercise recaps deriving simple proximity from a variety of “starting feature” locations (Roads—lines, Water—polygons, Ranch—point).



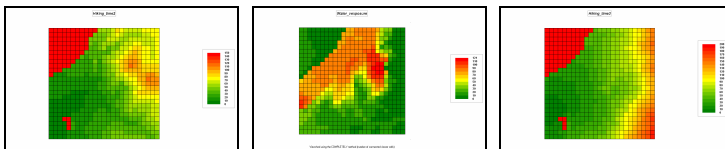
[Exercise 4.5 Effective Proximity](#)

Considering Intervening Conditions — this exercise describes a simple model for assessing hiking time from the Ranch to all other locations considering different intervening conditions (Roads and Covertypes maps).



[Exercise 4.6 Identifying Optimal Paths](#)

Paths — this exercise demonstrates generating the optimal path (best) for hiking between the Ranch and the cabin based on the effective proximity map (Accumulation Surface) derived in the previous exercise.



[Exercise 4.7 Extending the Proximity](#)

Analysis — this exercise extends the effective proximity analysis for hiking by including considerations of relative steepness (slope) and aesthetics (visual connectivity to water).

Topic 5. Calculating Visual Exposure — Visual analysis is an extension of effective distance measurement that considers line-of-sight connectivity among map locations. This section discusses the procedures, considerations and applications of derived viewshed and visual exposure maps.

18 Line-of-Sight Buffers Add Intelligence to Maps (GW, December 2000) — describes procedures for creating line-of-sight buffers that track relative visual exposure and noise levels.

...current online link T13, select “[Creating Line-of-Sight Buffers](#)”

19 Identify and Use Visual Exposure to Create Viewshed Maps (GW, June 2001) — discusses basic considerations and procedures for establishing viewsheds and visual exposure from point, line and polygonal features.

...current online link T15, select “[Identifying and Using Visual Exposure](#)”

20 Visual Exposure Is in the Eye of the Beholder (GW, July 2001) — investigates procedures for assessing simple and weighted visual exposure.

...current online link T15, select "[There's More That Meets the Eye](#)"

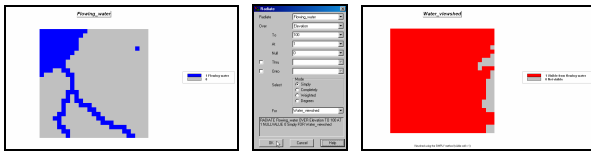
21 Use Exposure Maps and Fat Buttons to Assess Visual Impact (GW, August 2001) — describes procedures for creating a simple model that determines the relative visual impact of alternative power line routes on local residences.

...current online link T15, select "[Assessing Visual Impact](#)"

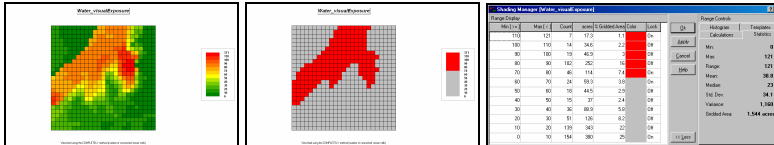
Further Reading (companion CD)

- **Keywords for Online Search** — listing of several keywords that can be used in online searches for additional material related to viewshed and visual exposure analysis.
- **Extended Visual Exposure Techniques** — three references describing extended techniques involving weighted visual exposure for assessing overall aesthetics and visual vulnerability.
- **Visual Exposure Application Examples** — two references containing annotated examples using visual analysis in land planning and natural resource management contexts.

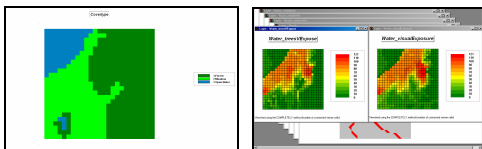
Hands-on Experience (companion CD)



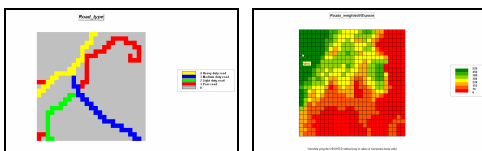
Exercise 5.1 Calculating Viewsheds — in this exercise you will first create a map of all the water locations (viewer map) in the Tutor25 database and then generate a simple viewshed map that indicates the visual connectivity to water— all locations are identified as either 0= not seen or 1= seen from at least one water location.



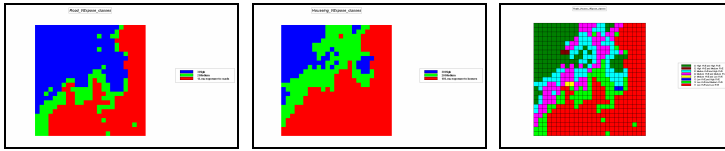
Exercise 5.2 Calculating Visual Exposure — this exercise demonstrates generating a visual exposure map to water indicating the number water locations visually connected to each grid location in a project area— 0= not seen with increasing values indicating higher visual exposure to water.



Exercise 5.3 Accounting for Screens — this exercise extends the previous exercise to create another visual exposure map to water that accounts for a screening forest canopy of 75 feet and then compares the result to the "non-screened" solution to determine the differences in the two approaches.

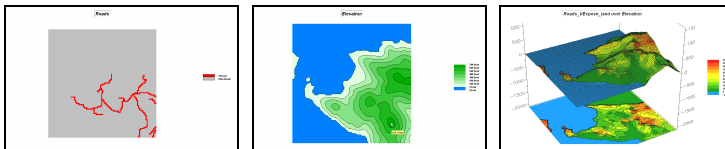


Exercise 5.4 Calculating Weighted Visual Exposure — this exercise first calibrates Roads in terms of traffic flow and then creates a weighted visual exposure map accounting for the relative amount of traffic on different road types— 0= not seen from any road location with increasing values indicating higher weighted visual exposure to traffic flows.



[Exercise 5.5 Modeling Visual](#)

Exposure Impacts — *this exercise creates and classifies visual exposure maps for relative connectivity to roads and houses (Low, Medium, High) and then combines the two classified maps into a single map that characterizes the joint visual exposure for each map location using a 2-digit code—a location with a value of 11 indicates 1= Low housing exposure and 1= Low roads exposure; a value of 12= Low/Medium, ... to a value of 33= High/High.*



[Exercise 5.6 Extending Visual](#)

Analysis to Other Areas — *this exercise creates a visual exposure map to roads and graphically overlays it on the Elevation surface for the Island database.*

Topic 6. Summarizing Neighbors — *Values surrounding a location can be used to investigate localized variation, anomalies, and trends in mapped data. This section discusses the advanced Neighbors grouping of operators that characterize map values occurring within a roving window centered at a location by either the surface configuration implied or a simple statistical summary.*

22 Computer Processing Aids Spatial Neighborhood Analysis (GW, October 2005) — *discusses procedures for calculating slope and profile from an elevation surface (DEM).*

...current online link T26, select "[Analyzing Terrain-based Neighborhoods](#)"

23 Milking Spatial Context Information (GW, November 2005) — *describes a procedure for deriving a customer density surface identifying relative concentrations of customers throughout a project area.*

...current online link T26, select "[Milking Spatial Context](#)"

24 Spatially Aggregated Reporting: The Probability Is Good (GW, January 2006) — *discusses techniques for smoothing "salt and pepper" results and deriving probability surfaces from aggregated incident records.*

...current online link T26, select "[The Probability is Good](#)"

Further Reading (companion CD)

- **Keywords for Online Search** — *listing of several keywords that can be used in online searches for additional material related to calculating and using neighborhood summary operations.*
- **Extended Neighborhood Techniques** — *three references describing customer density analysis and extended techniques for weight-averaging filters using decay functions.*

- **Micro-Terrain Analysis** — seven references describing techniques for characterizing concave/convex features, localized variation and terrain roughness, as well as discussion of terrain slope and its effect on surface area calculations.
- **Landscape Analysis Techniques** — four references describing techniques for calculating nearby-neighbor statistics, core area/edge, fragmentation and other landscape structure indices.
- **Landscape Structure Application Examples** — three references containing annotated examples for assessing cover type diversity, characterizing narrowness and delineating/summarizing core area of landscape parcels.

Hands-on Experience (companion CD)

Topic 7. Basic Spatial Modeling Approaches — *Spatial Modeling involves “thinking with maps” to solve a problem by deriving a solution map through a logical series of map analysis operations applied to base maps in a manner analogous to a cooking recipe. This section describes a progression of models that demonstrate the procedures and considerations in deriving areas of suitable wildlife habitat.*

25 Suitability Models Find the Good, the Bad and the Hugag (GW, July 2004) — *develops a simple Binary suitability model for characterizing wildlife habitat preferences.*

...current online link T23, select “[A Simple Habitat Model](#)”

26 Mapping Techniques Rate Hugag Habitat Suitability (GW, August 2004) — *expands discussion to Binary Progression and Rating suitability models that contain more information about relative habitat preferences and interactions.*

...current online link T23, select “[Rating Habitat Suitability](#)”

27 Logic and Extent Elevate Suitability Models to New Levels (GW, October 2004) — *extends the discussion of the Rating Suitability model to include additional habitat considerations and criteria weighting.*

...current online link T23, select “[Extending Suitability Models](#)”

Further Reading (companion CD)

- **Keywords for Online Search** — *listing of several keywords that can be used in online searches for additional material related to spatial modeling approaches, procedures and applications.*
- **Geo-Business Application Examples** — *three references containing annotated examples for assessing customer access and store competition analysis.*
- **Wildfire Application Examples** — *two references containing annotated examples for modeling wildfire response and risk and a feature article describing an extensive project modeling wildfire risk for the southern states..*
- **Precision Agriculture Application Examples** — *five references containing annotated examples for generating yield maps, summarizing sub-field areas, generating similarity maps and assessing temporal and localized variation effects.*

Hands-on Experience (companion CD)

Topic 8. Spatial Modeling Example — *Successful spatial models require the integration human judgment and analytical processing. This section describes the spatial reasoning and processing considerations surrounding a routing model that considers preferences for a variety of map criteria in determining the best path and optimal corridor for a proposed power line.*

28 A Three-Step Process Identifies Preferred Routes (GW, July 2003) — *describes the basic steps used in Least Cost Path analysis for determining the optimal routing considering a single criterion.*

...current online link T19, select "[Identifying the Most Preferred Route](#)"

39 Consider Multiple Criteria when Routing (GW, August 2003) — *expands discussion by considering multiple siting criteria for an overall "cost/avoidance" map and establishing optimal path corridors.*

...current online link T19, select "[Considering Multi-Criteria in Routing](#)"

30 A Recipe for Calibrating and Weighting GIS Model Criteria (GW, September 2003) — *identifies procedures for infusing stakeholder input by calibrating and weighting map layers in a routing model.*

...current online link T19, select "[Calibrating and Weighting GIS Model Criteria](#)"

31 Think with Maps to Evaluate Alternative Routes (GW, October 2003) — *describes procedures for comparing routes in terms of overall and site-specific "costs" for alternative routes generated by different routing scenarios.*

...current online link T19, select "[Evaluating Alternative Routes](#)"

Further Reading (companion CD)

- **Keywords for Online Search** — *listing of several keywords that can be used in online searches for additional material related to routing and optimal path analysis.*
- **Infusing Stakeholder Input into Routing** — *two references describing procedures for integrating stakeholder input in calibrating and weighting model criteria used in deriving alternative routes.*
- **Extended Routing Techniques** — *three references describing procedures for straightening and centering optimal paths and identifying optimal path networks connecting disperse points.*
- **Extended Accumulation Analysis Techniques** — *four references describing procedures for constructing and analyzing accumulation surfaces, as well as deriving the Nth best and stepped paths.*

Hands-on Experience (companion CD)

Topic 9. Basic Techniques in Spatial Statistics — *Spatial Statistics utilizes information about the spatial arrangement inherent in a data set to help explain variation and is based on the assumption that "nearby things are more alike than distant things." This section focuses on surface modeling techniques used to generate and evaluate the geographic distribution implied by a set of discrete point samples.*

32 GIS Data Are Rarely Normal (GW, October 1998) — *establishes the direct link between Data Space representing the numeric distribution/pattern and Geographic Space representing the geographic distribution/pattern of mapped data.*

...current online link T8, select "[GIS Data Are Rarely Normal](#)"

33 The Average is Hard to Find (GW, May 2006) — *introduces the fundamental concepts involved in generating continuous geographic distributions from point sampled data.*

...current online link T2, select "[The Average is Hardly Anywhere](#)"

34 Under the Hood of Spatial Interpolation (GW, June 2006) — *discusses the underlying assumptions and approaches used in Inverse Distance and Kriging spatial interpolation techniques.*

...current online link T2, select "[Under the Hood of Spatial Interpolation](#)"

35 Justifiable Interpolation (GW, February 1997) — *describes a procedure using Residual Analysis for evaluating spatial interpolation results.*

...current online link T2, select "[Justifiable Interpolation](#)"

Further Reading (companion CD)

- **Keywords for Online Search** — *listing of several keywords that can be used in online searches for additional material related to surface modeling and spatial interpolation.*
- **Modeling Error Propagation** — *two references describing procedures utilizing "shadow maps of error" in assessing certainty of spatial coincidence and generating "normalized error surfaces" for visualizing the geographic distribution of error.*
- **Point Sampling Considerations** — *two references discussing the concepts and considerations in point sampling design, as well as the relative advantages of different sampling patterns.*
- **Advanced Concepts in Spatial Dependency** — *seven references discussing advanced concepts in spatial dependency to include assessing spatial autocorrelation, the effects of different spatial arrangements of point samples, generating maps of spatial dependency and incorporating direction as well as distance in deriving spatial autocorrelation.*

Hands-on Experience (companion CD)

Topic 10. Spatial Data Mining — *Spatial Data Mining investigates the relationships within and among mapped data to characterize, compare, segment and map-ematically model spatial dependency. This section focuses on basic techniques for comparing maps, assessing similarity and clustering as means to understand and utilize spatial relationships in decision-making.*

36 Statistically Compare Discrete Maps (GW, July 2006) — *describes a procedure using a Coincidence Summary Table to quantitatively compare the similarity between the spatial patterns of two discrete maps.*

...current online link T16, select "[Comparing Discrete Maps](#)"

37 Comparing Continuous Map Surfaces (GW, September 2006) — *describes a procedure for generating and summarizing the difference between the geographic distributions of two continuous map surfaces.*

...current online link T16, select "[Comparing Continuous Map Surfaces](#)"

38 Geographic Software Removes Guesswork from Map Comparisons

(GW, October 2001) — *describes a procedure using Data Distance to identify the relative similarity of the data pattern for a specified location to the data patterns of all other locations within a map stack of data.*

...current online link T16, select "[Calculating Map Similarity](#)"

39 Use Similarity to Identify Data Zones (GW, November 2001) — *describes a procedure combining numerical and geographic distributions to identify areas that are statistically unusual within a map stack of data.*

...current online link T16, select "[Identifying Data Zones](#)"

40 Use Statistics to Map Data Clusters (GW, December 2001) — *describes a procedure using standard Clustering techniques to identify areas having similar data patterns within a map stack of data.*

...current online link T16, select "[Mapping Data Clusters](#)"

41 Spatial Data Mining Down on the Farm (GW, August 2006) — *describes the basic steps in Precision Agriculture for site-specific crop management and extends the discussion to a general Spatial Data Mining Process that addresses mapped data analysis applications in other fields.*

...current online link T16, select "[Spatial Data Mining Down on the Farm](#)"

Further Reading (companion CD)

- **Keywords for Online Search** — *listing of several keywords that can be used in online searches for additional material related to spatial data mining.*
- **Underlying Spatial Data Mining Concepts** — *four references discussing the linkages between geographic space and data space used in characterizing data patterns and their spatial arrangement.*
- **Precision Agriculture Applications** — *three references describing the application of spatial data mining for production increases, cost savings, improved stewardship and environmental benefits.*
- **Geo-Business Applications** — *three references discussing the application of spatial data mining in assessing retail sales and predictive modeling.*
- **Advanced Map Comparison Techniques** — *three references describing extended map comparison techniques for discrete maps and continuous map surfaces.*
- **Approaches Used in Deriving Prediction Maps** — *three references describing basic concepts and procedures used in deriving equations for generating and evaluating predictive map surfaces from a map stack of independent variables.*

Hands-on Experience (companion CD)

Epilog — *GIS in general and map analysis in particular is radically changing how we perceive and utilize maps. This section discusses different GIS adoption paths, their driving factors and impacts on the current and future dynamics within the GIS community.*

42 Pathways to GIS (GW December 2006, in preparation) — *explores the different evolutionary paths of GIS adoption for Natural Resources, Facilities Management, Public Health, Business and Precision Agriculture.*

43 A Multifaceted GIS Community (GW January 2007, in preparation) — *investigates the technical shifts and cultural impacts of the rapidly expanding GIS tent covering general users, application developers and tool programmers.*

Further Reading (companion CD)

- **Keywords for Online Search** — *listing of several keywords that can be used in online searches for additional material related to GIS community characteristics and dynamics.*
- **GIS Community Issues** — *two references discussing spatial reasoning skills and the interaction between traditional science and spatial technology.*
- **GIS Education Considerations** — *six references discussing how map analysis is enlarging the traditional educational view of mapping, student concerns, career paths and the relevance of grid-based map analysis in contemporary curricula.*

Hands-on Experience (companion CD)

Appendix (companion CD)

A. Quick Set of Exercises — *a short set of exercises demonstrating several of the basic map analysis concepts within a geo-business context.*

- Installing MapCalc
- Mapped Data Visualization and Summary
- Identifying Unusual Areas
- Identifying Data Zones
- Creating Travel-Time Maps
- Competition Analysis
- Additional Tutorial Exercises

B. Creating Your Own Grid Database — *describes procedures for creating a MapCalc database and exchanging data with a variety of other systems.*

- Creating Your Own Database (Empty Map Set)
- Importing Vector Data via Add New Layers
- Importing Grid Data via the File Tool
- Importing Grid Data via the Map Analysis Tool
- Exporting Grid Data via Map Analysis Tool
- Exporting Grid Data via File Tool
- Seamless Data Exchange with Surfer
- Seamless Data Exchange with MapInfo

Resources (companion CD)

Companion CD — Description of support material and direct links to *Further Reading*, *Hands-on Experience*, Text Figures, Companion Software, and Databases contained on the companion CD.

Additional Online Materials — Description of other materials available online and their direct links.

Instructor CD — Description of the optional instructor CD containing a comprehensive set of instructional materials supporting a variety of workshops and courses including syllabus, PowerPoint lectures, exercises, databases, and study/exam questions and answers.

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