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Testing the Usability of Interactive Maps in CommonGIS

Natalia Andrienko, Gennady Andrienko, Hans Voss, Fatima Bernardo, Joana Hipolito, and Ursula Kretchmer

The paper reports on an experimental study aimed at assessing the usability of five different interactive tools for exploratory analysis of geographically referenced data implemented in CommonGIS. Usability was assessed in terms of tool learnability, memorability, and user satisfaction. The study provided valuable data concerning the usability of each individual tool; we also derived some conclusions relevant to geovisualization techniques in general. We found that users were, in principle, able to understand and adopt the new ideas of map interactivity and manipulability. However, these ideas needed to be appropriately introduced; people could hardly grasp them just from the appearance of the maps and controls. An introductory demonstration was sufficient to understand the purposes of the interactive tools, and a short training session enabled people to use them. The importance of educating users is a particular challenge for geovisualization tools that are intended to be accessed over the Internet.

Keywords: Geographical visualization, interactive maps, usability engineering, usability evaluation, user studies.

Flexible Standardization: Making Interoperability Accessible to Agencies with Limited Resources

Nadine Schuurman

Semantic standardization is an integral part of sharing data for GIS and spatial analysis. It is part of a broader rubric of interoperability or the ability to share geographic information across multiple platforms and contexts. GIScience researchers have made considerable progress towards understanding and addressing the multiple challenges involved in achieving interoperability. For local government agencies interested in

sharing spatial data, however, current interoperability approaches based on object-oriented data models represent idealistic solutions to problems of semantic heterogeneity that often exceed the level of sophistication and funding available. They are waiting for the market to decide how interoperability should be resolved. In order to assist in this transition, this paper presents a rule-based Visual Basic application to standardize the semantics of simple spatial entities using several classification systems. We use the example of well-log data, and argue that this approach enables agencies to share and structure data effectively in an interim period during which market and research standards for semantic interoperability are being determined. It contributes to a geospatial data infrastructure, while allowing agencies to share spatial data in a manner consistent with their level of expertise and existing data structures.
Keywords: Standardization, interoperability, semantic heterogeneity, classification, Visual Basic

A New World Geographic Reference System

Keith C. Clarke, Peter H. Dana, and Jordan T. Hastings
A new global georeferencing system —- the World Geographic Reference System (WGRS) -— is proposed. This system has particular advantages for location description and communication with electronic devices, i.e., in digital environments that are shared between humans and machines. The new World Geographic Reference System strikes a compromise between the dominant use of numbers in established scientific coordinate systems, such as latitude/longitude, and the colloquial preference for names, particularly names of administrative units and populated places, in everyday life. Specifically, WGRS defines a system of uniform regional grids, each 100x100 km in extent, anchored on and named by prominent cultural and/or physical features. Subsets of these regional grids, called local grids, which are particularly adapted to smaller places, also may be defined. A location within a regional or local grid is georeferenced by suffixing the grid identifier with a coordinate string of dotted-digit-pairs that represent interleaved Cartesian x-y displacements from the grid origin. A typical WGRS locator, for example, is US.DC.WAS.54.18.28, representing a 100x100 m area, the southwest corner of which is 0.512

of the way across (east) and 0.488 of the way up (north) in the Washington, D.C., grid, roughly the lawn surrounding the Washington Monument. This locator, which is easily interpreted by both humans and machines, also may be effectively communicated between them via computer networks using a notation, such as "wgrp://US.DC.WAS.54.18.28" in web code. The similarity of WGRS locators (WGLs) to Uniform Resource Locators (URLs) on the Internet is intentional, facilitating their use in Web and wireless application interfaces, especially those employed in location-based service systems.
Keywords: Coordinate systems, geocoding, georeferencing, mapping grids

Spatial Forecasting of Disease Risk and Uncertainty

Lee De Cola
Because maps typically represent the value of a single variable over 2-dimensional space, cartographers must simplify the display of multiscale complexity, temporal dynamics, and underlying uncertainty. A choropleth disease risk map based on data for polygonal regions might depict incidence (cases per 100,000 people) within each polygon for a year but ignore the uncertainty that results from finer-scale variation, generalization, misreporting, small numbers, and future unknowns. In response to such limitations, this paper reports on the bivariate mapping of data "quantity" and "quality" of Lyme disease forecasts for states of the United States. Historical state data for 1990-2000 are used in an autoregressive model to forecast 2001-2010 disease incidence and a probability index of confidence, each of which is then kriged to provide two spatial grids representing continuous values over the nation. A single bivariate map is produced from the combination of the incidence grid (using a blue-to-red hue spectrum), and a probabilistic confidence grid (used to control the saturation of the hue at each grid cell). The resultant maps are easily interpretable, and the approach may be applied to such problems as detecting unusual disease occurrences, visualizing past and future incidence, and assembling a consistent regional disease atlas showing patterns of forecasted risks in light of probabilistic confidence.

Keywords: Risk maps, kriging, choropleth maps, uncertainty, disease, forecasting, ARIMA

Variations of the Gringorten Square Equal-area Map Projection

1. Graham Cogley

Gringorten's square equal-area map projection has been forgotten since its appearance in 1972. I describe a modern implementation, including details of how to arrange, in different ways, the fundamental Gringorten projection of a sexadecant (one sixteenth of the surface of the sphere) onto a triangle. The Gringorten Mark I projection is an arrangement in which one hemisphere forms a square, with the other hemisphere disposed around it so that the whole sphere projects as a diamond, which may then be rotated to appear as a square. I introduce an alternative arrangement, the Gringorten Mark II, which is twice as high as it is wide, with one hemisphere on top of the other. These variants are compared with some other square map projections. Maps that fill a rectangular space completely can be very useful where, as on computer screens, space is limited and must be used efficiently.

Keywords: Map projections, square maps, equal-area maps, computer cartography, optimization of computer screen space

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The Exploratory Essays Initiative: Background and Overview

Mark Monmonier and David Woodward

This special issue of Cartography and Geographic Information Science (CaGIS) arises out of planning for Volume Six (Cartography in the

Twentieth Century) of the History of Cartography, a multi-volume series that has performed a dual role as a reference work and interpretive narrative for the history of mapmaking in all periods and cultures. When the History of Cartography Project was conceived in 1977, the original plan was for four volumes to cover the subject to 1900, the traditional cutoff date for carto-bibliographers and map historians. This plan was sharply criticized by one of our editorial advisers, Walter W. Ristow, then chief of the Geography and Map Division of the Library of Congress, who pointed out that the story would stop before the most prolific cartographic century. The history of twentieth-century cartography was added to the plans, and in December 1984, Brian Harley and David Woodward invited Mark Monmonier to be a co-editor for Volume 6. A detailed outline for the volume was drafted in 1985, but plans were put on hold as work on other volumes mushroomed. We eventually modified the outline for discussion at a three-day conference on issues and events in twentieth-century cartography held at the Library of Congress on October 9-11, 1997. The conference was attended by thirty-four scholars, practitioners, and institutional sponsors, with support from the National Endowment for the Humanities.

The Historical Role of Photomechanical Techniques in Map Production

Karen Severud Cook

From the 1880s until the 1970s, photomechanical techniques played an important role in map making. Images created by and for photography were manipulated to form the printing image(s) from which the map was reproduced in multiple copies. After experiments in mapmaking in the 1860s, photomechanical techniques gained acceptance by the 1880s and, thereafter, increasingly dominated mapmaking until their rapid decline after the 1970s, as the shift to computers and electronic technology occurred. When they replaced earlier manual methods in the nineteenth century, photomechanical techniques caused the tools and materials of map production and the roles of personnel to change. Control over image production shifted from the printer to the cartographer as pen-and-ink drafting and associated collage techniques developed in the early 1900s,

and even more so when scribing came into general use in the 1960s. Having thus assumed more direct responsibility for the end product (the printed map), the cartographer also adopted methods of predicting and controlling its appearance, such as standardized tools and materials, drafting specifications, flow charting, and color proofing. Through the faster and cheaper production of maps whose graphic presentation of information was enhanced by tonal effects and color printing, photomechanical production techniques also contributed to the growth of the map trade and of map use during the twentieth century.
KEYWORDS: Photomechanical map production; map design; map reproduction; production tools; production techniques; production materials; pen-and-ink drafting; photographic halftone screen; photographic tint screen; stick-up; negative scribing; technical pens; photolithography; photoengraving; collage techniques

The Impact on Topographic Mapping of Developments in Land and Air Survey: 1900-1939

Peter Collier
At the beginning of the twentieth century, little of the world outside of Europe, India, and parts of North America had been covered by topographic mapping. By the end of the century there were few areas that were not covered by topographic mapping, if only at small scales. Most of the technological changes that made this extension of map coverage possible were pioneered during the period 1900-1939. This paper reviews the technological developments in land and air survey that took place during that period and relates them to the drive to produce cost-effective mapping for civil and military purposes.
KEYWORDS: Topographic mapping; twentieth century; photogrammetry; land survey; technological developments

American Promotional Road Mapping in the Twentieth Century

James R. Akerman

This paper sketches the broad outlines of the practices of map publishers, industrial concerns, motor clubs, and state governments to convince Americans to become motoring tourists and, hence, to consume the goods, services, and landscapes these interests wished to promote. Their efforts were rooted in the promotional mapping of American railroads during the nineteenth century and in bicycle mapping. Yet, the particular demands of automobile travel, including long-distance navigation under the control of the travelers themselves, argues for an almost unique dependence on maps, which in turn gave road maps considerable value as promotional tools.
KEYWORDS: Automobile road maps, promotional cartography, map publishing, map marketing, map use, consumers

Towards the Automated Map Factory: Early Automation at the U.S. Geological Survey

Patrick H. McHaffie
This paper is concerned with changes in map work at the U.S. Geological Survey during the period from 1950 to 1974. At the start of this period, mapmaking at USGS was dominated by manual techniques organized to conform to twentieth-century advances in photogrammetry, drafting techniques, materials, and industrial organization. During the 1950s and 1960s, technologies that had been developed in other sectors of American science and industry were inserted into mapping processes with hopes of huge productivity gains and added efficiencies. The development paths of two in-house devices, Autoplot and Autoline, illustrate the ways in which cartographic automation became an agency policy as well as a powerful ideology.
KEYWORDS: Cartography, labor process, automation, United States Geological Survey, oral history

The Politics of the Map in the Early Twentieth Century

Michael Heffernan
Drawing on material from several countries, principally Britain, France, and the United States, this paper considers the politics of mapmaking in

the years before, during, and immediately after World War I. Following a discussion of some noteworthy but hitherto overlooked mapping projects from the period around 1900, the paper examines the wartime production of maps as aids to geopolitical strategy in three Allied cities—London, Paris, and New York—with particular reference to the major geographical societies in these locations.
KEYWORDS: Geopolitical maps, international relations, early twentieth century, World War I

Allied Military Model Making during World War II

Alastair W. Pearson
It is generally accepted that the three-dimensional nature of the digital terrain model enhances our visualization of surfaces. Modern techniques enable a detailed landscape to be constructed as a facsimile of reality that provides an opportunity to move through or fly over the landscape. Given these benefits, it is little surprise that simulations using digital terrain models are employed as essential visual aids for briefing and training military personnel prior to land, air, and sea operations. Though these capabilities are significant, they are not necessarily, in the basic sense, new. This paper traces the development and examines the role of terrain models made by the Allies during World War II, a period prior to the development of computer-based modeling. Though made from basic materials, these sophisticated terrain models were hand crafted by enlisted sculptors, architects, stage designers, and artists, who carefully modeled a sculpture of the landscape to be an invaluable aid during key military operations of World War II.
KEYWORDS: Military mapping, terrain modeling, World War II

Maps for Ordinary Consumers versus Maps for the Military: Double Standards of Map Accuracy in Soviet Cartography, 1917–1991

Alexey V. Postnikov
Soviet cartography shared several important characteristics with the Russian cartography from which it emerged. Geographical expeditions were extremely important for filling out the contents of both Russian and

Soviet state topographic maps. Cartography had been centralized in many ways in Russian times, but the centralization became absolute under the Soviet system. At the same time cartography came under centralized control of the government in the State Cartographic Service, and the publication and use of large-scale maps were subject to governmental restrictions. The 1:100,000 map of the USSR was compiled in 1954, and was not designed to provide ordinary consumers with topographic information. Any maps for ordinary users, their scales notwithstanding, were based on the 1:2,500,000 map of the country. In the 1970s, the map was deliberately impaired by a cartographic projection that resulted in random distortions of the map's contents.
KEYWORDS: Cartography, topography, geography, geomorphology, surveys, security, accuracy, archives, Russia, USSR, air surveys, geodesy, geographical descriptions

American Cartographic Transformations during the Cold War

John Cloud
A great convergence of cartography, secrecy, and power occurred during the Cold War. In the American case, a complex series of interactions between secret and classified programs and institutions and their publicly accessible counterparts accomplished both traditional and novel objectives of military geographic intelligence. This process also yielded the World Geodetic System, a mass-centered "figure of the earth" at accuracies adequate for warfare with intercontinental ballistic missiles. A structural and institutional separation developed between enterprises charged with overhead data acquisition systems, which were classified at increasingly high levels of secrecy, and those responsible for data reduction, analysis, and mapping systems, which remained largely unclassified and publicly accessible, in part to conceal the classified data acquisition systems. This structural separation destabilized photogrammetric mapping by displacing systems that privileged dimensional stability with systems that privileged novel sensor types more appropriate to Cold War geo-political objectives and constraints. Eventually, photogrammetric mapping systems were re-stabilized by

successfully implementing analytical solutions imposed in digital mapping and data management systems. This achievement re-privileged dimensional stability, now redefined to the new media of geo-referenced digital data. In the early 1970s these developments culminated in advanced research projects of Military Geographic Intelligence Systems (MGIS). Their deployment in the Vietnam War was both their apex and their undoing. In the aftermath, classified mapping and database systems diverged from civilian versions of MGIS, which became known as Geographic Information Systems (GIS).
KEYWORDS: Military geographic information; panoramic cameras; terrain analysis; World Geodetic System; analytical solutions; photogrammetry; Intelligence Community; Cold War; Vietnam War; Military-Industrial-Academic Complex; Talent-Keyhole; Corona; data acquisition; data reduction

Cognitive Map-Design Research in the Twentieth Century: Theoretical and Empirical Approaches

Daniel R. Montello
Cognitive map-design research has the goal of understanding human cognition in order to improve the design and use of maps. As a systematic sub-discipline of cartography, cognitive map-design research is a phenomenon of the twentieth century, specifically the latter half. Robinson's The Look of Maps, published in 1952, played a seminal role in the genesis of cognitive map-design research in several countries, but it had interesting precursors. Empirical work that followed from The Look of Maps included psychophysical studies of graduated circles and studies of eye movements during map reading. Theoretical work that followed included a variety of cognitive theories but especially the development of the communication model as a comprehensive framework for scientific cartography. I chart the changing fortunes of cognitive map-design research after The Look of Maps and offer explanations for these changes. I also consider the legacy of cognitive map-design research—ways in which it has or has not mattered. I conclude with a list of questions suggested, but not decisively answered, by this exploratory essay.

KEYWORDS: History of cartography, cartographic research, map perception, map cognition, communication model, Arthur Robinson

A History of Twentieth-Century American Academic Cartography

Robert McMaster and Susanna McMaster

The academic discipline of cartography is a twentieth-century phenomenon. From its incipient roots in landscape representation in geology and the mapping of socio-economic data in geography, it grew into its own sub-discipline with graduate programs, research paradigms, and a scientific literature of its own. It came close to establishing a national center for cartography in the late 1960s. After rather sporadic activity before World War II, the period from 1946 to 1986 saw the building of major graduate programs at the universities of Wisconsin, Kansas, and Washington. Other programs were created, often with the doctoral students from those three. At the end of the twentieth century, cartography underwent significant changes in relation to the emerging discipline of geographic information science. The future for academic cartography is less certain, as graduate programs adjust the balances among the many components of mapping science, including cartography, geovisualization, GI science, GIS systems, spatial analysis/statistics, and remote sensing.

KEYWORDS: John Paul Goode, Erwin Raisz, Richard Edes Harrison, Arthur Robinson, George Jenks, John Sherman, Waldo Tobler, analytical cartography.

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A Graphical Method for Exploring Spatiotemporal Point Distributions

Yukio Sadahiro

ABSTRACT: A spatiotemporal point distribution is a set of points defined by the combination of a spatial region and a time period. It is used for representing a set of discrete events, such as traffic accidents, and a set of points that characterize line and polygon objects such as the turning points of insect movement. Analysis of a spatiotemporal point distribution is more difficult than an ordinary spatial point distribution because it has to be treated in a three- or four-dimensional spatiotemporal region, where data visualization and analysis have not been fully explored. This paper proposes a new method for representing the spatiotemporal point distribution, which is useful for exploratory analysis. The method summarizes the information extracted from the point distribution, and thus helps us find important and interesting patterns in the distribution. It consists of two steps: conversion of a spatiotemporal point distribution into a surface, and graphic representation of the surface. Along with a theoretical description of the method, technical details including a computational algorithm are discussed. To test the validity of the method, an expansion of convenience stores in Tokyo, Japan, is analyzed.

KEYWORDS: Graphical representation, exploratory analysis, spatiotemporal point distribution, peak diagram

Interactivity Types in Geographic Visualization

Jeremy W. Crampton

ABSTRACT: This paper introduces and discusses types of interactivity that can be used in digital mapping environments. The interactivity types are placed in the framework of geographic visualization (GVis) in order to extend the GVis emphasis on exploratory, interactive and private

functions of spatial displays. After defining interactivity in general, four categories of interactivity are proposed: with (1) the Data; (2) the Data Representation; (3) the Temporal Dimension; and (4) Contextualizing Interaction. Three benefits of this typology are discussed. First, interactivity types can be combined to build an interactive environment. More powerful interactive mapping environments not only employ more interactivity types, but combine types from different categories. Second, the typology allows cartographers to compare and critique different mapping and GIS environments and gives cartography educators and students a mechanism for understanding the different types of interactivity, as well as a set of concepts for imagining and creating new interactive environments. Third, a typology of interactivity gives interface designers a mechanism with which to identify needs and measure interface effectiveness. In order to examine these issues in practice, two common interactive mapping environments are briefly examined to determine the interactivity types employed, and a measurable difference of interactive potential is obtained.
KEYWORDS: Interactivity, typology, geovisualization

Artificial Neural Networks as a Method of Spatial Interpolation for Digital Elevation Models

David A. Merwin, Robert G. Cromley, and Daniel L. Civco
ABSTRACT: This paper examines the performance of artificial neural networks (ANNs) as a method of spatial interpolation, when presented with irregular and regular samples of elevation data. The results of the ANN interpolation are compared with results obtained by kriging. Tests of spatial bias in the systematic errors contained in each of the neural network-derived DEMs were conducted using four attributes: slope, aspect, average direction and average distance from the nearest sampled value. Based on RMS and other evaluation measures, the accuracy of estimated DEMs from regular and irregular sample distributions using neural networks is lower than the accuracy level derived from kriging. The accuracy level of the ANN interpolators also decreases as the range of elevation values in DEMs increases. As reported in the literature, ANNs are approximate interpolators, and the pattern of under-prediction and

over-prediction of elevation values in this study revealed that all estimated values fell within the range of sample elevations. Neural networks cannot predict values outside the range of elevation values contained in the sample, a property shared by other interpolators such as inverse weighted distance.
KEYWORDS: Spatial interpolation, artificial neural networks (ANN), digital elevation model (DEM)

Predicting Data Loss and Duplication when Resampling from Equal-Angle Grids

1. Jon Kimerling

ABSTRACT: Global data sets for elevation and other environmental phenomena are commonly distributed as “equal-angle” grids with cell edges defined by equal angular increments of latitude and longitude (quadrilateral cells). Equal-angle grids of varying spatial resolution are the primary data source for small-scale maps of global or continental extent produced as scientific or commercial products. Nearest-neighbor resampling of grid data is commonly employed to create maps on a variety of projection surfaces, but little attention has been paid to the loss and duplication of data in the equal angle grid that is a consequence of the resampling process. This paper focuses on the creation and use of what is termed a Data Loss and Duplication Map (DLDM) as an essential tool for understanding the spatial and mathematical nature of data loss and duplication during resampling. DLDMs corresponding in spatial resolution to the ETOPO5 global elevation data set were created for the cylindrical equal area, sinusoidal, and Lambert azimuthal equal-area world map projections. Each DLDM not only allowed the global pattern of data loss and duplication to be visualized, but also provided data for graphs showing the extent of loss and duplication at five-minute latitude and longitude intervals. These graphs proved essential to deriving equations for each projection that predict the extent and location of data loss and duplication on the DLDM and hence in the ETOPO5 data set.
KEYWORDS: Equal-angle global grids; nearest-neighbor resampling; data loss and duplication map; resampling error.

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Visual Search for Land Use Objects in Aerial Photographs

Robert Lloyd and Michael E. Hodgson

Although visual search has been a topic of interest for some time, most search processes have considered simple target symbols in a plain background. The purpose of the current study was to consider more realistic search processes that involved complex targets and backgrounds. A cognitive experiment was conducted in which subjects searched for specific types of land use in aerial photographs. Subjects were presented displays with simple or complex backgrounds that had from one to five primary and secondary objects related to four different types of land use. Primary objects were stores, schools, churches, and farmhouses; secondary objects included parking lots, athletic fields, cemeteries, and agricultural fields. Subjects searched each photograph and determined if the stated target was present or absent. The efficiency of the visual search was measured by reaction time. Reaction times significantly decreased as the number of objects in the photograph increased. The separation of primary and secondary land-use objects significantly increased reaction times. Searches done with complex backgrounds were significantly longer than searches done with simple backgrounds. Visual searches were significantly faster when schools and churches were targets in the photographs and significantly slower when stores and farmhouses were targets.

Keywords: visual search, aerial photographs, reaction times

Qibla, and Related, Map Projections

Waldo Tobler

The qibla problem determination of the direction to Mecca has given rise to retro-azimuthal map projections, an interesting, albeit unusual and

little known, class of map projections. Principal contributors to this subject were Craig and Hammer, both writing in 1910. A property of retro-azimuthal projections is that the parallels are bent downwards towards the equator. The resulting maps, when extended to the entire world, thus must overlap themselves. An unusual recent discovery from Iran suggests that Muslims might have been prior inventors of a similar projection, by at least several centuries. A later corollary by Schoy leads to a new "cylindrical" azimuthal map projection with parallels bending away from the equator, here illustrated for the first time.
Keywords: Azimuthal directions, map projections, Mecca, qibla, retro-azimuthals

An Evaluation of Fractal Methods for Characterizing Image Complexity

Nina Siu-Ngan Lam, Hong-lie Qiu, Dale A. Quattrochi and Charles W. Emerson
Previously, we developed an integrated software package called ICAMS (Image Characterization and Modeling System) to provide specialized spatial analytical functions for interpreting remote sensing data. This paper evaluates three fractal dimension measurement methods that have been implemented in ICAMS: isarithm, variogram, and a modified version of triangular prism. To provide insights into how the fractal methods compare with conventional spatial techniques in measuring landscape complexity, the performance of two spatial autocorrelation methods, Moran's I and Geary's C, is also evaluated. Results from analyzing 25 simulated surfaces having known fractal dimensions show that both the isarithm and triangular prism methods can accurately measure a range of fractal surfaces. The triangular prism method is most accurate at estimating the fractal dimension of surfaces having higher spatial complexity, but it is sensitive to contrast stretching. The variogram method is a comparatively poor estimator for all surfaces, particularly those with high fractal dimensions. As with the fractal techniques, spatial autocorrelation techniques have been found to be useful for measuring complex images, but not images with low dimensionality. Fractal measurement methods, as well as spatial autocorrelation techniques, can

be applied directly to unclassified images and could serve as a tool for change detection and data mining.
Keywords: Fractal measurement, spatial autocorrelation, simulated surfaces, data mining

An Inverse Solution to the Winkel Tripel Projection Using Partial Derivatives

Cengizhan Ipbuker
In cartographic applications it is frequently necessary to transform the rectangular coordinates from one projection into another. In this case, one must first calculate the geographical coordinates from the rectangular coordinates of the existing map and then project these new geographical coordinates to the desired projection. This is called an inverse solution. If both of the plane coordinates are functions of the variables longitude and latitude, it may not be easy to derive the geographical coordinates. This paper describes an iterative approach for the inverse solution of the Winkel Tripel projection using partial derivatives. I chose the Winkel Tripel projection because it is commonly used for mapping the whole world. It has a special importance in atlas cartography where it is regarded as a suitable projection with relatively little distortion, distributed more uniformly than many other atlas projections.
Keywords: Winkel Tripel, inverse solution, Newton's iteration, partial derivatives, Jacobian matrix

Towards a Participatory GIS: Evaluating Case Studies of Participatory Rural Appraisal and GIS in the Developing World

Brian H. King
The recognition that local participation is a critical goal of development has contributed to the popularity in a set of techniques designed to increase local participation and knowledge in planning processes. Identified as participatory rural appraisal (PRA), this trend is marked by the use of a variety of high-end technologies, including geographic

information systems (GIS). An interesting and related trend has come from members of the GIS community who argue that a “participatory GIS” is required to ensure local knowledge and participation in a variety of planning initiatives. This synergy of interests has resulted in a growth of research in the developing world that attempts to merge PRA methods with GIS tools. This paper examines the separate, but increasingly complementary, traditions of PRA and GIS. Ten case studies that combine participatory methods with GIS in Latin America, Africa, and Asia are evaluated to consider how these traditions are being applied by communities to protect ownership of territory, present local knowledge of natural resources, and to engage in long-term planning. This paper suggests that although GIS has the potential to increase participation in planning processes, a commonality of the majority of case studies is limited attention to the participatory process itself. It would address how access to information and GIS tools varies within communities, as well as the effectiveness of a participatory GIS in shaping policy outcomes. Although participation can be advanced through the use of GIS, this paper concludes by suggesting that research on the availability of these tools should not serve as a substitute for critical analyses of their use and effectiveness by local communities.
Keywords: Participatory GIS, community-based GIS, GIS and society, PRA, development

Book Review

Geographic Information Systems and Science, Longley P A, Goodchild M F, Maguire D J, and Rhind D W (eds). John Wiley & Sons, Chichester, Sussex, 2001. 454 pages. $87.56 cloth (ISBN 0-471-49521-2).

Geographic information systems (GI systems) and science (GI science) have been progressing at blinding speeds as geographic information scientists (GI scientists) continue the quest for new ways of describing, understanding, and predicting the spatial interactions between humans and the earth. However, in this progress a disproportionate amount of

published materials focus on the spatially aware professionals (SAPs). There are only a few books that we can truly say provide a holistic coverage of the GIS discipline for non-SAP audiences. For many years, Burrough's Principles of Geographical Information Systems for Land Resources Assessment was the main textbook available. Burrough's book, coupled with the authoritative two-volume Geographical Information Systems: Principles and Applications, were the staple of many university introductory GIS courses. Stand-alone textbooks with geographic information education goals are scarce.

It is in this context that Geographic Information Systems and Science by Longley et al. is a much needed addition. In their book, the authors use a broad brush to paint a comprehensive picture of the GIS discipline in a clear and non-threatening style of writing, showing trans-disciplinary relationships where they exist, providing a copious supply of examples to reinforce theory, highlighting influential personalities and their work, and pointing the way to Internet-based materials for readers who wish to explore topics in more detail.

Geographic Information Systems and Science has a foreword and afterword by Joe Lobley, a preface, a list of acronyms, an epilog, and nineteen chapters covering the principles (ideas), techniques (concepts) and practice (action) of geographic information problem solving. The rapid trans-disciplinary growth of GIS, the differing learning requirements for SAPs and non-SAPs, together with changing education modes and the increasing influence of information and communication (ICT) tools in the learning process have all shaped the form and content of this book. Improving capability to address geographic problems through better understanding, improved expertise, and recognition of unintended consequences and strong professional values are the main topics of this work, as the authors point out in the preface.

In the introduction section consisting of chapters 1 and 2, GIS is placed in a problem-solving context. The history of GIS, issues of scale, problem-solving paradigms, and the content of GI systems, GI science, and GI education are gradually outlined. This is supported by a gallery of applications that emphasise the spatial nature of our everyday lives. For the new reader, the applications provide a real-world experience map to aid personal navigation through the theory that follows. Chapters 3 to 7

unmask the scientific principles that govern the discipline. Theoretical issues such as representing geographic space and processes, georeferencing, characteristics of geographic data, errors and uncertainty in representing reality, and the important role of metadata in spatial data interchange are discussed in conceptual rather than technical detail. Chapters 8 to 15 form the second section of the book and they cover the main techniques of GIS analysis. Starting with a broad-based discussion of commercial GIS software, the content progresses through the chapters using the traditional data gathering, data input and processing, spatial data analysis and visualization, and error analysis process flows that characterize GIS data handling. By showing the links between GIS applications, scientific principles, and people-oriented empirical analysis, the authors set the scene for the next section. Chapters 16 to 19 comprise the final section that is dedicated to examining the role of people and organizations in GIS practice. How do we integrate people and GIS technology in a holistic manner to effectively address the objectives of the organization? To understand this question, the authors present an organizational analysis perspective that casts a broad net on issues such as operational planning and management, asset and risk management, and collaboration strategies between public and private organizations at local, regional, and global levels. The epilog summarizes the chapters and places them in proper perspective. After reaching this stage of the book, the new reader is better able to understand the current status of GI systems, science, and studies, and to critically follow the authors on a short journey as they look ahead to the potentials and challenges of GIS in the coming years.

Overall, this is an excellent book for readers looking for a user-friendly introduction to the links and concepts of GIS. It is a textbook, and strong pedagogical features predominate to give readers refreshing ways of interacting with the content. At 10” x 7.5” x 1” and full-color, it grabs your attention immediately. A further look under the cover reveals that each chapter starts with an overview and clear learning objectives, and that there are text boxes to highlight important concepts or to present personality profiles. There is a strong focus on geographic problem solving through examples and sufficient in-depth theory to aid understanding and to chart solution strategies. Questions for further

study, general online Internet resources, reference links to mostly its technical predecessor, Geographical Information Systems: Principles and Applications, and links to the ESRI Virtual Campus and the NCGIA Core Curricula round off the diversity of quality interactive content that is packaged within the pages of this book.

However, if there is one shortcoming it has to be the neglect of any serious discussion about freeware and shareware GIS. In some developing countries, and for many individuals, the present price of commercial GIS software is a barrier to widespread adoption of the technology. For this sector of the digital divide, freeware and shareware GIS software provide sometimes the only means for practical GIS training and education. The social and political consequences of this are of significance and deserve some mention in the book. Nevertheless, this missed opportunity does not diminish the tremendous effort of the authors and the value of this work as the most complete scholarship that presently exists on geographic information science.

This book will be of great value to undergraduate and graduate students studying GIS, serious lay readers interested in the subject, and GIS managers and academics who may need to refresh their GIS knowledge.

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Book Review

Parallel Processing Algorithms for GIS, Richard Healey, Steve Dowers, Bruce Gittings, and Mike Mineter (eds). Taylor and Francis Ltd., London. 1997. 470 pages. Hardcopy $105 (paperback $48).

The increasing availability of large quantity of GIS and remote sensing data, the growing complexity of spatial algorithms, and the burdensome requirement of real-time GIS operation are the most compelling reasons for exploiting parallel computation in the GIS context. In the past twenty years, a great deal of progress in parallel GIS and remote sensing has been made worldwide. However, most of those results are limited in algorithmatical level or to a particular parallel computer platform. Parallel

GIS and remote sensing has not grown at a healthy and speedy pace due, in part, to a lack of a systematic study as well as a good textbook on the subject. Parallel Processing Algorithms for GIS, edited by Richard Healey, Steve Dowers, Bruce Gittings, and Mike Mineter, and published by Taylor & Francis, fills this gap and is indeed a groundbreaking book on this subject.

Unlike other edited collections, which usually lack a sustained goal, this book aims to give readers "a clear picture of both the technical problem and the benefit/cost of developing GIS algorithms in a parallel environment." It does a very nice job in meeting its goal. The editors as well as the authors of a large portion of this book are from the University of Edinburgh, a leading parallel GIS research institute in the world. Their study on parallel GIS is much more serious, comprehensive and systematic than any other places, which is reflected by the content of this book.

This book has five parts. Part 1 discusses basic concepts, terminology, and techniques of parallel processing. The readers should be able to grasp the fundamental issues, such as hardware, software, basic parallel programming concepts, and data I/O. Parts Two and Three originate from a research project on parallel GIS at the University of Edinburgh. Part Two serves as a cornerstone of the whole book and addresses the general issues of parallel software design in a GIS application, including data structure (vector and raster), data format and topology, data management in a parallel environment and software reusability. Part Three gives some examples of developing parallel algorithms. Three algorithms are described: vector-raster conversion, raster-vector conversion, and polygon overlay. Part Four presents research progress achieved elsewhere.

In the past twenty years, people's perspective about parallel computation has changed from overly optimistic and enthusiastic to more realistic and practical. A proper review about parallel GIS is given in Part Five. Although this is the shortest part, it presents some very important issues, such as hardware, software, data, and expertise, which are too important to be ignored by any serious parallel GIS professional.

Although this book gives a good systematic study on parallel GIS, it is apparent that parallel GIS as well as GIS is still lacking in theoretical

fundamentals. Currently, the most successful and active areas of parallel computation are physics, climate modeling, material science, and biology. One common reason for their successes is that all of them have very solid theoretical fundamentals. In a typical parallel computation project, good theories and models usually help to set up the project objective, guide the algorithm development, and interpret the result. Unfortunately, many parallel GIS projects lack such kind of theoretical support and therefore their objectives are merely to speed up the operations, which is much less appealing and valuable. This is the area that neither geography nor this book has any clear answer for at this moment.

Finally, I would like to reiterate a point from this book to end this review. “There is a shortage of skilled staff in parallel processing, there are even fewer individuals with expertise in the complex and sometime arcane world of GIS algorithm. To find those with both types of skills is therefore even more difficult, and makes interdisciplinary collaboration essential”(p.4). This book builds a nice bridge between the GIS and parallel computation communities. If you are an established GIS professional, this book might echo many of your experiences, thoughts, and concerns from different viewpoints. If you are a parallel computer expert, this book could help you to enter a new and very promising territory. If you are an enthusiastic parallel GIS newcomer, this is an excellent reference book and a guideline. [Yang Cheng, Jet Propulsion Laboratory, Pasadena, California]