

Editorial

It has been over 50 years since one of the first Geographic Information System (GIS) publications introduced the use of computers for spatial data management, analysis, and mapping (Tomlinson 1962). While the field has been and still is heavily driven by technology, Professor David M. Mark is amongst a group of visionaries who assert the depth and richness of intellectual challenges, and push for rigorous scientific inquiries into the nature of geographic information and its ensuing consequences on representation, computation, communication, and decision-making. After Goodchild (1992) outlined the scope of Geographical Information Science (GIScience), Mark (2003) defined the field and differentiated ‘GIScience Research’ from ‘Research using GIS.’ This special issue is a tribute to Professor Mark’s scholarship and fundamental contributions to the development of GIScience upon his retirement from the University at Buffalo, The State University of New York, and the directorship of the Buffalo site of the National Center for Geographic Information and Analysis (NCGIA).

Mark has written or co-authored more than 220 publications and supervised more than 62 graduate theses or dissertations. He played a critical role in building the NCGIA and University Consortium for Geographic Information Science (UCGIS). He was one of the founding members for the two most influencing conference series still active today in the academic GIS community: the international GIScience conference and the Conference on Spatial Information Theory (COSIT). He was instrumental in the founding of the NSF-ESF Young Scholars with the GIScience Summer School and the Vespucci Summer Institute; both have had profound impacts on many early career GIScientists across the Atlantic. Mark’s sustained contributions to GIScience research and education contributed significantly to the breadth and depth of a vibrant interdisciplinary and transdisciplinary field of study.

As this special issue shows, Mark pioneered many new fronts of GIScience research since 1970. His early work on terrain analysis and digital elevation modeling pushed methodological fused between quantitative geomorphology, spatial analysis, and analytical cartography. He played a key role in various GIScience milestones, including algorithms and data structures for Triangular Irregular Networks (TINs), Thiessen polygons, drainage network analysis, as well as quadtree and octree data structures. He was also a leader in informing the GIScience community about spatial reasoning, followed by linguistic research, leading to the exploration of spatial metaphors for handling geographic information, and conceptualizing naive geographic concepts. His empirical research included spatial concepts in language and spatial ontologies, which exposed experimental and formal models of geographic space, geographic things, and spatial relations. His research set the foundation for formalizing spatial cognition and conceptual neighbors of topological relations, and furthermore sprouted his research in cross-cultural and cross-linguistic variations and geographic categories. Most recently, his ethnophysiology research, a concept he and his colleagues developed, opened a new line of GIScience inquiries into geographic conceptualization and embedded ontological implications in language and verbal communication. Always driven by intellectual curiosity, Mark’s

research opened many new perspectives in GIScience and stimulated discussions across interdisciplinary communities of scholars.

The special issue highlights the broad spectrum of Dr. Mark's research and includes six papers in three categories: (1) papers that review and contextualize Mark's scholarship; (2) papers that examine Mark's contribution to new lines of GIScience inquiries; and (3) papers that expand upon Mark's interest to new topics of spatial studies. In the first category, Andre Skupin retrieved metadata records from 50,000 publications and 4,000,000 co-citations related to Mark's papers from the ISI Web of Science, Scopus, and Google Scholar databases. He then identified 9000 publications for scientometric analysis to illustrate Mark's domain of influence among 19 super communities of scholars. He illustrated the core intellectual structures within the reach of Mark's work and detailed network connections among publications on common themes and co-authorships. This analysis exemplifies Mark's impact on various knowledge domains, as evident not only by the diverse set of topics of his publications, but also by 'the distinct and meaningful community structures that emerge from the co-citation analysis' that has had not only lasting influences on GIScience, but also even resurgent influences, such as in contemporary quaternary science. Complimentarily, Zhan *et al.* focused Mark's 20 most cited publications and evaluated the global influence of Mark's scholarship. The 20 publications covered four distinct research themes of digital elevation modeling, geomorphology, cognitive models, and ontology, in addition to three papers on sediment deposit analysis, naive geography, and digital earth. These 20 papers generated 1820 level-1 citations and 18,110 level-2 citations based on data from Web of Science and Google Scholar as of 6 May 2012. These citation numbers are outstanding, as GIScience communities are still mainly young and small compared to other more established disciplines. Zhan *et al.* developed a GeoSI index to measure the geographic extent of scholarly influence. They showed that the citation footprint of Mark's publications spread over 80 countries with, unsurprisingly, high concentrations in North America, Europe, Asia, and Australia. This analysis exemplifies the lasting international influence and global reach of Mark's research.

The second category of papers included in this special issue focuses on a particular topic of interest to Mark. The paper by Turk and Stea discusses Mark's most recent contributions to ethnophysiography research, a term these authors have coined together with Mark. While Mark contributed significantly to advancing fundamental geographic and geospatial theories in his work, he remained a hands-on researcher throughout his academic career. He collected and analyzed data first-hand for his empirical projects, and proactively sought comments and suggestions from his colleagues, including his graduate students. Turk and Stea summarized not only Mark's transformation of his long-term interests in landforms and linguistics to ethnophysiography but also his novel approaches and diligent efforts to problem conceptualization, literature reviews, field surveys, data analysis, and formal model development. As a scientist, Mark has showed unparalleled perseverance in a basic quest for new knowledge, coupled with a keen sense of how to formulate theoretical questions from empirical observations. His genuine curiosity penetrates his love for sports (but only those that do not start with the letter B, as he would be quick to point out), especially the Canadian national sport of ice hockey and American football. Hence, Rogerson's paper on the home field advantage and winning probabilities could not better exemplify Mark's fundamental curiosity about the world beyond the academic playing field. Mark often engages his research mind also in seemingly casual conversations and transforms mundane discussions into the wonder of intellectual exercises and pursuits of fundamental truths. His

meticulous attention to detail and honed ability to create summative lists permeates his research and social interactions, and this in turn often stimulates new ideas, or simply awes his peers and students.

Finally, the papers by Derungs and Purves and by Feng and Sorokine constitute the third category that expands upon Mark's research. Inspired by Mark's ethnophysiological research, Derungs and Purves examined landscape conceptualizations through historical mountaineering documents. They extracted landscape descriptions from approximately 10,000 articles, and linked the descriptions to the geographic footprints of the described landforms. While Mark investigated cross-cultural linguistic variations in naming landform features from field surveys and qualitative interviews, Derungs and Purves developed quantitative methods to automatically identify terms of natural features extracted from a large historical text corpus, dated back to 1863. Their approach explored when, where, and what kinds of landform terms were used to specify landscape features. In other words, Derungs and Purves showed a way to elicit the changing nature of landscape conceptualizations over space and time in Switzerland. Complementarily, Feng and Sorokine examined the categorizations of hydrological and terrain features through official geospatial data standards in the United States, Taiwan, and the Russian Federation. Their comparative analyses suggested that geospatial data standards have strong hierarchical structures in which *IsA* relations serve as the dominant link between pairs of subsumed-subsuming categories. While similar categories exist across the three investigated standards, their meanings vary. Feng and Sorokine thus provided another independent source of evidence for cultural and linguistic differences in landscape conceptualization across varying cultural domains. The mapping of categories across the three studied systems offered a first step to pursue additional data interoperability activities and improved cross-linguistic support for geospatial information retrieval in English, Mandarin, and Russian. Feng and Sorokine's work echoes Mark's pioneering research on contrasting geographic entity types in English and French (Mark 1993). Mark (1993) not only argued, 'classification is one of the fundamental tools of science' but also offered that categorization 'appears to be near to the core of human cognition itself' (p. 270).

While six papers cannot do justice to cover the full scope of Mark's research contributions to GIScience, this special issue nevertheless is intended to bestow highlights of his vast scholarly contributions and significant research impacts. We shall also acknowledge Mark's exceptional achievements in substantiating GIScience education. In 1998, Mark led a team of 15 cross-disciplinary faculty members at the University at Buffalo to develop a truly multidisciplinary and innovative GIScience Doctoral Program and, as a result, received a prestigious US NSF-IGERT award of over \$2.2 million. His leadership propelled the recognition of doctoral education in GIScience not only in the United States, but also across the world with the idea to promote the interdisciplinary pursuit of GIScience doctoral degrees amongst the brightest and finest young minds. His educational successes continued. In 2003, he competitively won a second IGERT award (~\$3.8 million) to renew the Buffalo GIScience IGERT program. Overall, the IGERT program supported more than 50 doctoral level trainees. His remarkable IGERT success in building nationally and internationally recognized multidisciplinary GIScience doctoral programs is outstanding, not only to IGERT fellows at Buffalo but also to GIScience education at large. Dr. Mark has influenced many scholars through the breadth of his GIScience scholarship and depth of his spatial thinking. It was our privilege to work with the authors in compiling this special issue to honor his scholarship and legacy.

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