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EDITORAL

GeoViz: interactive maps that help people think

This issue of IJGIS showcases research activities related to how map displays can support users in visuospatial decision making for solving complex spatiotemporal problems. It represents a selection of the contributions made to a dedicated scientific workshop organized by the International Cartographic Association (ICA) Commissions on Geovisualization and Cognitive Visualization. The workshop was held over 3 days, from 6–8 March 2013, at HafenCity University in Hamburg, Germany.

Sources of spatial data abound. Some spatial data are well-structured, some are messy, and others are streaming in at fast rates. Some data sets are so large that they have been creatively termed 'big data'. Analysing and synthesising these messy, large and fast changing data sets to produce meaningful insights about phenomena and processes provides both computational and cognitive challenges. While computers can provide answers, people are required to make these answers meaningful.

At the same time, the world faces significant problems that are affecting or will soon begin to affect our daily lives: food security, climate change and environmental hazards, traffic congestion, economic crises and biodiversity, amongst others. But both computers and people can do amazing things when tasked with a challenge. These amazing things, however, do not arise out of nowhere. They require a concerted effort to design interactive analytical cartographic representations of these messy, big and potentially rapidly changing data sets; representations that can effectively support spatiotemporal inference and decision making by people (Andrienko *et al.* 2010). Thus there is a need to bring together researchers who can contribute to our understanding of how technology, people and spatial representations of information work effectively together to solve the world's pressing problems.

The specialist workshop brought together 76 researchers from 18 countries working on the design, implementation and evaluation of interactive analytical cartographic representations. The workshop programme was derived from 44 submissions, and included 36 presentations grouped into 12 sessions of regular talks presenting mature research, mini-talks presenting works in progress, and Birds of a Feather discussions about emerging topics such as uncertainty visualization and the use of colour. Based on the reviews of submitted extended abstracts and presentations at the workshop, the guest editors invited authors of the 10 most highly ranked regular presentations to submit full articles to this special issue. Each submission was reviewed by two to three external reviewers and the guest editors to protect anonymity of reviewers. The guest editors handled contributions by two of the conference co-organizers separately, to assure a fair and transparent review process. After several rounds of reviewing, five articles have been accepted for the special issue. These articles exemplify current research directions in geovisualization.

We are very grateful to the reviewers and the authors for their diligent and extremely efficient work. It is notable that the reviewers not only critiqued the articles but also gave concrete recommendations to the authors for their improvement through revision.

Turdukulov and colleagues describe a novel algorithm for detecting flock patterns in trajectory data sets. The proposed algorithm uses transaction-based data representations of

trajectories to generate a database that facilitates the application of scalable and efficient frequent pattern mining algorithms. Systematic comparisons based on one synthetic and two real data sets resulted in a significant performance improvement over existing methods. The algorithm has been integrated into a visual environment. The visual analytics system allows manipulation of input parameters and interactive re-computation of flocks, in addition to visual inspection of the spatiotemporal distribution of flocks in a space–time cube, and interactive selection of interesting flocks for further analysis and verification.

Kinkeldey addresses an important problem of uncertainty visualization in the context of land cover change analysis. The authors identify relevant analysis tasks and suggest a dual-view display that shows uncertainty of changes in their spatial (by noise annotation lines on a map), temporal (by a barcode display in a change info view) and attributive dimensions. The views are dynamically linked and cross-filtered. This allows both the overall assessment of uncertainty and investigation of details of interest. The prototype has been evaluated by several non-professional users and received, in general, quite positive feedback.

Inspired by century-old 2D static perspective panorama maps, Pasewaldt and colleagues introduce novel, real-time, multi-perspective 3D panorama-rendering techniques that can be integrated in various 3D virtual environment applications running not only on static, large-screen desktop systems but also on small-screen, hand-held mobile devices. The authors propose Multi-Perspective 3D Panoramas that effectively combine long-standing design principles from cartography with well-established concepts from information visualization, including state-of-the-art computer graphics rendering techniques. A key component of their 3D panorama solution is a multi-perspective view that seamlessly combines multiple user viewpoints into a single image. In doing so, authors can mitigate occlusion problems and maximize the use of screen space, two typical drawbacks in conventional virtual 3D city and landscape model systems. A first web-based user evaluation produced encouraging results for further development.

Van Dijk and Haunert propose a novel wrinkle to well-established fish-eye map projections or lens distortions in cartography, also known as focus-and-context techniques in information visualization. These map projection algorithms enlarge a particular region of interest (i.e., focus area) in a map, without removing the surrounding map area (i.e., context), and thus without changing a map's original size. The authors extend their own algorithm, developed specifically for network maps, that not only minimizes distortions of the context area but additionally offers real-time performance. This makes their novel algorithm applicable to interactive mapping systems and also attractive in the context of mobile map use with dynamically changing geographic footprints.

Last, but not least, following an iterative, task-based and user-centred design approach, Slingsby and collaborators developed a highly interactive, web-based graphical user interface together with local government to make citizen survey data accessible to the general public. Authors integrate well-established cartographic visualization techniques with novel approaches from information visualization to inform the design of fluid visual interactions with statistical data. This enables a wide range of diverse users to view, compare and interpret information collected by local authorities. Formative user evaluations with local authorities, including passive monitoring of public use by means of keyboard and mouse interaction logs, provides first insights into usage patterns, whilst not interfering directly with user activity. On the one hand, the authors discovered that even when facilitating access to complex statistical data through an aesthetically pleasing and interaction-rich user interface, the public will not necessarily engage more often or in

larger numbers with the data than when data sets are just provided for download. On the other hand, the authors found that their novel visualization approach has been effectively utilized by the local authority in a variety of ways to explore and derive knowledge from their data in ways that have informed local policy and thus may have an effect on future service provision.

In summary, we hope that this selection of articles that describes current efforts in contemporary analytical cartography will be interesting and useful not only for people primarily occupied with analysis and/or visualization of spatial data but also for more general readers as they search for effective technical and graphical means of representing and analysing their spatial and temporal datasets. Doing so should be beneficial as they make maps that help people think in a range of important applied contexts.

Sadly, our colleague Pete Fisher passed away whilst we were writing this editorial.

Pete was well known as a giant in GIScience, a role strongly associated with his editorship of this journal, but perhaps less closely associated with visualization and the successive ICA Commissions on Visualization and Virtual Environments and Geovisualization. Yet, Pete's approach to GIScience and consideration of uncertainty was highly dependent upon visual representation and exploration, and he was a notable cartographic innovator. We'd like to acknowledge his significant contributions to the advancement of ideas that have led to interactive and engaging maps that reflect uncertainty and act as interfaces for data exploration.

Pete was an important contributor to the 'Visualization in Geographical Information Systems' meeting in Loughborough in the early 1990s. His animated and sonified maps brought to life the uncertainties associated with the classification of land cover from remotely sensed imagery. The combination of his imaginative ideas, enthusiastic presentation and seemingly uncontrollable bleeping maps brought the house down. But they delivered an important message about cartographic possibilities, the dynamism and uncertainty associated with the worlds we were trying to represent and made an important and lasting impression. At this time Pete led on a paper for the *Cartographic Journal* in which the synergies between cartography and scientific visualization were detailed with the two PhD students he inherited at Leicester (Fisher *et al.* 1993). The article drew attention to a rich vein of possibilities that his co-authors have been working on ever since.

The Loughborough meeting resulted in the *Visualization in Geographical Information Systems* book (Hearnshaw and Unwin 1994) and was attended by many of those who went on to establish the ICA Commission in Visualization in 1995. Pete edited a follow-up book on 'Virtual Reality in Geography' with Dave Unwin several years later (Fisher and Unwin 2003), the result of a similar workshop at which visualization and its role in geographic enquiry were the focus.

We can't remember which ICA Commission meetings Pete attended, but he was always supportive as a contributor and reviewer and as an advocate for visualization. He encouraged members of his group at the University of Leicester to attend commission meetings, and several papers resulted from Pete's contributions in this way over the years. Pete was superb at establishing an environment for creative research that pushed the boundaries of mapping, and the influential cdv and LandSerf software packages were developed at Leicester in close association with Pete in this context.

Indeed, the 1998 paper 'Is GIS Hidebound by the Legacy of Cartography?' (Fisher 1998) acts as a rallying call for cartographic visualization and is still a great read for those developing interactive maps. The clear expression of a need for effective software design 'to transform … data into intelligible views and exploratory tools' remains sharply pertinent nearly 20 years later. It's what we're all trying to do in the Commission, and

it is, in broad terms, what the authors of the articles in this special issue are attempting to achieve despite the cartographic legacy as we use maps in new ways in the age of data. It's always well worth a read.

Perhaps even Pete underestimated how hidebound we all were by the traditional map. We shouldn't underestimate his influence on the development of a new cartographic legacy – that of the dynamic map that enables us to make sense of dynamic phenomena and difficult data through creative, informed and effective visualization. Let's keep making these and improving the way in which we do so, whilst acknowledging some of the great ideas, enthusiasm and other efforts of one of the great contributors to our discipline: Peter Fisher, innovator and pioneer in visualization in GIScience. The guest editors are Gennady Andrienko and Sara Irina Fabrikant, and the GeoViz Hamburg 2013 workshop co-organizers are Amy L. Griffin, Jason Dykes and Jochen Schiewe.

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