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Geovisual analytics: design and implementation

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EDITORIAL

Geovisual analytics: design and implementation

This special issue presents a series of papers that document the state-of-the-art research on the topic of geovisual analytics. The special issue is presented as two parts. This first issue, comprising of four papers, is focused on *design and implementation considerations in geovisual analytics* (Part I). Part II will follow, with an additional four papers, which is focused on the *human factors in geovisual analytics*.

Geovisual analytics is frequently defined as "the science of analytical reasoning facilitated by interactive visual interfaces" (Thomas and Cook 2005). Design and implementation are both critical elements underpinning the theoretical and practical constructs of geovisual analytics. Especially with the advent of recent developments in the areas of big data and smart cities (Batty 2012), geovisual analytics theories, tools and techniques are increasingly important to develop and support such endeavours. Each of these developments is integral to the functioning of Digital Earth applications and to the achievement of the Digital Earth vision, which includes as one of its pillars 'visualisation and exploration' (Foresman 2008).

The agenda of Digital Earth is becoming increasingly important as society tackles significant challenges including, the growth and ageing of the population, the continued growth of urban settlements and the subsequent decline in rural communities and a changing climate, to name just a few of these challenges. Geovisual analytics in the context of the Digital Earth is assisting in the realisation of techniques and technologies that can be used to plan for a sustainable, productive and resilient global future. The design and implementation of such geovisual analytics tools and techniques are crucial if we are to begin to address the concerns as outlined by Carson (1962) in her seminal work *Silent Springs*, which created a societal awakening of the impacts human behaviour has on our environment.

In this special issue, you will find an expert discussion on the *definition of a map*; centred around Beck's famous London tube "map", asking the question 'is this a diagram or a map?' and challenging the relatively established and common thinking that a map is a precise geometric expression of what we see (Cartwright 2014). Cartwright offers a philosophical view as well as an expert community survey on the topic, and studies the slightly provocative, yet fundamentally important question as to how should we really define a 'map'. The tension between where map design starts and stops and where engineering (through the use of geographical information systems) begins is a challenging concept earlier raised by Cartwright (2004) as he annunciated the concept of 'Engineered Serendipity'. This is an important concept to ponder when designing and implementing visualisation and exploratory tools, which support different ways of accessing, analysing and interrogating geospatial data.

We live in a world which transcends two-dimensional map space and it is critical for geovisual analytics design and implementation to (re)consider the third dimension (3D).

The advent of virtual globe technology in the early 2000s with the release of such platforms as Google Earth and NASA's World Wind has seen a proliferation of more user friendly windows into geospatial data and ways to move beyond the two-dimensional map (Aurambout, Pettit, and Lewis 2008). The work of Shojaei et al. (2014) looks at building upon such advances through the design and implementation of an online Google Earth WebGL prototype visualisation platform which provides an important foundation to realising a 3D cadastre. As the rapid urbanisation of our planet continues it is becoming increasingly important to be able to visualise and analyse the built environment in the third dimension. Hence, the design and implementation of a 3D-view prototype platform that considers its users closely, as reported by Shojaei et al. (2014), and supports specialists including: land surveyors, land registrars, city managers and building managers, are crucial for the future planning of sustainable cities.

To further support the visualisation of city data and the associated activities of urban researchers, designers and planners in interacting with these data; the dynamic linking of digital views offer exciting possibilities. Widjaja et al. (2014) have designed and implemented a solution for the dynamic 'brushing' between different data views, from map to graph, chart and tabular views of heterogeneous data. This coordinated multiple views (CMV) solution supports geovisual analytics of complex data cubes and has been initially developed and tested in the context of Australian cities. Both Widjaja et al.'s CMV solution and Shojaei et al.'s 3D Cadastre offer important advancement in supporting the interrogation and visualisation of big data as we embrace the revolution of smart cities (Batty 2012).

It is also important to realise geovisual analytics solutions beyond urban landscapes as natural systems and environmental well-being are significant elements to the vision of Digital Earth (Foresman 2008). The work by Benke et al. (2013) provides a novel design and implementation of a geovisual analytics approach as a rural landscape design decision support framework. This research takes into account spatial-temporal datasets based on ruminant behaviour captured using GPS collars attached to the animals. The benefits of such a geovisual analytics approach is to provide further insights into animal behaviour within the paddock which has environmental impacts in the form of nitrogen emissions which, in turn, can have broader impacts on rural environment if such nitrogen deposits happen to be close proximity to waterways. Such work is important as it takes into account a 'systems thinking' approach to understanding the complex interactions that occur within our landscapes.

These four papers provide a potent collection of contributions pertaining to the design and implementation considerations pertaining to the emerging interdisciplinary field of geovisual analytics. Below you will find a more precise summary of each paper:

The first paper of this special issue opens with a fundamental discussion on the definition of the word *map* (Cartwright 2014). The paper introduces us to various formal definitions and following that, introduces a qualitative survey on Beck's iconic London representation that is commonly called "the Tube Map". Cartwright (2014) provides input from 83 international experts, and offers a rigorous examination of the terms *map* and *diagram* based on their input as well as other authoritative sources. The concept *diagrammatic map* is also considered. Cartwright (2014) suggests that we should rethink whether absolute geographic positions are necessary for a representation to be called a map. This paper offers a healthy intellectual discussion bridging a more technological view with a more design view based on a qualitative expert survey.

The second paper of the special issue presents a review of the latest technology on 3D visualisations for cadastral use and assesses existing solutions in the context of user requirements (Shojaei et al. 2014). Taking a user-centred approach, the paper also offers a prototype visualisation solution based on user requirements, implemented in WebGL and Three.js. Based on the prototype, further expert input was collected and the implementation appears to be appropriate for the purpose and bears promise for an efficient Web-based solution as it transfers important operations to graphics processor unit (GPU). The implementation may enable the import of 3D objects and property management for cadastres in a flexible, platform-independent manner as WebGL and Three.js will run in any modern browser and computer.

The third paper by Widjaja et al. (2014) tackles the issue of how to support the visualisation of the vast array of data relating to cities coming from disparate sources. This research focuses on the development of a solution for coordinated multiple views (CMV) in the context of a web-based environment implemented as part of Australian Urban Research Infrastructure Network (AURIN) portal. The CMV approach is applied to *data cubes* which are subjected to hierarchical dimensioning. The solution currently works for data that aligns to one of Australian Bureau of Statistics (ABS) standard geography categories. It enables end users to the AURIN portal to dynamically brush across map, graph and tabular data to support on the fly visual exploration of the rich tapestry of data comprising Australia's urban settlements.

The fourth and final paper in this special issue is by Benke et al. (2013) and focuses on a geovisual analytics framework to enhance the understanding of the spatial-temporal movements of sheep through their grazing behaviour and in particular N emissions. This is done through the development of a multi-agent model in the context of sheep movements in a paddock taking into account data inputs such as weather, land use and animal location logged using GPS. Algorithms entered into the model included behaviour rules, risk assessment and uncertainty and performance indicators. The output data comprised plots, maps and statistical data that can be visualised both spatially and aspatially. In this research, a geovisual analytics implementation provided a means to assist decision-makers (farmers and natural resource management) as it visually synthesises large amounts of data and deal with the problem of information overload. This research provides a very real example of how geovisual analytics can assist with the bridging the gap between research and policy and decision-makers by being able to visually display complex spatial-temporal data in way which invite the end user to explore the modelled results.

Concluding remarks

As we begin to carefully examine what is truly possible in terms of geovisual analytics, there is a need to take into account the important elements of design and implementation. This special issue has provided a collection of insightful papers which challenge our thinking in how to design and implement geovisual analytics tools and techniques which can help shape the future of our planet. With the advent of big data and smart cities, data visualisation techniques are becoming increasingly important as also acknowledged by Cheshire and Batty (2012). There is a need to be able to more easily circumnavigate our cities, both in real and virtual environments, and to better understand the dimensions of space and time. Likewise, there is a need for the design and implementation of geovisual analytics tools and techniques to gain critical insights into how to reduce our ecological footprint and preserve the natural environment. There has not been a time in history where society has been more globally connected and this presents exciting opportunities for realising the vision of Digital Earth. At the same time, we are increasingly living in a digital world and a focus on the intersection between *digital* and *human* concepts is needed to harmonise our efforts in solving the pressing issues of our time. Geovisual analytics in many ways offers us opportunities to further explore the digital landscape comprising of geospatial data, information and knowledge and push the boundaries of what is possible within the human condition in reasoning across space and time to deal with complex problems.

This has been the first of two special issues on geovisual analytics. This issue has focused on the important aspects of design and implementation. In the next special issue we will focus our attention on the deliberation of human factors as it is absolutely critical that we understand how people use, interact and learn from the emerging interdisciplinary field of geovisual analytics.

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