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Guest Editorial

Developments in Quantitative Human Geography, Urban Modelling, and Geographic Information Science

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This special issue of Transactions in GIS presents ten research articles selected from the 18th GIS Research UK (GISRUK) conference that took place at University College London (UK) in April 2010, on the theme of 'Tackling Global Challenges'. These contributions provide a vivid account of the novel and interdisciplinary approaches being currently developed to tackle a variety of global geospatial challenges. Our selection illustrates ways in which complex and dynamic problems can be tackled through bridging the gaps between long-established technical and epistemological silos within the broad community that we here describe as 'Quantitative Human Geography, Urban Modelling and Geographic Information Science' (hence the title of this editorial).

The ten contributions in this issue comprise a diverse range of application areas including: historical urban growth; businesses and retail location and dynamics; crime and health disparities; house prices; agricultural land uses; animal tracking; and pedestrian wayfinding. Nonetheless, behind such apparent diversity lies a methodological interest in tackling a set of three core research questions: urban classification and modelling; point pattern detection; and individual trajectories' analyses. Despite each article adopting a particular angle and domain in which to solve these issues, there is striking overlap along several dimensions. The articles can be grouped according to the spatial ontologies and data models underlying their analysis, including: surfaces (Stanilov and Batty; Brunsdon; Elaalem, Comber and Fisher), polygons (Weber and Chapman; Chaudhry and Mackaness), points (Dearden and Wilson; Leibovici et al.), networks (Shiode), and trajectories (Laube and Purvess; Schroder, Mackaness and Gittins). Some contributions specifically tackle recurrent yet unsolved methodological issues, such as the effect of spatio-temporal scale (Stanilov and Batty; Laube and Purvess; Shiode), the participatory value of spatial analysis (Dearden and Wilson; Weber and Chapman; Schroder, Mackaness and Gittins), the automatic detection of patterns, associations and

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causality (Chaudhry and Mackaness; Brunsdon; Leibovici et al.) and fuzzy membership (Elaalem, Comber and Fisher). In terms of modelling approaches and common research methods, we find an innovative range of proposals borrowing and adapting techniques from a plethora of disciplines and domains of knowledge, such as biological sciences, image processing, urban planning, physics, earth sciences, crime science, marketing, economics and others. For example, we find the use of cellular automata and agent-based models (Stanilov and Batty; Dearden and Wilson), Monte Carlo simulation (Laube and Purvess), kernel regression and density estimation (Brunsdon; Chaudhry and Mackaness; Leibovici et al.), Spatio-temporal Scan Statistics (Leibovici et al.; Shiode), and Analytical Hierarchical Process (AHP) (Elaalem, Comber and Fisher; Weber and Chapman).

We will briefly introduce the contributions of each article loosely organized around the stated three core research issues.

Urban Classification and Modelling

This group of papers focuses on classifying patterns of urban form and function at a variety of spatial scales, with some authors additionally modelling the dynamic temporal evolution of these models.

Stanilov and Batty present a model of the historic urban growth of London between 1875 and 2005. Implementing a cellular automata approach, they outline key determinants of urban growth and land use in the west of the city. Their model is based on a rich database of historical cartography modelled at a very fine spatial and temporal scale. They conclude that spatial relationships between urban land uses and the physical environment are surprisingly consistent through time and highly path-dependent on initial conditions. These relationships constitute what they term a 'genetic code' or 'spatial signature' that determines the probabilities of urban land development in any given metropolitan area. As they point out, it would be very interesting to compare this model with other global cities to illustrate how much their urban growth genetic codes diverge.

Dearden and Wilson propose the use of participatory simulation and visual analytics as a method for modelling the evolution of complex urban systems. They develop an agent-based model of regional retail planning for South Yorkshire, UK, comprising a series of 'retail games' between developers, shops and shoppers across a variety of geographical scales. They conclude this approach to be a valuable asset in providing effective model validation, testing and critique; and to gain a better understanding of self-organizing processes that inform urban dynamics, than would likely be possible with static and expert-led approaches to urban simulation.

Chaudhry and Mackaness develop an automatic procedure to classify retail spaces from a large scale topographic database. By analysing the form, composition, extent and footprint patterns of buildings together with centrality and accessibility indicators, they come up with an automated algorithm to delineate the extent of retail spaces and classify them into a set typology of retail uses. In the age of ubiquitous information about almost everywhere in our cities, they demonstrate that inferring urban function from cartographic form is a very plausible alternative in the delineation of retail spaces.

Weber and Chapman introduce a business location intelligence system to attract inward business investments to London. They build a decision support tool to explore and rank London's business neighbourhoods according to investor requirements. Their innovative approach combines a bespoke geodemographic classification of geo-business neighbourhoods, with investors' decision making preferences using an Analytical

Hierarchy Process (AHP) technique. They present the evaluation of a prototype tool developed for a London business development agency.

Finally, Elaalem, Comber and Fisher compare the performance of two methods to assign fuzzy membership to surfaces of non-urban land uses: Analytical Hierarchical Process and Ideal Point. Their illustration determines the suitability for wheat crop production in Libya, concluding the importance of correctly assigning weights to each variable in the model according to opinions gathered from local experts in the field.

Point Pattern Detection

Much human activity can be represented as a cloud of points with a spatio-temporal location and other associated attributes. The increasing and dynamic availability of these types of data are driving a demand for new methods that quickly and intuitively transform these raw geographic entities into insightful information through detecting hotspot patterns, associations and trends.

Leibovici et al. develop a solution for the problem of establishing spatial associations between hotspot maps derived from multidimensional population phenomena. Their solution is based on a spatial scan statistic and a set of simulation algorithms for various neighbourhood sizes, kernel functions and measures of association between clusters. They demonstrate the potential value of this approach with an application developed in R that models the health outcomes of different population age groups to an episode of a contagious disease.

Shiode proposes a new approach to crime hotspot detection when distance is constrained in network space. She proposes the concept of the network-based search window (NT-SW), a dynamic point pattern kernel that follows the street grid to detect hotspots of crime incidents by adapting conventional spatio-temporal search algorithms; STAC and SaTScan to a network topology. This is an interesting proposition since most human activities occur in public or private spaces that can only be accessed through a convoluted street network, and hence much more constrained in practice than under the two-dimensional plane underlying most hotspot models.

Brunsdon develops a method of trend surface fitting over point locations with the ability to identify potential sharp discontinuities in such surfaces. Adapting an algorithm from the field of image processing to detect object boundaries, he proposes a novel approach termed Bilateral Kernel Regression (BKR). This is applied to a house price point dataset to automatically detect sharp discontinuities in housing market values, validating the robustness of their assignment. This approach is extremely useful for detecting unexpected discontinuities in human phenomena when no prior information is available on the expected geographic dynamics or the characteristics of the study area.

Individual Trajectories' Analysis

The last two articles relate to a new and growing problem for spatial analysis; individual trajectory data. Although initially collected as a set of points with a spatio-temporal location, as specified in the previous point pattern analysis section, the manipulation of these points is completely different since their time and sequencing acquire a totally different fourth dimension in these studies (issues of path, direction, speed, sinuosity, flows, temporal cycles, etc). Laube and Purves argue that the GIScience community has

yet to develop adequate methods that take into account the high levels of uncertainty associated with changes in the spatio-temporal scale and measurement error in the interpretation of trajectory data. They investigate these effects using individual trajectories from ten cows and Monte Carlo simulation, demonstrating how one of such sources of uncertainty, the effect of spatio-temporal sampling, termed *granularity grief*, operates in practice.

Lastly, Schroder, Mackaness and Gittins investigate the role that recognizable landmarks and direction of approach to them play in pedestrian wayfinding with an aim of improving automatic route direction descriptions in pedestrian navigation systems. They devise a series of user experiments to understand perceptions of the salience of landmarks and preferences in interpreting route directions in pedestrian trajectories. They conclude that pedestrian navigation is much more complex than car navigation. Hence, it requires a nuanced understanding of the rich environment that surrounds the pedestrian and in-depth knowledge about the variety in human perception of such environments and the instructions provided to navigate through it.

In presenting this special issue we hope to illustrate the interdisciplinary approaches being developed in the contemporary spatial sciences to tackle key research problems through novel contributions in quantitative human geography, urban modelling and Geographic Information Science. The GISRUK conference series (http://www.geo.ed.ac.uk/gisruk/) has proved a key platform to disseminate and enhance such innovative approaches, highlighting the diversity, vibrancy and increased maturity of this research community. We would like to thank the editors of Transactions in GIS for their support in publishing this special issue, the national and local organizers of GISRUK 2010 and above all the contributors to this special issue.

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