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INTRODUCTION

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ABSTRACT

With the emergence of new forms of geospatial/urban big data and advanced spatial analytics and machine learning methods, new patterns and phenomena can be explored and discovered in our cities and societies. In this special issue, we presented an overview of nine studies to understand how to use urban data science and GIS in healthcare services, hospitality and safety, transportation and mobility, economy, urban planning, higher education, and natural disasters, spreading across developed countries in North America and Europe, as well as Global South areas in Asia and the Middle East. The embrace of diverse geo-computational methods in this special issue brings forward an outlook to future GIS and Urban Data Science towards more advanced computational capability, global vision and urban-focused research.

KEYWORDS
GIS; urban data science; urban analytics; informatics

Background

In the information age (Castells 1998), new forms of urban big data demand an in-depth understanding and diversified interpretation of human interactions with contemporary society. Urban Informatics (Shi et al. 2021) has surged as an interdisciplinary subject encompassing urban data science, informatics, GIS, various information and communication technology, big data analytics, smart cities, etc., and encourage people from academics, industry and public sectors to jointly explore the open data emerging in the context of urban environments (Foth, Choi, and Satchell 2011), such as social media data (Wang and Li 2021; Wang, Gerber, and Brown 2012; Chen, Cho, and Jang 2015), mobile data (Bogomolov et al. 2014; Ros'es, Kadar, and Malleson 2021), Geolocational data (Kikuchi, Amemiya, and Shimada 2012; Hutt, Bowers, and Johnson 2021; Song et al. 2019; Tu et al. 2021), image data (Law et al., 2020; Woodworth et al. 2014; Liu et al. 2020) and video data (Ashby 2019; Lindegaard and Bernasco 2018). It has often been applied to visualize the digital information from the society we reside in, to interpret the human interactions with surrounding urban socio-economic environments, and to provide data-driven evidence for decision-making and industrial innovation.

In parallel boom of 21st century’s development of computer science and data visualization, GIS, geocomputation and urban analytics research methods, such as Kernel Density Estimation (KDE) (Bailey and Gatrell, 1995), geographically weighted regression (Cahill and Mulligan, 2007; Fotheringham, Brunsdon, and Charlton 2002), spatial autocorrelation and regression models (Anselin, 2009), spatio-temporal Bayesian modelling (Hu et al. 2018; Haining and Li 2020; Law, Quick, and Javadi 2020), Risk Terrain Modelling (RTM) (Caplan, Kennedy and Mille 2011), etc., had been utilized widely in urban fields, such as healthcare accessibility (Kim, Byron, and Yeo 2018), services resilience especially against the pandemic (Li, 2021); urban safety and crime mapping (Hart, Lersch, and Chataway 2020), crime pattern detection (Chainey, 2020) aggregated at street segments (Tom-Jack, Bernstein, and Loyola 2019) and urban mobility (Sinclair et al. 2021; Sarim et al., 2021), hence brings forward the essentiality to apply such computational techniques in a geographically holistic sense. The special issue of Annals of GIS on GIS and Urban Data Science had compiled nine novel and original manuscripts demonstrating research on the main aspects of geo-informatics applications in urban contexts, in the hope of drawing follow-up inspirations towards further contributions to the literature.

Overview of this special issue

The articles included in this issue make significant contributions to the research in GIS and urban data science. These nine papers represent the diversity of urban data applications in different sectors, healthcare services (e.g. hospital services), hospitality and safety (e.g. Airbnb and crime), transportation and mobility (e.g. bike sharing),...
economy (e.g. retail business and labour force), urban planning (e.g. nightlight data), higher education (e.g. big scholarly data) and natural disasters (e.g. winter storm) across broad regions in North America, Europe and Asia, as depicted in Table 1. In combination of administrative data (e.g. Census) with the emerging forms of data such as bike sharing, airbnb, tweets, or night time light images, rich methods had been deployed including traditional (spatial) statistical or optimization methods such as OLS regression, GWR, and MCLP, as well as some advanced methods from GeoAI such as spatial clustering, travel pattern recognition, and text mining.

**Outlook to the future**

Computational methods and data sciences are transforming the conventional GIS into a new comprehensive discipline, with the notation of urban analytics, location intelligence, and more recently GeoAI (Janowicz et al. 2020; Kandt and Batty 2021). As showcased in the paper on this special issue, geospatial research has been applied in various applications, e.g. transport, retail, social interactions, using conventional methods, e.g. OLS regression; kernel density estimation and comparatively more recent computation methods, e.g. spatial network analysis and density-based spatial clustering methods. In pursuing further advancements in GIS and data, the next three sub-outlooks present a research agenda for achieving such objectives.

**Advanced computational methods**

A clearly pointed research direction is to build on the knowledge and skill around the different domains. We see how much GIS has been advanced by new computational methods and the ‘invasion’ of data science. This trend will continue, as the 5Vs of big data challenge the conventional GIS way of handling and analysing data. Moreover, domain knowledge becomes even more important to assist and solve real-world problems with the support of AI.

**Table 1. Publication summary of the special issue.**

| Publication | Topic | Data | Spatial scale | Methods |
|-------------|-------|------|---------------|---------|
| Wang & Wang (2022) | Hospital services | • 2011 State Inpatient Databases (SID) of Florida (2,992,066 records); Zip Code Tabulation Areas (ZCTAs) | City (Florida, US) | • Refined Dartmouth method for defining HSAs; Spatialized network community detection methods for defining HSAs (constrained Louvain method-ScLouvain, and spatially constrained Leiden method-ScLeiden); 3 quality measures for HSAs: localization index (LI), geographic compactness, and balanced region size. |
| Bearisto et al. (2021) | Sharing economy | • Bike sharing data from Nextbike Glasgow (2018–2019) | City (Glasgow, UK) | • OLS regression • Two-step floating catchment area (2SFCA) methodology • Maximum covering location problem (MCLP) |
| Hladik et al. (2021) | Retail services | • Places data from Facebook Graph API (6,800) | City (Brno, Czech Republic) | • Choropleth map • Nearest Neighbour Index • Kernel density analysis • Normalized Difference Index • OLS regression • GWR model with Monte Carlo non-stationarity test |
| Maldonado-Guzmán (2020) | Crime and sharing economy | • Number of crimes against property and people in 2017 (55,911) • Airbnb lodging (InsideAirbnb) • Census data | City (Barcelona, Spain) | |
Global vision

The vast amount of data being generated around the world provides a unique opportunity for globally collaborative research and comparative studies of regions. Unlike in the old days, most research is based on locally generated data. Nowadays many data sets are available globally in a uniform format, for instance, Airbnb, Twitter, and Google mobility. It is now promising to promote the global research community and solve problems collectively. In particular, most of the research is in the context of developed countries and more attention needs to be given to the developing countries in the Global South and marginalized groups.

Urban focused research

As most of the world’s population is moving to cities (UN report, 2018), they also generate new urban challenges, e.g. social inequality, housing issues, ageing society, and health hazards. Data-driven methods have been proposed and demonstrated in this special issue to further tackle these problems, but more research and exploration need to be investigated to generate practical solutions and policy implementations for different urban issues.

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