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Applications and issues of big data in tourism research

Scott Peters
Simon Fraser University

Peter Keller
Simon Fraser University

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Introduction:

This paper explores the current applications and associated issues surrounding Big Data in tourism research. Following a brief introduction of Big Data, we explore common Big Data sources and their methodologies for tourism studies including search engine data, webpage and booking data, user generated content (UGC), and device data. We identify opportunities, challenges and recognized concerns Big Data brings to tourism research. Using Canadian Federal legislation as an example, we then explore broader challenges associated with access and use of Big Data in tourism, including issues of ethics and judicial challenges related to privacy laws and legislation. We conclude with speculation what possibilities Big Data will bring to tourism research going forward.

Big Data

Big Data is not just a lot of data, nor is it a singular entity. There is no universal agreement for a definitive definition for Big Data and it is better thought of as an umbrella term. Big data addresses the opportunities, challenges, analyses and trends associated with huge volumes of data caused by an expanding and diverse collection of entities continuously generated around the world by and about people, notably via smart sensors and devices (Wu et al., 2014; De Mauro et al., 2016). Big Data recognizes that there are significant challenges as well as opportunities dealing with massive amounts of data and their fusion. Big Data therefore is more about the challenges that define it, as well as the steps that are being taken to overcome them. One could think of Big Data as a loose collection of tools, technologies and techniques that address three key areas: storage, processing, and analytics. It's the integration of these three areas with the 3 V's associated with Big Data (volume, velocity, variety) that give it its current taxonomy (Clarke, 2016; Li et al., 2018a).

Big Data has attracted the attention of tourism marketing, planning and research with a number of emerging trends. In order to make sense of these trends, we separated Big Data streams into four broad categories: 1) Search engine data, 2) Webpage and Booking data, 3) User Generated Content (UGC), and 4) Device data. Below we introduce and review each category and associated subcategories and discuss their potential to offer new insights into tourism, as well as what issues and concerns there may exist.

Search Engine Data

Search engine data are those that record where and how on-line search engines are used to seek information. Search engine data have been used in tourism research primarily to predict tourism volume at a variety of geographic scales, from tightly bound destinations like resorts and cities to larger tourism regions and entire countries (see Table 1). Search engine data do look to be a strong indicator of visitation numbers that can be further refined by combining them with other data and machine learning (Sun et al., 2019) including data streams like regional

weather data (Bi et al., 2020). The main engines that look to have been studied are Google and Baidu, with the accompanying services of Google trends and Baidu index as key data sources (Li et al, 2018a). These data have been used to establish and adjust pricing for variations in demand (Divino and McAleer, 2010), to manage staffing levels, and to more generally anticipate and address periods of unusually high (or low) demand (Li et al., 2018b).

Table 1		
Region	**Search Engine(s)**	**Author(s)**
Vienna, Austria	Google	Gunter and Önder (2016)
Beijing, China	Baidu and Google	Sun et al (2019)
Forbidden City, China	Baidu	Huang et al (2017)
Jiuzhaigou and Huangshan Mountain Area, China	Baidu	Bi et al (2020)
Hainan Province, China	Baidu and Google	Yang et al (2015)
Cyprus	Google	Dergiades et al (2018)
Puerto Rico	Google	Rivera (2016)

These data also facilitate Search Engine Marketing (SEM) and Search Engine Optimization (SEO). The assist creation of advertisements and decision where and how to post them especially in a cost-per-click model used by Google to charge advertisers (Angeloni and Rossi, 2021). These data offer insights into keyword selection to drive users to a website.

Webpage and booking data

Of significant interest especially to destination marketing and the tourism service industry are data about web page use, how webpages are navigated, and on-line bookings (e.g. for hotels, alternative lodging, or activities like theme parks) (Plaza, 2011; Ghose et al., 2012; Saito et al., 2016). Analyses of page visits, return visits, bounce rates, direct vs. indirect visits etc. as well as sequence of page visits offer useful insights into expressions of interests and eventual success rate (bookings) as well as assisting with product pricing (Plaza, 2011; Ghose et al., 2010; Saito et al., 2016, Zhang et al., 2019).
.
A challenge here is that these data usually are safeguarded by the entities that oversee them (i.e. the hotels, travel agencies, or webpage owners) limiting their access for curiosity based research and to establish best practices of analyses and interpretation as well as to seek novel and interesting insights.

User Generated Content Data

User generated content data (UGC) consist of the posting of information on social media platforms. UGC data are abundant and growing, but not necessarily always easily or directly accessible.There are two types of UGC Data: Online textual data and online photo data.

Online textual data refers to the posting of information on various social media platforms such as Twitter and Facebook, or online blog and review sites, of which TripAdvisor is by far the most prominent data source but Yelp, Expedia and personal blogs have also been used in some studies (Lu and Stepchenkova, 2012; Xu and Li, 2016; Guo, et al., 2017; Liu, et al., 2017; Li et al, 2018). Online textual information yields insights into tourists' likes and dislikes, preferences, price sensitivities, responses to policies, and perceptions as well as behaviour.

The other major source of UGC data are the photos posted to various social media platforms and other online services. These photos uploaded by tourists contain a wealth of useful information in relation to users, locations and times, especially if the photos are geotagged. These provide a new perspective to study tourist behaviour (Vu, et al., 2015), tourism recommendations including preferred spots and travelling plans (Lee, et al., 2014; Zhou et al, 2015), and tourism marketing (Deng and Li, 2018).

Device Data

Device data include data capture of a tourist's location and mobility through Global Positioning Systems (GPS) recordings, roaming data and Radio Frequency Identification (RFID). It is speculated that as the Internet of Things (IoT) becomes more prevalent in tourism applications (Wang et al, 2020) device data will generate a massive amount of high quality data (Shoval and Ahas, 2016). So far, GPS data have been the most utilised by tourism researchers to track the whereabouts of tourists as well as their specific movement patterns on site (e.g. McKercher et al., 2012; Zakrisson and Zillinger, 2012; Beeco et al., 2013), especially with the development of mobile apps that are able to replace the expensive and cumbersome stand-alone GPS loggers (Ayscue et al., 2016; Brovellie et al., 2016). Beyond tracking personal devices, there are a plethora of other ways to gather mobility and movement data capitalising on GPS and video surveillance including site specific multiple point video recordings, tracking bicycle sharing services, monitoring rented vehicle movements, and recording movements of chartered yachts.

Big Data Dilemmas: Ethical considerations

Tourism is in an exciting period transitioning from data scarcity to possibility of data superabundance (Weaver, 2021) in an instrumented universe and a surveillance world. This will only continue to be exacerbated as computing technology and adaptation of social media and mobile technologies continue to spread and advance.

There are three categories of Big Data stakeholders: Big Data collectors, Big Data utilizers, and Big Data generators (Zwier, 2014). Big Data collectors determine the 'what' and 'why' data are collected as well as how they are collected and where they are collected from. They also determine who can access them, and how long they are stored. Big Data collectors may collect the data with or without purpose, but as surveillance capitalism continues to grow and be a source of power (Zuboff, 2019), the days of unutilized data may be already passed. Big Data utilizers are the production side that (re)defines the utilisation of the data by articulating needs and wants, by imposing order on data collection, and by creating new innovation and knowledge by combining datasets or otherwise being able to manipulate them in an advantageous way. Big Data generators encompass a broad category comprising artificial actors (i.e. sensors) and natural actors (i.e. people) that voluntarily, involuntarily, knowingly and unknowingly generate a staggering amount of data. Challenges begin to arise because of the uneven power dynamics that exist between these groups as Big Data is becoming more commonly adopted and integral to business and politics.

So far there has been a lack of meaningful oversight able to keep up with the rapid development and associated possibilities of Big Data. Technology and its application make it possible for individuals today to be located and tracked, and to access what they post verbally and pictorially as well as express likes and dislikes on the web. All while allowing ownership of these data to belong to corporations, and in the absence of full awareness how these data are potentially used (Zwiller, 2014). The reality that vast amounts of data about individuals and groups today are acquired by data scraping and web crawlers is however being challenged by those with concern over lack of informed consent, the right to privacy and otherwise ethical use.

Tourism is part of commercial enterprise and economic activity that have potential to gain significant competitive edge and profit from participating in Big Data. How tourism will embrace and take advantage of Big Data is being informed by contemporary and emerging practices in other areas of marketing, service delivery and behaviour manipulation, with concern that this exacerbates a world where revenue and numbers take precedence over people (Weaver, 2021). Productive, ethical and meaningful use of Big Data in tourism will likely be a growing area of research

What is often overlooked are issues of data quality and the challenges that arise from consolidating multiple datasets, repurposing data, and applying analytical tools to the resulting datasets (Clarke 2016). Some aspects of data quality already are addressed (e.g. the possibility of fake reviews or inaccurate GPS or mobile roaming data). However, data quality is a topic of contention in Big Data analytics that tourism researchers will find fertile ground to participate in.

Today we know relatively little about how Big Data is used in decision making. Zwitter (2014) argues that the very nature of Big Data challenges and impacts our ability to really understand its potential, and to make informed decisions based on Big Data. An example of this captured in Merendino et al.'s (2018) investigating how Big Data has disrupted board level decision making processes. Their study yielded important findings in three areas: Individual cognitive capabilities, challenges of board cohesion, and impacts on responsibility and control within

senior teams. This will be a rich area for study in tourism related decision making on both, the supply and demand sides.

Big Data generally are device and proprietary software dependent. There do exist sectors within tourism that collect their own primary Big Data, notably very large corporations (hotel chains, car rental agencies, …) and booking agencies. Otherwise Big data usually are secondary data belonging to a third party, making them expensive and challenging to access and analyse. Beyond doubt, Big Data today already is used widely and effectively by large corporations active in the tourism industry, including the transportation, accommodation, and food and beverages sectors as well as those on the large scale attraction supply side (events, conference planning, themed attractions, …). These tourism industries are likely to use Big Data competitively behind closed doors in a proprietary manner. Their insights, their best and worst practices, and their findings are unlikely to reach the public except in the exception where there is a willingness to collaborate and share publicly. There therefore will be a lag between what is published in peer reviewed journals and textbooks and how the tourism industry actually uses Big Data.

At the risk of overgeneralization, Big Data tends to be collected, controlled and analysed by corporations operating with little oversight or expectations of accountability. While they must operate within existing legislation and should pay attention to ethical consideration, they often operate at a cutting edge ahead of legislation or where an ethical conversation so far has not considered the relevant issues.

Judicial Complications: A Canadian Example

The reality is that courts and policy makers often struggle to keep up with the rapid advances of technology, and Big Data is no exception. For example, *Dinerstein v Google* showcases how the US Health Insurance Portability and Accountability Act (HIPAA) is starting to show its age and is not equipped to tackle 21st century problems (Cohen and Mello, 2019).

However more than 100 nations now have data privacy laws, typically requiring organisations to collect personal data only for an express purpose and not to re-use these data for unrelated purposes. What all this boils down to is that Big Data and its integration into the tourism industry is fertile ground for investigation. In order to examine this in a real-world context, we reviewed Canadian privacy and data laws to better understand their relevance to tourists and Big Data use by the tourism industry in Canada.

The Privacy Commissioner of Canada (PC) and the Office of the Privacy Commissioner of Canada (OPC) oversee compliance with the Canadian Privacy Act (this Act covers the personal information-handling practices of federal government departments and agencies) and the Personal Information Protection and Electronic Documents Act (PIPEDA), Canada's federal private-sector privacy law (OPC, 2019).

PIPEDA was revised in May of 2019 to include: "Personal information can only be used for the purposes for which it was collected. If an organisation is going to use it for another purpose,

they must obtain consent again" (OPC, 2019). This has potential implications for Big Data collectors who now need to specify upfront to what end data are being collected. They are no longer allowed to re-package or re-purpose data already collected without consent. A way around this has been through crafting of lengthy and complex licence agreements users are asked to read and approve by click of a button. Reality is that few users have the patience, attention span or legal knowledge to understand such convoluted licence agreement contracts, and don't know how to argue or opt out of specific clauses. They therefore default to a simple click of approval since they wish to access the service offered, ignoring how data about them are captured or used. And where PIPEDA is violated or there is agreement that the licence agreements are unrealistic, enforcement is a challenge since the government and the legal system will need to secure access to the Big Data and understand their analytics and how results are actually used. Gaining this understanding and proving usage can be very difficult.

There are several ongoing court cases that could set precedent for privacy and data laws in Canada, including *Privacy Commissioner of Canada v Facebook, Inc.* (T-190-20) and *Google Reference* (T-1779-18).

The case against Facebook showcases major alleged shortcomings in regards to Facebook's data handling practices. At the time of writing this case has not been resolved. If the courts find the OPC's case compelling, they hold the power to impose binding orders on Facebook to correct or change its practices to achieve compliance.

The Google case also is in progress. It pertains to two important questions:
1. Does Google LLC in the operation of its search engine service, collect, use or disclose personal information in the course of commercial activities within the meaning of paragraph 4(1)(a) of PIPEDA when it indexes web pages and presents search results in response to searches of an individual's name?
2. Is the operation of Google's search engine service excluded from the application of Part I of PIPEDA by virtue of paragraph 4(2)(c) of PIPEDA because it involves the collection, use or disclosure of personal information for journalistic, artistic or literary purposes and for no other purpose? (There are different privacy laws pertaining to these purposes which would allow Google to circumnavigate current PIPEDA legislation)

These cases highlight the need and challenges to update privacy and data laws. The Canadian Government was planning on combating some of the issues by introducing Bill C-11, which would enact the *Consumer Privacy Protection Act* and the *Personal Information and Data Protection Tribunal Act* to make related and consequential amendments to other Acts (Government of Canada, 2020). This controversial bill was tabled in the House of Commons as of November, 2020 due to the Canadian federal election, and has yet to be reopened as of the time of writing.

In May of 2021, the Privacy Commissioner of Canada shared his analysis of Bill C-11 noting the bill "was misaligned and less protective than the laws of other jurisdictions in a number of ways" (OPC, 2021a). He argues that, if adopted, Bill C-11 would decrease consumer control over their

private data while increasing the flexibility of these companies being able to monetize it without the appropriate accountability. Overall, the commissioners' report outlined 60 recommendations which can be split into three overarching themes: 1) achieving a more appropriate weighting of privacy rights and commercial interests; 2) establishing specific rights and obligations; and 3) ensuring access to quick and effective remedies and the role of the OPC (OPC, 2021b). The report by the OPC (OPC, 2021a) explores each of these three themes in some detail. All have implications for tourism researchers and practitioners.

Conversations and actions related to Canadian federal legislation around Big Data are mirroried in provincial conversations and paralleled by many other jurisdictions around the world. The tension between large corporate and private interests leading Big Data collection and their analytics, the rights and freedoms of citizens to privacy and protection from undue manipulation and interference by these corporations, and the ability of legislation and the courts to keep up is a contemporary theme that is defining our current times.

Moving Forward:

New technologies and possible data streams are being introduced at a rapid rate. This creates exciting opportunities for the tourism industry as well as tourism research. Big Data is still a sunrise area for tourism research but a body of peer reviewed literature is beginning to emerge. Some areas are attracting more attention than others. Thus far, device data (other than GPS), webpage and bookings data look to remain under-studied, mainly due to realities of lack of access to privately and corporately held data as well as computational access and cost. The best way to expand research in this area is likely to improve relationships and trust between researchers and the tourism industry practitioners for mutual benefit and insight. There is no doubt that Big Data will continue to shape the way tourism research is being conducted. With the growing access to new data streams and analytical techniques, it's easy to get excited by the technology and the insights that may be gained from it, as long as we don't forget to reconcile the ethical and legal concerns that should also be factored into our research.

References:

Ayscue, E. P., Boley, B. B., & Mertzlufft, C. E. (2016). Mobile technology & resident attitude research. *Tourism Management*, *52*, 559–562. https://doi.org/10.1016/j.tourman.2015.08.002

Beeco, J. A., Huang, W.-J., Hallo, J. C., Norman, W. C., McGehee, N. G., McGee, J., & Goetcheus, C. (2013). GPS Tracking of Travel Routes of Wanderers and Planners. *Tourism Geographies*, *15*(3), 551–573. https://doi.org/10.1080/14616688.2012.726267

Bi, J.-W., Liu, Y., & Li, H. (2020). Daily tourism volume forecasting for tourist attractions. *Annals of Tourism Research*, *83*, 102923. https://doi.org/10.1016/j.annals.2020.102923

Brovelli, M. A., Minghini, M., & Zamboni, G. (2016). Public participation in GIS via mobile applications. *ISPRS Journal of Photogrammetry and Remote Sensing*, *114*, 306–315. https://doi.org/10.1016/j.isprsjprs.2015.04.002

Clarke, R. (2016). Big data, big risks. *Information Systems Journal*, *26*(1), 77–90. https://doi.org/10.1111/isj.12088

Cohen, I. G., & Mello, M. M. (2019). Big Data, Big Tech, and Protecting Patient Privacy. *JAMA*, *322*(12), 1141–1142. https://doi.org/10.1001/jama.2019.11365

De Mauro, A., Greco, M., & Grimaldi, M. (2016). A formal definition of Big Data based on its essential features. *Library Review*, *65*(3), 122–135. https://doi.org/10.1108/LR-06-2015-0061

Deng, N., & Li, X. (Robert). (2018). Feeling a destination through the "right" photos: A machine learning model for DMOs' photo selection. *Tourism Management*, *65*, 267–278. https://doi.org/10.1016/j.tourman.2017.09.010

Dergiades, T., Mavragani, E., & Pan, B. (2018). Google Trends and tourists' arrivals: Emerging biases and proposed corrections. *Tourism Management*, *66*, 108–120. https://doi.org/10.1016/j.tourman.2017.10.014

Ghose, A., Ipeirotis, P. G., & Li, B. (2012). Designing Ranking Systems for Hotels on Travel Search Engines by Mining User-Generated and Crowdsourced Content. *Marketing Science*, *31*(3), 493–520.

Government of Canada, D. of J. (2020, November 19). Department of Justice—Statement of Potential Charter Impacts. https://www.justice.gc.ca/eng/csj-sjc/pl/charter-charte/c11.html

Gunter, U., & Önder, I. (2016). Forecasting city arrivals with Google Analytics. *Annals of Tourism Research*, *61*, 199–212. https://doi.org/10.1016/j.annals.2016.10.007

Guo, Y., Barnes, S. J., & Jia, Q. (2017). Mining meaning from online ratings and reviews: Tourist satisfaction analysis using latent dirichlet allocation. *Tourism Management*, *59*, 467–483. https://doi.org/10.1016/j.tourman.2016.09.009

Huang, X., Zhang, L., & Ding, Y. (2017). The Baidu Index: Uses in predicting tourism flows –A case study of the Forbidden City. *Tourism Management*, *58*, 301–306. https://doi.org/10.1016/j.tourman.2016.03.015

Lee, I., Cai, G., & Lee, K. (2014). Exploration of geo-tagged photos through data mining approaches. *Expert Systems with Applications*, *41*(2), 397–405. https://doi.org/10.1016/j.eswa.2013.07.065

Li, J., Xu, L., Tang, L., Wang, S., & Li, L. (2018). Big data in tourism research: A literature review. *Tourism Management*, *68*, 301–323. https://doi.org/10.1016/j.tourman.2018.03.009

Li, S., Chen, T., Wang, L., & Ming, C. (2018b). Effective tourist volume forecasting supported by PCA and improved BPNN using Baidu index. Tourism Management, 68, 116–126. https://doi.org/10.1016/j.tourman.2018.03.006

Liu, Y., Teichert, T., Rossi, M., Li, H., & Hu, F. (2017). Big data for big insights: Investigating language-specific drivers of hotel satisfaction with 412,784 user-generated reviews. *Tourism Management*, *59*, 554–563. https://doi.org/10.1016/j.tourman.2016.08.012

Lu, W., & Stepchenkova, S. (2012). Ecotourism experiences reported online: Classification of satisfaction attributes. *Tourism Management*, *33*(3), 702–712. https://doi.org/10.1016/j.tourman.2011.08.003

McKercher, B., Shoval, N., Ng, E., & Birenboim, A. (2012). First and Repeat Visitor Behaviour: GPS Tracking and GIS Analysis in Hong Kong. *Tourism Geographies*, *14*(1), 147–161. https://doi.org/10.1080/14616688.2011.598542

Merendino, A., Dibb, S., Meadows, M., Quinn, L., Wilson, D., Simkin, L., & Canhoto, A. (2018). Big data, big decisions: The impact of big data on board level decision-making. *Journal of Business Research*, *93*, 67–78. https://doi.org/10.1016/j.jbusres.2018.08.029

OPC. (2018, January 9). PIPEDA in brief. https://www.priv.gc.ca/en/privacy-topics/privacy-laws-in-canada/the-personal-information-protection-and-electronic-documents-act-pipeda/pipeda_brief/

OPC. (2021a, February 3). PIPEDA Findings #2021-001: Joint investigation of Clearview AI, Inc. by the Office of the Privacy Commissioner of Canada, the Commission d'accès à l'information du Québec, the Information and Privacy Commissioner for British Columbia, and the Information Privacy Commissioner of Alberta. https://www.priv.gc.ca/en/opc-actions-and-decisions/investigations/investigations-into-businesses/2021/pipeda-2021-001/

OPC. (2021b, May 11). Submission of the Office of the Privacy Commissioner of Canada on Bill C-11, the Digital Charter Implementation Act, 2020. https://www.priv.gc.ca/en/opc-actions-and-decisions/submissions-to-consultations/sub_ethi_c11_2105/

OPC. (2021c, June 10). Police use of Facial Recognition Technology in Canada and the way forward. https://www.priv.gc.ca/en/opc-actions-and-decisions/ar_index/202021/sr_rcmp/#toc1

OPC, C. (2019, September 26). About the OPC. https://www.priv.gc.ca/en/about-the-opc/

OPC, C. (2021d, December 9). Projecting our values into laws. https://www.priv.gc.ca/en/opc-actions-and-decisions/ar_index/202021/ar_202021/#toc2

Rivera, R. (2016). A dynamic linear model to forecast hotel registrations in Puerto Rico using Google Trends data. *Tourism Management*, *57*, 12–20. https://doi.org/10.1016/j.tourman.2016.04.008

Saito, T., Takahashi, A., & Tsuda, H. (2016). Optimal room charge and expected sales under discrete choice models with limited capacity. *International Journal of Hospitality Management*, *57*, 116–131. https://doi.org/10.1016/j.ijhm.2016.06.006

Shoval, N., & Ahas, R. (2016). The use of tracking technologies in tourism research: The first decade. *Tourism Geographies*, *18*(5), 587–606. https://doi.org/10.1080/14616688.2016.1214977

Sun, S., Wei, Y., Tsui, K.-L., & Wang, S. (2019). Forecasting tourist arrivals with machine learning and internet search index. *Tourism Management*, *70*, 1–10. https://doi.org/10.1016/j.tourman.2018.07.010

Vu, H. Q., Li, G., Law, R., & Ye, B. H. (2015). Exploring the travel behaviors of inbound tourists to Hong Kong using geotagged photos. *Tourism Management*, *46*, 222–232. https://doi.org/10.1016/j.tourman.2014.07.003

Wang, W., Kumar, N., Chen, J., Gong, Z., Kong, X., Wei, W., & Gao, H. (2020). Realizing the Potential of the Internet of Things for Smart Tourism with 5G and AI. *IEEE Network*, *34*(6), 295–301. https://doi.org/10.1109/MNET.011.2000250

Weaver, A. (2021). Tourism, big data, and a crisis of analysis. *Annals of Tourism Research*, *88*, 103158. https://doi.org/10.1016/j.annals.2021.103158

Wu, X., Zhu, X., Wu, G.-Q., & Ding, W. (2014). Data mining with big data. *IEEE Transactions on Knowledge and Data Engineering*, *26*(1), 97–107. https://doi.org/10.1109/TKDE.2013.109

Xu, X., & Li, Y. (2016). The antecedents of customer satisfaction and dissatisfaction toward various types of hotels: A text mining approach. *International Journal of Hospitality Management*, *55*, 57–69. https://doi.org/10.1016/j.ijhm.2016.03.003

Yang, X., Pan, B., Evans, J. A., & Lv, B. (2015). Forecasting Chinese tourist volume with search engine data. *Tourism Management*, *46*, 386–397. https://doi.org/10.1016/j.tourman.2014.07.019

Zakrisson, I., & Zillinger, M. (2012). Emotions in motion: Tourist experiences in time and space. *Current Issues in Tourism*, *15*(6), 505–523. https://doi.org/10.1080/13683500.2011.615391

Zhou, X., Xu, C., & Kimmons, B. (2015). Detecting tourism destinations using scalable geospatial analysis based on cloud computing platform. *Computers, Environment and Urban Systems*, *54*, 144–153. https://doi.org/10.1016/j.compenvurbsys.2015.07.006

Zuboff, S. (2019). Surveillance Capitalism and the Challenge of Collective Action. New Labor Forum, 28(1), 10–29. https://doi.org/10.1177/1095796018819461

Zwitter, A. (2014). Big Data ethics. *Big Data & Society*, *1*(2), 2053951714559253. https://doi.org/10.1177/2053951714559253