Digital turn, digital geographies?

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Abstract

Geography is in the midst of a digital turn. This turn is reflected in both geographic scholarship and praxis across sub-disciplines. We advance a threefold categorization of the intensifying relationship between geography and the digital, documenting geographies produced through, produced by, and of the digital. Instead of promoting a single theoretical framework for making sense of the digital or proclaiming the advent of a separate field of 'digital geography', we conclude by suggesting conceptual, methodological and empirical questions and possible paths forward for the 'digital turn' across geography's many sub- disciplines.

Introduction

> No other technological innovation in human history has affected the practice of geography in such a profound way as the computer. It has drastically transformed both geography as an academic discipline and the geography of the world
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> (Sui and Morrill, 2004: 82).

Geography, we contend, is in the midst of a digital turn. Rather than suggesting a radical rupture with extant or antecedent geographical theory and praxis, we advance the notion of the 'digital turn' to capture the ways in which there has been a demonstrably marked turn *to* the digital as both object and subject of geographical inquiry, and to signal to the ways in which the digital has pervasively inflected geographic thought, scholarship, and practice.

Digital devices (computers, satellites, GPS, digital cameras, audio and video recorders, smartphones) and software packages (statistics programmes, spreadsheets, databases, GIS, qualitative analysis packages, word processing) have become indispensable to geographic practice and scholarship across sub-disciplines, regardless of conceptual approach. Current modes of generating, processing, storing, analysing and sharing data; creating and circulating texts, visualizations, maps, analytics, ideas, videos, podcasts and presentation slides; and, sharing information and engaging in public debate via mailing lists and social and mainstream media, are thoroughly dependent on computational technologies (Fraser, 2007; Kitchin *et al*., 2013)

Moreover, as digital technologies have become pervasively quotidian, mediating tasks such as work, travel, consumption, production, and leisure, they are having increasingly profound effects on phenomena that are of immediate concern to geographers: the nature of the

space economy and economic relations; the management and governance of places; the production of space, spatiality and mobilities; the processes, practices, and forms of mapping; the contours of spatial knowledge and imaginaries; and, the formation and enactment of spatial knowledge politics (Castells, 1996; Elwood and Leszczynski, 2013; Graham and Marvin, 2001; Rose et al., 2014; Wilson, 2012). Digital presences and practices are characterized by uneven geographies of underlying infrastructures, material forms, component resources, and sites of creation and disposal (Lepawsky, 2014; Zook, 2005). Similarly, there are distinct geographies of digital media such as those of the internet, games, the geoweb, and social, locative and spatial media (Dodge and Kitchin, 2002; Ash, 2015; Leszczynski, 2015b).

Following Lunenfeld (1999), we adopt a broad notion of 'the digital' as extending beyond computational technologies to encompass ontics, aesthetics, logics and discourses. As ontics, 'the digital' designates digital systems that 'translate all inputs and outputs into binary structures of 0s and 1s, which can be stored, transferred, or manipulated at the level of numbers, or 'digits'' (Lunenfeld, 1999: xv). The digitally mediated material technologies we engage with have recoded multiple other technologies, media, art forms, and indeed spatialities, in ways coincident with the binary nature of computing architectures. Digitality, then, is also an aesthetics, capturing the pervasiveness of digital technologies and shaping how we understand and experience space and spatiality as always-already 'marked by circuits of digitality' that are themselves irreducible to digital systems (Murray, 2008: 40). As we adopt and ubiquitously embed networked digital technologies across physical landscapes, they come to enact progressively routine orderings of quotidian rhythms, interactions, opportunities, spatial configurations, and flows (Franklin, 2015). We use 'the digital' then to make reference to material technologies characterized by binary computing architectures; the genre of socio-

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techno-cultural productions, artefacts, and orderings of everyday life that result from our spatial engagement with digital mediums; and the logics that both structure these ordering practices, as well as their effects. To this we add a fourth dimension, that of digital discourses which actively promote, enable, secure, and materially sustain the increasing reach of digital technologies.

The turn to the digital in Geography has, to a large degree, been thoroughly internalized and taken for granted, little acknowledged beyond some debates around epistemology and methods (e.g., Critical GIS, critical data studies), and work that explicitly takes the digital as its central focus. With regards to the latter, recent conference sessions and workshops have sought to highlight what has been termed 'digital geographies'[1], which in part echo developments in other disciplines which seek to establish new fields of study, including 'digital anthropology' (Horst and Miller, 2012), 'digital sociology' (Orton-Johnson and Prior, 2013; Lupton, 2014), and 'the digital humanities' (Offen, 2013; Travis, 2015). Rather than consign the digital to a distinct disciplinary subfield, or cast all geographies reshaped or mediated by the digital as 'digital geographies,' in this paper we seek to attest to the extent of the digital turn under way and argue that there is a need to more fully consider how the digital inflects Geography's many subfields and mediates how geographical knowledge is produced.

We advance a threefold categorisation of the relationship between Geography and the digital: geographies produced *through*, produced *by*, and *of* the digital. The division between these categories is by no means mutually exclusive, with many examples overlapping between them. Nonetheless, we think it provides a useful heuristic to illustrate the scope and extent of the digital turn. In the interests of brevity, our aim is not to document all studies that involve an engagement between Geography and the digital. Rather, we strive to illustrate, with selective examples, how the digital has become central to both the praxes and focus of contemporary

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geographical scholarship and to provide evidence of the evolving and intensifying digital turn. We conclude by suggesting conceptual, methodological and empirical questions that may aid the further development of Geography's turn to the digital.

Geographies *through* the digital

The digital has long figured as a prominent site, mode, and object of/for knowledge production in human geography (Rose, 2015). By this we mean that the digital has been engaged to actualize heterodox epistemologies in the service of producing geographic knowledge and to enact knowledge politics, while simultaneously being the subject of epistemological critique.

Early approaches to engaging with digital knowledge production in human geography were rooted in the quantitative revolution and the use of computing to undertake new forms of statistical analysis and modelling (Haggett, 1966; Hagerstrand, 1967). This was accompanied by the first digital mapping projects (Balchin and Coleman, 1967; Tobler, 1959), their enrolment into national cartographic initiatives and later spatial data infrastructures, and the development of nascent Geographic Information Systems (GIS) from the mid-1960s (Tomlinson, 1968; Foresman, 1998). Digital technologies then underwrote the development of positivist spatial science, GIS and later GIScience, as well as remote sensing and advanced photogrammetry. More recently, such quantitative geographical analysis has become more closely aligned with data science. With the rise of spatial big data and new machine learning analytics (e.g., data mining and pattern recognition, geovisualisation, spatial statistics, prediction, optimisation and simulation), there has been a renewed interest in developing what has been termed the computational social sciences (Lazer *et al*., 2009) and data-driven geography (Miller and Goodchild, 2014) to produce inherently longitudinal quantitative studies with much greater breadth, depth, scale, and timeliness (Kitchin, 2014b).

Positivist spatial science was critiqued on epistemological grounds by Marxist and humanistic geographers in the 1970s and feminist geographers beginning in the 1980s. However, the main critique of underlying digital computation surfaced in the 1990s, particularly in debates about the role, status, and use of GIS in the discipline. The main lines of attack were drawn from emerging ideas in critical cartography, especially Harley's (1989) 'map deconstruction', and feminist critiques of science and vision. Harley emphasized that maps are never 'the territory' but rather technologies which normalize, legitimate, underwrite, and render transparent material exercises of power. As geographic information systems (GIS) became entrenched as a mainstream presence within the discipline, critical cartography likewise influenced the flourishing of Critical GIS, which constituted a concerted effort at incorporating what were at the time trenchant critiques of the technology and its attendant practices (see Pickles 1995). Critical GIS drew on feminist critiques of both science and (scientific) representation to challenge the supposed neutrality of GIS (see Leszczynski and Elwood, 2015). Feminist critiques of science were used to further challenge the inherent epistemological limitations of GIS artefacts (maps) and practices of discretization in two additional ways. First, questions were raised about exactly *whose* knowledges are being produced, *by* and *for* whom in deployments of and practices with the technology. Critiques highlighted the colonialist militarism, masculinist positivism and cartographic rationalities of GIScience that inherently produced ethnocentric, empiricist, and disembodied knowledges (Bondi and Domosh, 1992; Dixon and Jones, 1998). Second, the 'God-trick' (Haraway 1991) of GIS - a 'view from nowhere' premised on the disembodied trope of the separation between the viewing subject (the GIS practitioner) and the object of vision (space) – was exposed as a totalizing scopic regime passed off as objective knowledge about the world (Roberts and Stein, 1995; Rocheleau, 1995).

The visual persists as an epistemological concern and entry point for engaging digital technologies in current geographic scholarship. In relation to the visual, particular emphasis is given to the epistemic rationalities imposed by the telos of digitally networked spatial platforms that continue to render the objects of representation – spaces, cities, people – 'knowable' in ways that privilege abstraction and calculability. The bulk of such approaches are most closely aligned with an aesthetic conception of the digital (Lunenfeld, 1999). Parks (2009) for instance argues that Google Earth's vertical scopic regime encourages zooming past the geopolitical contexts of genocide (Darfur) straight into images that mobilize tropes of human misery, waste, and dispossession. At the more local end of the spectrum, Wilson (2011) demonstrates that issues of community poverty and signs of socioeconomic disenfranchisement in city neighbourhoods are reduced to superficial objects (abandoned shopping carts, refuse awaiting collection) that can be discerned by the geocoding eye. In turn these objects can be imaged and quantified at the moment of being abstracted as digital records on location-enabled handhelds. Elsewhere, Rose (2016a) relates drone warfare and smart cities via a shared masculinist visuality that she terms the 'aerial view' that appears on the screens of the command-and-control centres where practices of both smart urbanism and autonomous warfare are coordinated and operationalized.

Many initial critiques of GIS sought to dismiss the technology from the discipline as the embodiment of objectionable epistemologies. However, interventions from critical GIS demonstrated precisely the opposite: digital media could be appropriated and repurposed to produce spatial knowledges that are situated, reflexive, non-masculinist, emotional/affected, inclusive and polyvocal, and flexible rather than foundational (Elwood, 2006; Kwan, 2002; Pavlovskaya, 2006; Schuurman, 2002). Feminist GIS interventions in particular repurposed quantitative methodologies and geovisualization techniques within mixed-methods approaches

that sought to effect and make subaltern and counter-hegemonic geographies visible (e.g., Kwan, 2002; Pavlovskaya, 2002). Similarly, participatory or public participation GIS (P/PGIS) sought to reconfigure who performed and for whom geographic knowledge was produced by empowering groups historically on the losing side of the 'digital divide' (women, indigenous peoples, racial/ethnic minorities) to conduct GIS analysis (Sieber, 2006).

That digital artifacts serve as objects, sites and modes of knowledge production is of course not limited to GIS. We now live in a present characterized by an abundant and diverse array of spatially-enabled digital devices, platforms, applications and services that have become ordinary and expected presences in our everyday lives. As a result of their pervasiveness, new spatial media are intensely bound up in the production of myriad, highly quotidian, spatial knowledges (Elwood and Leszczynski, 2013. For instance, the Surui, an indigenous Amazonian people, repurposed location-enabled Android handhelds introduced to chronicle and geolocate instances of illegal logging and mining within their territory to document sites of cultural, historical and spiritual significance and uploaded them to Google Earth as an interactive layer for navigation and exploration (Forero, 2013)[2].

Digital technologies are also the standard media of knowledge generation and analysis in qualitative research. For example, interviews and focus groups are being captured and transcribed using digital recorders. Social interactions are being observed in online forums using internet ethnographies (Hine, 2000). Transcriptions are being managed and analyzed using qualitative software (Hinchliffe *et al*., 1997). Participatory research is being conducted using digital cameras and video recorders. Increasingly, digital methods for capturing and analyzing qualitative and non-structured data, which can only be performed digitally, are being deployed (Rogers, 2013). This is particularly so with respect to the digital humanities, which seeks to use

the power of computation to make sense of the vast troves of natively-digital content (e.g. radio, television, Web content etc) as well as analogue and unstructured data that has been digitized (e.g., millions of books, documents, newspapers, photographs, art works, material objects, etc). Digital humanities research is aided by new tools of data curation, management, and analysis capable of handling massive numbers of data objects. Rather than concentrating on a handful of novels or photographs, it becomes possible to search, connect and analyse across a large number of related works and use key techniques such as mapping and geovisualisation to reveal spatial patterns and processes (Travis, 2015).

The proliferation and public accessibility of digital platforms for geographic knowledge production "[poses] epistemological challenges to the dominant theory of truth, in particular advancing a shift away from the correspondence model of truth towards consensus and performative interpretations" (Warf and Sui, 2010: 197). As such the politics of geographical knowledge production with the digital – which involves questions of how particular knowledges come to be considered legitimate (Elwood and Leszczynski, 2013) - remain influenced and marked by hegemonic social relations of, amongst others, race, class, and gender, as well as global digital divisions of labour (Graham and Foster, 2016). Moreover, they increasingly reflect the interests of the corporate entities that own and exert control over dominant digital spatial platforms by, for example, managing the use of APIs (Application Programming Interfaces) to which they may revoke access, without explanation, at any time (Leszczynski, 2012).

The necessity for geographers to continue to move between enrolling the digital within critical geographic praxis whilst simultaneously engaging digitally-mediated knowledges is imperative in a present characterized by the diversification, rampant commercialization, and pervasiveness of locative media (Leszczynski, 2015b; Wilson, 2012); and the rollout of digital

archives and repositories (Offen, 2013). As digital platforms simultaneously deterritorialize labour practices and re-entrench spatially uneven patterns of the precarious positioning of workers in content and commodity chains that reflect global core-peripheries (Graham et al., 2014, 2015), we need to attend to the geographies produced *by* the digital.

Geographies *produced by* the digital

Since the early 1990s, there have been a series of studies that have examined how the digital is mediating and augmenting the production of space and transforming socio-spatial relations. Initially, this work concentrated on how ICTs, and the Internet in particular, were transforming economic, cultural, social, and political geographies. Some work took a technologically determinist position declaring that networked ICTs flattened distance and rendered geography irrelevant by overcoming space with time through the instantaneous transfer of information (Cairncross 1997; Friedman, 2005). Others however argued that while ICTs produced space-time compression and distanciation, geography remained critical.

Examined from a political economy perspective, it was clear that the new information economy was leading to changes in how companies and employment patterns were spatially structured through processes of concentration and dispersal, inducing significant urban-regional restructuring and the creation of a post-industrial landscape (Castells, 1996; Graham and Marvin, 2001). Geographical research highlighted how urban hierarchies were being reinforced through the concentration of command and control, and the agglomeration of information-rich business into key places (Moss, 1986). Consequently, many cities sought to pro-actively 'wire' themselves to attract inward investment and position themselves in the global informational economy (Warf, 1995). At the same time, many office activities, business services and

production centres were decentralised to the suburbs, more peripheral cities, or other countries to avail of cheaper rent and labour costs (Breathnach, 2000).

At the same time, cities were starting to become much more reliant on digital systems with respect to their planning, management and governance, and digital infrastructures and devices were starting to be routinely embedded into the spatial fabric of cities themselves (Mitchell, 1996). Although city managers had been experimenting with using computer models and management systems to inform policy and govern cities since the early 1970s (Flood, 2011), it was only from the mid-1980s onwards that GIS and other land-use, planning and architecture software packages became common tools for urban management, along with updated urban control rooms for utility and transport infrastructures. From the 1990s onwards, cities became increasingly computational with traditional infrastructures augmented with networked sensors, transponders, and actuators, enabling new forms of real-time operational governance. For Graham and Marvin (2001), these new digital tools and mediated infrastructures were key components of the emerging neoliberal city, becoming increasingly privatised but also important means for enacting governance and control and creating particular power geometries. This generated what they termed splintering urbanism, a planning logic characterized by uneven development through the creation of differential and fragmentary infrastructures and services that are organized as much, if not more, for profit than public good.

Related research, also rooted in political economy, noted that far from flattening social and economic divides, digital social inequalities have only intensified along lines of access to ICTs. For Castells (1996), the social and spatial polarisation inherent in the digital divide was characterised by a separation between what he termed the 'space of flows' (well-connected, mobile and more opportunities) and the 'space of places' (poorly connected, fixed, and isolated).

This digital divide takes many forms, including divisions between classes, urban locations and nations (Dodge and Kitchin, 2002). This continues to be an on-going issue, both with respect to access to digital technologies and infrastructures, but also the content of the internet, which is decidedly skewed in its focus (Graham et al., 2014).

The 'digital divide' has more recently been complicated by the proliferation of digital technologies and content (data) in the spaces and practices of everyday life – such as growth of smartphones – as well as the now entirely quotidian nature of information communication technologies (ICTs) around the world (Graham, 2011; Kleine, 2013). Questions of how digitally-mediated knowledge is produced, by whom, and in whose interests continue to attract attention. For instance, Graham and collaborators (Graham *et al*., 2015a/b) have demonstrated that increased connectivity in Africa, in the form of expanded telecommunications infrastructures, has not translated into direct increases in individual participation on digital platforms or resulted in a seamless, proportionate incorporation of African economies into global technology and information sectors.

Over the past decade, much of the work on the relationship between the digital and the urban has focused on smart cities. Some of this research is informed by a political economic framework for documenting how the underlying discourses and rollout of smart city technologies are rooted in a neoliberal ethos of market-led and technocratic solutions to city governance and development that reinforce existing power geometries and social and spatial inequalities rather than eroding or reconfiguring them (e.g., Greenfield, 2013; Datta, 2015; Shelton et al. 2015). Smart cities have also been approached from a more positivistic stance that utilises and promotes a computational social science approach. Here, research is principally concerned with utilising urban big data to computationally model and simulate urban processes and with producing new

tools and apps, such as urban dashboards, that reshape how cities are planned and how people

navigate and interact with urban spaces (Batty, 2014; Offenhuber and Ratti, 2013).

Elsewhere, research draws from poststructural theory to consider the ways in which the

digital production of space and mobilities is mediating new forms of governmentality. At the

turn of the new millennium, Amin and Thrift (2002: 125) noted that '[n]early every urban

practice is becoming mediated by code.' Dodge and Kitchin (2005) argued that such was the

importance of software to the production of space that in many cases code and space were

mutually constituted as 'code/space': if the software failed the space could not be produced as

intended. However, they asserted that the relationship between code and space is neither

deterministic nor universal. Rather how code/space emerges is contingent, relational and context-

dependent, unfolding in multifarious and imperfect ways.

One of the key ways in which code/spaces are enacted is in the regulation and control of

space and the reproduction of regimes of governmentality. The policing of areas is increasingly

being undertaken through networked surveillance and security apparatuses, and how populations

are managed is mediated by information systems and databases. Such technologies on the one

hand enforce new forms of (self)disciplining (Foucault, 1977), and on the other enact new forms

of control (Deleuze, 1992; Sadowski and Pasquale, 2015). With respect to the latter, expressions

of power are not visible and threatening, as with sovereign or disciplinary regimes. Rather,

power is exerted subtly through distributed protocols that define and regulate access to resources

and spaces and reshape behaviour. One manifestation of such control is socio-spatial sorting,

whereby people are evaluated via algorithms that calculate and enforce differential access with

respect to perceived worth (e.g., customer, credit and crime profiling) (Graham, 2005).

Discipline and control are increasingly being dispensed through forms of automated management

wherein governmentality is enacted through automated, automatic and autonomous systems (Amoore and Hall, 2009; Kitchin and Dodge, 2011).

Over the last decade, research has focused not only on the wiring of the networked smart city, but also on how to theoretically and empirically engage the technologies themselves. Specifically, this swathe of research has attended to the rollout and effects of new spatial and locative technologies, such as online mapping tools with accompanying APIs that enable the easy production of map mashups, user-generated spatial databases and mapping systems (e.g., OpenStreetMap and WikiMapia), and locative media and augmented reality (e.g., satnavs and location based social networking). Collectively, these were initially engaged as constituting what was termed 'the geoweb' - the aggregate of spatial technologies and geo-referenced information organized and transmitted through the internet and accessed through spatial media. These spatial media are having profound effects on the production of space/spatiality, mobility, and knowledge politics. As geographic spaces are being evermore complemented with various kinds of georeferenced and real-time data (Gordon and de Souza e Silva, 2011; Graham and Zook, 2013), spatial media is creating new spatial practices enabling individuals to check into locations, create personalised georeferenced data, navigate routes, and locate friends and services. As such, spaces are being increasingly mediated and experienced through digital interfaces, in turn transforming the 'social production of space and the spatial production of society' (Sutko and de Souza e Silva, 2010: 812) and generating new spatialities that have variously been termed code/spaces, hybrid spaces (de Souza e Silva, 2006), digiplace (Zook and Graham, 2007), net locality (Gordon and de Souza e Silva, 2011), augmented reality (Graham et al,, 2013), and mediated spatiality (Leszczynski, 2015b). Spatial media mediate social encounters within spaces and provide different ways to know and navigate locales, enabling on-the-fly scheduling of

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meetings and serendipitous encounters. Importantly they do so *in situ*, on-the-move and in real-time, augmenting a whole series of activities such as shopping, wayfinding, sightseeing, and protesting, They also alter the traditional basis of knowledge politics because they transform the nature of expertise in terms of who can generate spatial data, and open up different epistemological strategies for asserting 'truth' (Elwood and Leszczynski, 2013).

Geographies *of* the digital

While work in contemporary human geography is attentive to the pervasiveness of digital, networked spatial media in the spaces and practices of everyday life, geographers' early engagements with charting the geographies *of* the digital took the form of a theoretical and empirical exploration of the digital as a particular geographical domain with its own logics and structures. These studies sought to apply pre-existing geographical ideas and methodologies to study what it considered to be a new material, spatial and technical realm of communication and interaction (the internet/cyberspace, virtual worlds, digital games) and their associated socio-technical assemblages of production.

Initially, geographies of the digital conceptualised digitally mediated experience as a form of cyber or virtual space (Crang *et al*., 1999; Fisher and Unwin, 2003). Cyberspace served as a kind of metaphor for understanding the worlds accessed by digital technologies, such as webpages, forums, multi-user dungeons and online video games, and how those worlds are constructed through sets of ICTs (Dodge and Kitchin 2002). Here, cyberspace was understood as the outcome of a set of connected material objects (screens, routers, servers), working in relation to a human body (Zook *et al*., 2004; Kinsley, 2013b). As Hillis (1999) has helpfully shown, this metaphor of cyberspace operated around a predominantly visual understanding of space in which various computer generated environments were accessed via a screen. Cyberspace was

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something to be surveyed, made sense of, and experienced by the eye. In doing so, spatial experience was primarily understood as the co-production between a cognitively imbued human body, a set of objects that made up an environment, and the mind which operated to unify this set of disjunctive entities into a holistically experienced world. As a kind of spatial landscape, it appeared logical to map cyberspace as one would any new terrain; as a set of material infrastructures and a space for shared experience (Shields, 2003). However, as Kinsley (2013b) and Graham (2013) have argued, the terms cyberspace and virtual space are problematic because they create a distinction between two supposedly different realms (digital and analogue, or virtual and actual), covering over the complex processes through which they are entwined. Extending earlier work by economic geographers interested in the distribution and concentration of internet infrastructure (e.g., Malecki, 2002; Zook, 2005), Blum (2012) and Starosielski (2015), amongst others, have grounded metaphors, such as those of 'cyberspace' and 'the cloud', by tracing the actual spatialities of internet infrastructures at both local and global scales. These spatialities include the instantiation of digital networks as internet exchanges, data centres, fibre optic cables and their landing sites, as well as the contentious economic, social, political, and historical contexts of their geographies.

Another body of work has charted the spatialities of video games and social media. What unites these areas of research is a concern for theorising the relationship between body and screen and how engaging and communicating through screens alters the spatial understandings, embodied knowledge, political awareness and social relationships of users. In the case of video games, Ash (2009, 2010) has suggested that engaging with game environments cultivates new modes of spatial awareness organised around ethologies of action that guide players without thinking in order to capture and hold their attention. Shaw and Warf (2009) suggest these digital

environments can also influence geopolitical understandings by shaping how users imagine other people and places around the world.

Working from a feminist perspective, geographers have explored how digital technologies transform social reproduction. For example, Longhurst (2013) has argued that the visual nature of digital technologies, such as Skype video calls, re-orients bodily relations between family members and create feelings of connection that are absent when communicating through telephone or email. Others note how digital technologies reorganise socio-spatial relations between different activities such as work, rest and mobility and between different family members, such as adults and children (Chan, 2008; Larsen 2006; Valentine and Holloway, 2002). These studies highlight how digital technologies challenge notions of place-based identity as defined by a shared location and how pre-existing social relations are not extinguished, but rather transformed.

Distinct from this approach, a related body of work has plotted the material geographies of ubiquitous computing (digital objects and processes embedded into the environment, such as RFID tags and sensors) (Galloway, 2004). Here, digital geographies are figured as sets of technologies that go beyond an engagement with an interface or screen as a virtual geography (Kinsley, 2013a), or as an infrastructure whose primary aim is to enable this virtual geography (Graham, 1998). Instead, the focus is on the 'actual geographies that evolve on the surface of the earth in the information age: the changes in and among places resulting from the increased ability to store, transmit and manipulate vast amounts of information, and the new patterns of geographical differentiation, privilege and disadvantage that these changes are bringing about' (Sheppard et al., 1999: 798). As Galloway (2004: 387) argues, ubiquitous computing 'did not seek to transcend the flesh and privilege the technological'. Instead, 'ubiquitous computing was

positioned to bring computers to 'our world' (domesticating them), rather than us having to adapt to the 'computer world' (domesticating us)'. Geographies of ubiquitous computing have thus examined the insertion and uptake of digital objects and markers into environments, such as place tagged podcasts (Arikawa et al., 2007), barometric pressure sensors (Retscher, 2007) and wifi routers (Köbben, 2007).

Most recently, an emerging body of work has begun to trace the generation and flows of big data and algorithms. While geographies of the digital have understood data to be key to all digital communication, big data refers to a quantitative and qualitative shift in the amount, velocity, variety, resolution and flexibility of data that is now collected and analysed by a range of devices (Kitchin, 2014b). Geographers have explored the spaces of big data, including volunteered geographic information, in a variety of ways. Crampton *et al*. (2013) have detailed how geotagged data from services such as Twitter can be used to understand socio-spatial processes such as riots and response to natural disasters. They also recognise the limitations of such an approach, suggesting geotagged data is often non-representative given that it is generated by a relatively small number of people within any population. Further, analysts are typically working with secondary data 'fumes' visible to users of locative social media services, rather than full data sets, as these data sets remain commercially confidential and inaccessible to researchers (Arribas-Bel, 2014; Thatcher 2014). Elsewhere, Graham and Shelton (2013) argue that any spatial big data necessarily create large data shadows, where groups who are considered valuable are increasingly data mined, while other populations are excluded from analysis. DeLyser and Sui (2013) thus argue, that analysing the spatiality of big data requires novel methodological approaches that cross between qualitative and quantitative methods because big data alone cannot offer a comprehensive geography of the digital.

Emerging research has also identified glaring inequalities in the geographies of big data production. Graham *et al*. (2015) in particular evidence stark global North-South polarities in the geographies of information which reflect and reproduce global economic core-peripheries. For example, there have been more Wikipedia articles written about the uninhabited continent of Antarctica than all of the countries of Africa combined (Graham, 2009). The production of geocoded content about places furthermore exhibits a form of informational magnetism, whereby individuals in digitally underrepresented parts of the world, such as the Middle East-North Africa (MENA) region, are more likely to contribute content and edits to Wikipedia about places in the global North (the 'core') than they are about the places in which they themselves live (global informational peripheries) (Graham *et al*., 2015).These uneven contours of geographic content also manifest locally. For example, in the aftermath of Hurricane Sandy, the wealthy New York borough of Manhattan cast a far larger Twitter 'data shadow' than the most severely affected, more socioeconomically deprived areas of the tri-state coastline, giving the impression that Manhattan was more deserving of an earlier and/or more concentrated emergency response than was merited (Shelton *et al*., 2014).

As Kwan (2016) has recently contended, however, much of what geographers have to date been engaging as 'big data' is actually the effect of algorithms; i.e., not unfiltered big data but the result of algorithmic processing of datasets. In human geography, this turn to algorithms as an object/subject of research is reflected in increasing interest in algorithmic governance and governmentality (Kitchin and Dodge 2011; Amoore and Poitukh, 2015; Leszczynski 2016), as well as the spatialities of algorithms themselves, i.e., the geographies of their coding, circulation, and appropriation (Amoore, 2016).

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Digital turn, digital geography?

If the definition of a 'turn' is a concerted reorientation of focus of attention and approach, then it is fair to say that over the past two decades Geography has experienced a 'digital turn'. Across all sub-disciplines, there has been a recognition of how the digital is reshaping the production and experience of space, place, nature, landscape, mobility, and environment. This recognition is underpinned by a turn *to* the digital as subject/object of geographical scholarship, and a profound inflection of geographic theory and praxis by the digital, whether understood as ontics, aesthetics, logics, or discourse, or an assemblage thereof.

In this paper, we have strived to evidence the digital turn by charting the intensifying history of Geography's engagement with the digital, with an emphasis on contemporary theoretical and empirical interventions that we have approached through the tripartite heuristic of geographies *through* the digital, geographies *produced by* the digital, and geographies *of* the digital. Given the scope and extent of the digital turn, we have had space to focus on only a small sample of such work. Our choice to profile work concerned with the relationship between the digital and the urban, for example, is not to the exclusion of non-urban research, such as that investigating the negative regional impacts of the lack of broadband infrastructure in rural areas or the use of software-enabled technologies in farming, or the robust body of work in e-waste and digital dumping grounds, which are disproportionately located in impoverished regions of the Global South. Indeed, there are countless other interventions we could have discussed that trace, either explicitly or more obliquely, how digital technologies recast economic, political, social, cultural, health, and other geographies.

These exclusions notwithstanding, the epistemologies and methodologies of geographical scholarship and research are now thoroughly mediated by digital technologies. These

technologies alter, in all kinds of explicit and subtle ways the kinds of questions that are asked,

how they are asked and answered, the ways in which knowledges are constructed, communicated

and debated, as well as the material spatialities and geographies of their production,

transmission, and appropriation. For us, these considerations capture the extent, emphases, and

effects of Geography's 'digital turn,' and not the imperative towards designating a field of

'digital geography' that should or could be established within the discipline. Similar attempts

have been underway in Anthropology and Sociology for a number of years. In both cases, the

focus is broad, encompassing the anthropology and sociology 'of', 'produced by', and 'produced

through' the digital. The consequence, we believe, is to recast nearly all anthropology and

sociology as 'digital anthropology' and 'digital sociology' to some degree, especially given the

reliance of digital technologies in knowledge production. But if everything becomes 'digital,'

then 'digital' becomes an empty signifier and unworthy of distinct denotation. While we do

maintain that there is a need to think critically about the relationship between Geography and the

digital, we contend that rather than cast all of those geographies as 'digital geography,' it is more

meaningful to think about how the digital reshapes many geographies, mediates the production

of geographic knowledge, and itself has many geographies.

By framing the digital in this way, we avoid the decontextualization of digital

approaches, methodologies, and research studies from their subdisciplinary domains such as

urban geography or geographies of development. Instead, the emphasis remains on how an

engagement with the digital develops our collective understandings of cities and development, as

well as health, politics, economy, society, culture, and the environment, amongst others. It also

allows for 'the digital' to function as a site and mode for intersectional research that cuts across

research foci and leverages methodologies from multiple geographical subdisciplines. Attending

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to the geography of rare metals used in the production of digital technologies, for instance, raises questions in the fields of resource and development geographies, postcolonial studies, as well as geopolitics. This enables the differences the digital makes to research, epistemology and knowledge production to be contextualised within a broader knowledge base and the history of theory, concepts, models and empirical findings within and across geographic sub-domains. For example, we feel it makes sense to frame smart city developments within debates around the long history of urbanisation and urbanism, rather than to set them within a field of digital geography.

Disciplinary engagement with the digital is a rapidly developing field with many aspects of the intensifying relationship between Geography and digitality deserving of further conceptual, methodological, and empirical attention. As a preliminary prospectus for future work, we argue that there is much to be gained from identifying synergies with the theory and praxis of disciplines that focus more substantially on the specifically technical aspects of the digital, such as Science and Technology Studies, Software Studies, Cybernetics, Critical Data Studies, Game Studies, Platform Studies, (New) Media Studies, Informatics, and Human-Computer Interaction. We believe this is critically important because if we are to identify and meaningfully influence the effects and outcomes of digital technologies, then it is imperative that we understand the nature and operationalization of technology infrastructures and protocols. As Nadine Schuurman (2000) argued with reference to GIS and its critics in the late 1990s, epistemological quandaries of the technology arise from its material architectures.

We believe geographers are uniquely placed to interrogate the materialities of digital computation in innovative ways. Geographers' theorisations of space, time and relationality can be fruitfully developed to consider how digital computation and its associated objects are both

singular things, with particular capacities, that also create shared space times for both other technical objects and the humans who use those objects. This calls for further attention to be given to the work that non-human infrastructures perform that always exceeds the technical parameters of their design. Tim Schwanen (2015) develops three potential strategies for studying digital computation in this way. In relation to smartphone apps, he suggests that researchers begin with the app itself rather than 'the human individual, her needs, preferences, valuations or even the social practices she is enrolled in' (Schwanen, 2015: 682). Practically, this can take the form of understanding the script design of the app and then understand how users engage with the script design for example. Schwanen also suggests that we consider how engagements between the objects of digital computation and humans creates new objects: in terms of apps, this might be affective senses of reward or competition (also see Cockayne 2016). Finally, we can understand how the disjunction between design and use shapes broader practices with these technologies.

A substantive empirical examination and theorization of the political economies of spatial big data, algorithms and geolocation technologies remains underdeveloped. While work in this area has begun (see Leszczynski, 2012, 2014; Wilson, 2012), to date, there has been little engagement with the ways in which 'disruptive' activities of the sharing/platform/gig economies are completely contingent on geologistics as a business model (e.g., Uber as a business model; app-driven services of the 'last mile' economy; accommodation platforms such as Airbnb). There is a need to further connect empirical research in this vein to burgeoning geographical analyses of the reconfiguration of labour in the gig economy, the rise of digital labour, and the uneven global geographies of microwork.

Rather than advocating for a single focus on political economic concerns, we encourage geographers to critically reflect upon the wider *dispotif* or assemblage of the digital. Foucault's (1977) concept of the 'dispositif' refers to a 'thoroughly heterogeneous ensemble consisting of discourses, institutions, architectural forms, regulatory decisions, laws, administrative measures, scientific statements, [and] philosophical, moral and philanthropic propositions' (in Gordon 1980: 194), which enhance and maintain the exercise of power within society. Unpacking a digital *dispotif* involves charting the wider discursive and material practices that interact in relational, contingent and contextual ways to shape the design, deployment, normalization and use of digital technologies in ways that serve and sustain particular kinds of interests (the economy, social capital) in society, consolidating and channeling the exercise of power. Kitchin (2014b) sets out a similar notion with respect to mapping out what he has termed data assemblages, arguing for the need to examine digital objects and infrastructures comprehensively, critically engaging their interlocking technical stack (platform, operating system, code, data, interface) and the epistemological, political economic, institutional, legal, and governmentalized contexts of their production, circulation, and operationalization in society.

Such a focus on data assemblages is one approach to tackle Crampton *et al.*'s (2013) imperative for empirically and methodologically going 'beyond the geotag', but work remains to be done in identifying and addressing the exclusions and inclusions of digital connectivity and discourse. As a first prerogative, there is a pressing need to destabilize the dominance of the Global North as a universal placeholder and de facto field site for geographical research about the digital. The recent expansion of digital infrastructures into parts of the world that have been historically disconnected allows for empirical assessment of the relationships between

connectivity, digital inclusion, and economic integration in ways that are not possible in the already connected Global North.

There is also further need to attend to questions around the ways in which big data economies, algorithms, digital technology design, and utopian narratives are informed by the persistence of colonialism and masculinism. Western-centric prototypes of the 'smart city' cannot – and should not – be transplanted onto megacities of the Global South with no consideration of a city's unique history, infrastructure, or context (Datta 2015). Similarly, as Gillian Rose (2016b) has recently argued, visions and discourses of the city are characteristically devoid of the presences of women; when they do appear, it is almost exclusively as the victims of violence.

Continuing to think along the lines of Crampton *et al.*'s (2013) imperative to go beyond the geotag, geographers need to be increasingly attuned to the ways in which algorithms and spatial big data - namely, personal locational traces - participate within epistemologies that equate data with definitive evidence of spatial presence, movement and behaviour in what Crawford (2014) terms 'data-driven regime[s] of truth.' As a function of the relationality of big data phenomena, data indicative of spatial presence, movement and behaviour are being used to infer social, political and religious affiliations about individuals, as well as their involvement and complicity in events and occurrences such as protests and their predisposition or likelihood towards participation in particular kinds of activities (see Leszczynski, 2015a). Such data-driven correlations are deeply informed by, and reproduce, longstanding socio-economic inequalities, which must continue to be made visible. Related to this, there is much work to be undertaken in mapping out the politics and ethics of spatial big data, open data initiatives, algorithms, and the impetus towards smart cities. This includes the need to examine the ownership and control of

data; the integration of data within urban operating systems, control rooms, and data markets; data security and integrity; data protection and privacy; data quality and provenance and dataveillance.

It is clear that ideals such as the OECD's (1980) Fair Information Practice Principles concerning notice, choice, consent, security, integrity, access, use and accountability are treated as redundant, with data being generated without consent and repurposed in the service of data-driven urbanism and the 'data-security assemblage' (Aradau and Blanke, 2015, Kitchin, 2014c; Shelton *et al.*, 2015). As Datta (2015), Greenfield (2013), Kitchin (2014c) and Leszczynski (2016) note, there is a strong neoliberal ethos underpinning such appropriations of data, with the technological solutionism deployed and the corporatisation of city services designed to buttress inequalities and enforce securitised regimes of law and order. Geographers are ideally placed to map the socio-spatial materialities of these various data regimes and to chart the promises and perils, socio-spatial processes, and political economies of data-driven urbanism. At the same time, geographers are well positioned to undertake normative analyses to investigate what a more fair, equitable and ethical smart city might look like. This is important because discourses of equitability are currently controlled by corporations who own this data and their platitudes regarding 'citizen-centric design' should not be taken at face value.

The digital has reshaped how geographical research is conducted, becoming a central focus across Geography's various sub-disciplines. In this paper, we have traced the multiple diverse epistemological and methodological frameworks through which the digital has been engaged in geography over the last half-century.With a particular emphasis on contemporary human geographies, we have intentionally abstained from promoting particular methods and/or theoretical approaches above others. Rather, we believe that the rapidly

diversifying and burgeoning universe of networked digital content, presences, praxes, phenomena, and technical protocols is deserving of a parallel multiplicity of epistemologies, political projects, and methodologies. As the proliferation, commercialization, and popularization of geolocation technologies in particular is itself engendering the flourishing of spatial ontologies and epistemologies, we encourage geographers to adopt and embrace an epistemological, ontological, and methodological openness in their engagements with the digital.

Notes

1. For example, the 'digital geographies, geographies of digitalia' sessions at the Association of American Geographers conference, Tampa Bay, April 8th-12th 2014; the 'co-production of digital geography' sessions at the Royal Geographical Society conference, London, August 27th-29th 2014; and the 'Digital Geography' workshop organized at the Open University, March 24th 2015.
2. The Surui cultural map Google Earth layer (.kmz) may be downloaded at https://www.google.co.uk/earth/outreach/stories/surui.html

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