Speculative futures: cities, data, and governance beyond smart urbanism

Agnieszka Leszczynski
School of Environment
University of Auckland

Citation: Leszczynski A (2016) Speculative futures: cities, data, and governance beyond smart urbanism. *Environment and Planning A* 48(9): 1691-1708.

Abstract

In this paper, I examine the convergence of big data and urban governance beyond the discursive and material contexts of the smart city. I argue that in addition to understanding the intensifying relationship between data, cities, and governance in terms of regimes of automated management and coordination in 'actually-existing' smart cities (Shelton et al., 2015), we should further engage with urban algorithmic governance and governmentality as material-discursive projects of future-ing, i.e., of anticipating particular kinds of cities-to-come. As urban big data looks to the future, it does so through the lens of an anticipatory security calculus fixated on identifying and diverting risks of urban anarchy and personal harm against which life in cities must be securitized. I suggest that such praxes of algorithmic speculation are discernible at two scales of urban big data praxis: the scale of the body, and that of the city itself. At the level of the urbanite body, I use the selective example of mobile neighbourhood safety apps to demonstrate how algorithmic governmentality enacts digital mediations of individual mobilities by routing individuals around 'unsafe' parts of the city in the interests of technologically ameliorating the risks of urban encounter. At the scale of the city, amongst other empirical examples, sentiment analytics approaches organized around preemption and prevention prefigure ephemeral spatialities of civic strife by aggregating and mapping individual emotions distilled from unstructured real-time content flows (such as Tweets). In both of these instances, the urban futures anticipated by the urban 'big data security assemblage' (Aradau & Blanke, 2015) are highly uneven, as data and algorithms cannot divest themselves of urban inequalities and the persistence of their geographies.

Keywords

algorithmic governance; big data; future; security; smart cities

Introduction

In this paper, I examine the convergence of big data and urban governance beyond the material and discursive context of the smart city. I argue that in addition to understanding the intensifying relationship between data and governance in terms of regimes of automated management and coordination in 'actually-existing' smart cities (Shelton et al., 2015), we should further engage with modes of urban algorithmic governance and governmentality as material-discursive projects of future-ing, i.e., of anticipating particular kinds of cities-to-

come. Indeed, David Lyon (2014) has argued that one of the defining characteristics of big data is that it "focus[es] on the future more than on the present and the past" (6). For him and others such as Aradau (2015), the future orientation of big data is latent in a speculative ethos which underwrites a complex of analytics practices designed to anticipate and shape the unfolding of possibilities, particularly those around social deviance, risk, and unrest. The notion of 'the future' is often discursively articulated as something necessarily different from the present and the past (Anderson, 2010; Kinsley; 2012; Massumi, 2007). While this promise of divergence may provoke affects of hope bound up in the prospect of change for the better (Anderson, 2006, 2014), the radical openness of the future as an endless set of potentialities simultaneously carries with it threats of disaster, emergency and anarchy against which contemporary liberal-democratic life must be securitized (Amoore, 2013; Anderson, 2010; Aradau and Blanke, 2015; de Goede and Randalls, 2009).

Per Amoore (2011), such securitization may be realized through the operationalization of a risk calculus which abstracts individual subjects into fragmented encodings she terms 'data derivatives.' Here, the security calculus is an algorithmic process by which data derivatives are cast onto a horizon of possibilities such that potential scenarios may themselves be ascribed degrees of "risk, suspicion and… value" (Amoore, 2014, 2011; Crampton, 2015a: 11). Decoupled from identifiable objects/subjects and stripped of context, the data derivative is theorized as being agnostic to current (or 'actual') conditions (Amoore, 2014). Data derivatives feed algorithmic determinations of potentiality which establish "what can be imagined and inferred about who [subjects] might be[come]" (Amoore, 2011: 24), rendering these speculative subjectivities actionable in the here-and-now in ways that are increasingly computationally enacted (i.e., data-driven and automated; Introna, 2015; Kinsley, 2012; Kitchin and Dodge, 2011).

Contemporary data-driven security as a safeguard against social as well as natural disaster is inherently a project of future-ing (Anderson, 2010), i.e., of making secure, resilient futures by circumscribing the horizon of possibilities to exclude potential scenarios deemed undesirable or deleterious. Futuring is organized around anticipatory regimes of governance which hold axiomatic that the "unforeseen can be made foreseeable, can be somehow folded into present decision" (Amoore, 2007: 226). The security-risk calculus which underwrites these modes of anticipatory governance seeks to identify, manage, minimize and insulate against exposure to adverse possibilities through shaping particular kinds of subjects, such as the "proto-suspect," who expressly contain or redirect future threats to equilibrium, stability, and order by actively participating in their own algorithmic self-regulation (Amoore, 2007: 226; Anderson, 2007; Crampton, 2015a). Accordingly Introna (2015) clarifies that 'algorithmic governance' is often intended to actually refer to techniques and practices of algorithmic *governmentality*: modes of governing whereby subjects are affected to govern themselves, as well as the ways in which data and algorithms have become a fixture of the entire ensemble

> formed by the institutions, procedures, analyses and reflections, … calculations and tactics that allow the exercise of this very specific albeit complex form of power, which has as its target population, as its principal form of knowledge political economy, and as its essential technical means apparatuses of security.
>
> (Foucault, 1991: 102)

While anticipatory algorithmic governmentality has often been narrowly engaged in terms of shaping particular kinds of subjects (see for example Amoore, 2011; Amoore and Hall, 2009; Cheney-Lippold 2011, Introna, 2015; Sadowski and Pasquale 2015), Crampton (2015a) is mindful to point out that these active productions of subjectivities have geographical outcomes. Algorithmic governance (as governmentality) is productive of subjects *and* spaces. And as cities have come to be constituted as much by their digital

shadows - content generated *about* city spaces *from* city spaces – as by bricks and mortar (Graham, 2013), much like subjects, they are subject to being dis/assembled across information flows. Inasmuch as it is possible to theorize a data derivative as an abstraction of individuals into discrete variables for a security-risk calculus (Amoore, 2011, 2014), it is possible to similarly posit an *urban* derivative. (Big) data about/from cities likewise feed a speculative security calculus that projects urban derivatives onto "an array of uncertain futures" in the interests of securitizing against that very uncertainty by rendering it actionable in the present through various kinds of preemptive urban interventions (Amoore, 2011: 24).

This is intimately bound up with the ways in which data have become "the modus operandi and raison d'etre" of contemporary modes of urban governance (Shelton et al., 2015: 16), particularly those immediately synonymous with 'smart city' initiatives which give precedence to data capture and analytics in support of a range of urban processes and practices including city planning, infrastructure operation, preemptive policing, and the management of urban mobilities and flows (see also Kitchin, 2014b; Roche, 2014, 2015; Sadowski and Pasquale, 2015). Smart cities are driven by and organized around efficiency gains on the time horizon of the present. Most real-time urban big data – such as that from road traffic sensors, pollution monitors, flood sensors – are appropriated within a very immediate time-frame to manage the here-and-now, whether interfaced via urban dashboards or centralized within command-and-control facilities such as the Operations Centre of the City of Rio (Kitchin, 2014b; Kitchin et al., 2015; Mattern, 2014, 2015).

But beyond the temporalities of the 'real-time city' (Kitchin, 2014b) and the concomitant preoccupations with maximizing efficiencies in the present, (big) data as they are enrolled within modes of urban governance simultaneously actualize "particular vision[s] of the future city" (Shelton et al., 2015, page 13). Accordingly, it serves us to ask, what kind of a city is envisioned and affected by big data as it looks to the future? Or, alternatively

stated, what is the array of potential urban futures enacted by urban derivatives as they are projected onto the horizon of possibilities via the data-security calculus? Questioning what kind of a city big data anticipates involves analytically and discursively moving beyond the emphases on efficiency and temporal immediacy implicit in narratives of smart urbanism. We must further account for the material workings and effects of longer-term temporalities which inflect modes of speculative algorithmic governance and governmentality in the service of anticipate particular kinds of cities. These anticipatory algorithmic governance/ governmentality regimes are themselves characteristically oriented around a telos of security rather than efficiency, as is consonant with an increasing intimacy between big data and security (Amoore, 2016; Aradau, 2015; Aradau and Blanke, 2015; Lyon, 2014). I argue that as the city is subsumed within the data-security assemblage as an object/subject of algorithmic governance (as governmentality), urban big data does not actually envision a radically different city as would be consistent with an understanding of the future as organically open, as something that always comes as a surprise (Anderson, 2010). Algorithmic governmentality cannot divest itself of actual urban realities of socio-spatial stratification to which the derivative is theoretically indifferent. Extant inequalities are abstracted into data flows, informing and propagating through the calculation of algorithmically anticipated urban futures. Even where only speculative, this can be evidenced at two scales of digital urban praxis: the scale of the urbanite body, and that of the city itself.

There are clearly many forms of urban big data that map at (and onto) the body and city scales. At the scale of the embodied urban subject, for example, this can include practices of logging and sharing personal spatial trajectories through practices of the quantified self; or, the continuous monitoring, tracking, and identification of individual bodies via distributed CCTV networks coupled to automated facial recognition technology seamlessly embedded across numerous cityscapes of the world. Here, however, I present and

work through two selective examples at each of the scales of both the body and the city to illustrate how the dividuation of the city into urban derivates feeds security calculi which are speculative in their logic, operationalizing an anticipation of cities-to-come in the interests of their securitization. The first example involves digital mediations of the individual urban experience through locative media, which affect subjects to opt-in to the algorithmic management of their mobilities as a practice of self-securitization against risks of particular kinds of urban encounter. I discuss these with reference to neighborhood safety applications. The second involves the ordering and regulation of city spaces achieved by tapping into spatialized real-time urban digital content productions and misappropriating them as proxies for collective dis/affection. These distillations of affect inform practices of prefiguring ephemeral spatialities of urban deviance and risk through sentiment analytics. I take each of these up in turn below, but first attend to the relationality between big data and cities.

Urban, big, data

'Big data' has emerged as a nebulous placeholder for varied aspects of the contemporary pervasiveness of data - digital abstractions of "observations, computations, experiments, [and records]" of phenomena - in the spaces and practices of everyday life (Kitchin, 2014a: 2). This pervasiveness has conventionally been characterized in terms of the sheer volume, variety, and velocity (the 'three V's') of continuous, real-time flows of information commensurate with the rise of content, the cloud, mobile computing, transactional capta, distributed sensor networks, and the digitization of records (see for example Mayer-Schonberger and Cukier, 2013). More recently, however, social scientists in particular have moved past instrumentalist definitions emphasizing the size, speed, and diversity of data generation by engaging 'big data' as socio-technical productions which form and function as data assemblages (Aradau and Blanke, 2015; Kitchin and Lauriault, 2014). 'Assemblage' here designates the institutional, political, economic, technological, affective

and social arrangements and practices which enable and prioritize enrollments and deployments of data within technologically-enacted processes (such as data analytics) leveraged towards the realization of particular kinds of social ends (boyd and Crawford, 2012; Crampton, 2015a; Crawford et al, 2014; Kitchin 2014a; Kitchin and Lauriault, 2014). Theorizing big data as an assemblage deemphasizes debates about thresholds at which data productions become sufficiently sizeable to be considered 'big,' and foregrounds instead the unprecedented extent to which data have become entirely ordinary and expected presences on 'the street' (Taylor et al., 2014).

The city itself has also been theorized as an assemblage, as comprising a uniquely "processual, relational, mobile and unequal" spatiality (McCann, 2011; McCann and Ward, 2011; McFarlane, 2011a; 2011b: 649; McGuirk, 2011). Geographers know that practices, actors, objects, institutions and processes come together in and occur (i.e., assemble) in space. In this way, it is possible to think about the city-assemblage in two senses of the term: as a spatial assemblage (a unique spatiality that may be engaged as an assemblage), and the city as actively spatializing (as giving spatial form to various assemblages). As an example of the latter, Haggerty and Ericson's (2000) 'surveillant assemblage,' which captures the emergent, rhizomatic nature of contemporary dataveillance, is theorized by the authors as inherently urban, enabled by the density of surveillance apparatuses in cities. Kitchin (2015) builds on this in his recent theorization of continuous geosurveillance as a phenomenon of the sensor-seeded, extensively monitored landscapes of the 'smart city'. These distributed sensor networks capture urban processes and abstract mobilities as data to be enrolled as functional inputs towards a series of (semi)automated operations and optimizations. Simultaneously, the city is also constituted by volumes of data generated *about* city spaces *from* city spaces through quotidian enrollments of mobile, digital information and communication technologies (ICTs) and the platforms and services that run on these devices. To quote

Graham (2013), "[c]ities ooze data[;] they cast innumerable data shadows" (117). This is not only the effect of the urban density of denizens and devices, but also of the ways in which content production is a demonstrably urban phenomenon. In their analysis of volunteered geographic information contributions (VGI) across three platforms – Twitter, Flickr, and Foursquare – Hecht and Stephens (2014) found a statistically significant urban bias in the per-capita user-generation of geospatial content. 'Urban big data' accordingly designates these multiple articulations of cities and data: the urban as site, subject, and seat of data capture and production practices.

The ways in which code, data, and algorithms assemble the city are geographically uneven. This is by no means a novel claim, but rather an enduring reality of the ways in which the 'softwirization'[1] of the city has underwritten the intensification of various practices of socio-spatial stratification that are rendered transparent by virtue of becoming progressively digitally mediated and automated (Dodge et al., 2009; Graham, 2005; Kitchin and Dodge, 2011; Monahan, 2008). Software, in other words, sorts the city (Graham, 2005): bodies are positioned as belonging in or excluded from certain spaces, and city spaces are characterized and geographically demarcated on the basis of the presences of the kinds of bodies deemed expected or anomalous therein.

As cities are increasingly constituted not only by software and code but also by data (Graham, 2013), the digital shadows they cast are not uniform but rather (re)enact urban inequalities. For example, a Google Maps search for 'restaurant' in Tel Aviv conducted from the same location in Arabic and Hebrew, respectively, returns radically divergent results, with different establishments appearing at the top of the results chain for a query conducted in either language (Graham and Zook, 2013). The result is a material reification of imaginaries of which kinds of bodies belong in which kinds of spaces (e.g., Arab speakers being directed to Arab sectors of the city; Hebrew speakers directed to Jewish quarters of the

city), and a shaping of commercial patronage behaviors and urban mobilities of individuals and social groups. As further expounded upon by Graham (2013), the results of such Balkanizations of spatial content (in this case along linguistic lines) are the concomitant material productions of socio-economically stratified cities.

Zook and Graham's (2013) analysis of the spatial contours of geolocated content is illustrative of how content and algorithms come together in the material (re)production of highly uneven urban geographies in the here and now, in real-time and on-demand. Yet as urban content, algorithms, and governance become ever more intimately bound in a '(big) data-security assemblage' that privileges and values the operationalization of data within analytics practices in the service of various forms of spatial securitization (of bodies, cities, nations; Aradau and Blanke, 2015), the security calculus does not only (re)produce extant urban inequalities in the present, but it also actively projects them forward in space and time. The material spatial effects and affects bound up in anticipations of unequal urban futures may be observed across what may initially appear to be distantiated and unrelated moments of contributing and tapping into spatial big data flows to support activities across multiple scales of digital practice. At one end of a spectrum of urban big data practices are highly individualized, ad-hoc enrollments of location-aware mobile devices and applications (apps) that mediate the personal urban experience by proposing to optimize individual bodily mobilities. At the opposite pole of the spectrum are city-scale practices of appropriating flows of real-time geocoded social media content to optimize regulatory spatial interventions by prefiguring and preempting spatial pre-futures of urban disorder.

Containing risks of urban encounter

Locationally-aware mobile devices are ubiquitous presences on city streets around the world. The urban experience is now thoroughly mediated by content, interfaces, and algorithms (de Souza e Silva and Frith, 2012; Sutko and de Souza e Silva, 2010). Location-

enabled hardware/software objects do more than enhance and streamline quotidian activities such as navigating through traffic or making public transportation connections. Increasingly these mediations are real-time; mobile applications and services continuously interface circuits of uninterrupted content flows by exploiting the locational awareness of positionally-enabled personal devices, often through the passive operation of locational utilities in the background of the mobile operating system. The utilities of these applications and services are varied, but a substantial proportion are predicated on anticipating individual motilities by seeking to manage, rather than outright curtail (i.e., discipline), the movements of bodies through cities.

The socio-spatial stratification effect bound up in the management of individual urban mobilities may be evidenced in a class of mobile applications that may loosely be referred to as neighborhood safety applications (or apps). These come in essentially two varieties. The first group consists of navigation-centric applications, such as Microsoft's patent for a Pedestrian Route Production utility, which dynamically route individuals around 'dangerous' areas of cities, re-calculating possible lines for travel on the basis of a user's current geographic position, spatial history, social interactions, and behavior, all of which are subject to capture as data. Apps of the second variety, such as the now-defunct *SketchFactor* and *Ghetto Tracker* (renamed *Good Part of Town* prior to its quick demise) released in major US cities, solicit user-contributed personal reviews of urban and suburban neighborhoods, at times combining these contributions with public data such as crime statistics, socio-economic and demographic data from the census. These services crowdsource and subsequently present this content in the form of aggregate ratings of the relative 'sketchiness' and 'ghettoness' of city spaces.

In the case of *SketchFactor*, these aggregate scores were presented as Chernoff face-like placemarks meant to inform non-locals about neighborhoods they should avoid visiting

and/or travelling through (McEnry, 2014). Contributors could indicate other factors (such as whether the area was poorly lit, or whether they observed instances/evidence of 'crime'), and could leave descriptive comments about what made the neighborhood 'sketchy' in their opinion. As described by Biddle (2014), the very branding of the app carries with it racist, classist connotations, as 'sketchy' is a term used almost exclusively by "young white people… to describe places where they don't feel safe because they watched all five seasons of [the HBO television series] *The Wire*" (a show set in inner-city Baltimore which explored, amongst others, themes of urban decay, social inequality and racial segregation). The racist framing of an app named *Ghetto Tracker* is more explicit, with 'ghetto' in the North American context constituting a derogatory designator for poor inner-city neighborhoods inhabited by racial and ethnic minorities often residing in housing projects (government housing). Even once renamed *Good Part of Town*, this branding carries with it reminders of the enduring spatial legacies of residential redlining in the U.S., which stripped racial and ethnic minorities of their rights to equitable homeownership (and accordingly equal opportunities in education, the accrual of wealth and home equity, and social mobility). Like *SketchFactor*, *Ghetto Tracker/Good Part of Town* similarly solicited user feedback about the relative safety of urban and suburban areas, making summative ratings and user comments accessible via map-based pop-ups under the auspices of providing 'travel advice' (Narula, 2013).

Both these navigation-centric and review-based types of neighborhood safety apps enact forms of algorithmic governmentality that prefigure and shape self-regulating subjects who willing position themselves within, and actively contribute to, an urban security calculus as a means of minimizing their own personal exposure to urban risks presented by risky bodies in risky spaces. Microsoft's Pedestrian Route Production patent for a dynamic foot-traffic travel application to run on the Windows phone is emblematic of the ways in which

such modes of algorithmic governmentality are predicated on an anticipatory logic that anticipates unequal urban futures. Popularly dubbed the 'Avoid Ghetto GPS' but never actually developed for market, the Pedestrian Route Production patent envisioned a map-based service that would dynamically (re)calculate a set of walking directions for users taking into account "user history, weather information, crime statistics, demographic information, etc." and subjecting this data to the routing algorithm, which would optimize travel across the city "according to at least one criterion, such as keeping a user safe," by "taking the user through neighborhoods with violent crime statistics below a certain threshold" (Tashev et al., 2012: no page). What was to constitute 'demographic information' or 'crime statistics,' and/or where such data was to be sourced, is nowhere specified in the patent application. This similarly holds for the vague reference to 'crime statistics.' The repeated use of language around the safety utility of the service to be realized through its routing of pedestrians around "unsafe neighborhood[s]" designates soft-speak for racialized and ethnic-minoritized poor inner-city American urban imaginaries of what those spaces look like and the kinds of bodies that are thought to populate them (Tashev et al., 2012: no page).

Accordingly Thatcher (2013) identifies the Pedestrian Route Production patent as more than simply a prospectus for a navigational utility that optimizes pedestrian movement through the city. In its very envisioning, the service anticipates futures that are always-already raced and classed. The promise of the technology to ensure "efficiency, safety, and new forms of coordination" is inseparable from, and is indeed predicated upon, the "[opening up of] a future wherein encounters on the city street are sorted by race; an unseen algorithm enabling users to only ever encounter those already sorted as demographically similar" (Thatcher, 2013: 967, 974). The Microsoft filing may in this way be thought of as a patent for a highly individualized risk calculus. It looks to affect subjects to assume responsibility for their own security by opting-in to an app that algorithmically triggers

behaviors that effectively avert and manage the risks of encountering risky (racialized, classed) bodies in risky (ethnic-minoritized, impoverished) spaces by simply not projecting these onto the array of potential futures (as possible trajectories for travel). The operationalization of this calculus depends on the abstraction of both subjects and cities into derivatives – geographic position of the user, crime statistics, weather – to be reassembled via the mobile interface, which recalculates the horizon of possibilities on the fly to reflect changes in real-time conditions.

For the purposes of this discussion, what is important about these apps is how they position themselves as material-discursive devices for enacting data-driven urban futures. They are highly speculative in orientation, anticipating cities that are risky by virtue of being socio-spatially stratified – around every city street loom threats to personal harm and safety bound up in the possibility of undesirable urban encounter. Informed by this anticipatory logic, these apps appropriate city spaces and denizens as data derivatives that may subsequently be reassembled by a speculative calculus of risk, such as that which would be operationalized by algorithmically routing pedestrians around 'unsafe' neighborhoods. As proposed, the continuous (re)calculation of routes for travel described in Microsoft's Route Production patent application is an enactment of future-ing, of addressing normative neoliberal subjects to self-securitize by actively participating in the algorithmic governmentality of their personal mobilities so as to offset the hypothetical risks associated with 'unsafe' urban encounters that loom on the horizon of possibilities. In the second instance, as is characteristic of the crowdsourced nature of both SketchFactor and Ghetto Tracker/Good Part of Town, these services assume hyper-responsibilized subjects who not only willingly position themselves within the remit of a spatial algorithmic calculus (of navigation, for example), but also actively contribute to it by generating highly affective, emotional content productions in the form of ratings and commentaries about city

neighborhoods. This (re)enacts an urban geography in which risks such as 'poor lighting,' observations of 'crime,' and even the presence of bodies deemed unsavory (homeless persons, residents of particular ethnic and racial backgrounds) can effectively be contained. Yet by spatially containing purported threats of urban encounter, these neighborhood safety apps would fail to actually enact any radically different city. In abstracting extant socio-spatial disparities as derivatives to be projected onto the horizon of possible urban futures, the algorithmic security calculus cannot divest itself of actual conditions on the ground, anticipating a socio-spatially stratified city.

Securitizing the city

While the city is pervasively interfaced via mobile devices which digitally mediate individual experiences of the urban, cities themselves also function as interfaces for data capture, generation, circulation, and aggregation (Barreneche, 2012; de Waal, 2014). The anticipatory ethos which underwrites speculative proposals for the containment of risks of urban encounter similarly informs city-scale forms of anticipatory governmentality oriented towards securitizing the city against the risks of city-wide social disorder latent in unstructured, non-curated data flows generated by largely unaffiliated[2] individuals participating on social media. When subjected to practices of big data handling known as 'sentiment analytics,' these piecemeal derivatives of urban emotion are algorithmically assembled to (supposedly) betray collective affects of alienation, incitement to violence, and lack of confidence in law enforcement. Such affects carry with them the threat of potentially materializing as contagious behaviors of urban disruption including protest, rioting, and looting. Sentiment analytics operationalizes a synthetic distillation of the emotional pulse of a city to inform a speculative anticipation of pre-futures of urban anarchy immanent in codified expressions of civic strife that can be mapped onto an urban geography. Neighborhoods or boroughs determined to be teetering on the verge of descent into disorder are effectively

rendered ripe for various kinds of interventions - such as heightened surveillance and increased police presence - designed to preempt the materialization of undesirable urban futures.

Sentiment analytics are part of a group of approaches to operationalizing big data referred to as 'predictive analytics,' which describes a "variety of statistical, modeling, data mining, and machine learning techniques to study recent and historical data, thereby allowing analysts to make predictions about the future" (Bertolucci, 2013: no page). These anticipated futures may then be shaped and/or preempted through combinations of formative (suggesting book titles to Amazon customers) and preventative (stocking up on flu vaccine) interventions that enable or forestall the unfolding of un/favorable scenarios (additional purchases, seasonal disease epidemics). 'Sentiment analytics' specifically are predictive-analytics based systems that interface social media platforms through their public streaming APIs and capture content as it is being generated by individuals in real-time in order to model a "population's behavior (opinions and sentiments) so as to produce geographical risk alerts" of threats to public order (Barreneche, 2012: 215; The Economist, 2012). While several such analytics suites have been developed (see Barreneche, 2012; The Economist, 2012), a particularly illustrative example is the British sentiment analytics engine EMOTIVE (Extracting the Meaning of Terse Information in a Geo-Visualization of Emotion). EMOTIVE was designed to monitor and map shared atmospheres of affect as expressed through individualized contributions to the social media platform Twitter (EMOTIVE, 2015; Press Association, 2013; Sykora et al., 2013).

EMOTIVE processes up to 2,000 Tweets per minute through a lexicon-based natural language processing (NLP) algorithm that matches emoticons and strings of words extracted from sparse, unstructured texts to a limited set of possible emotions – including anger, disgust, fear, happiness, sadness, loneliness, surprise, shame and inadequateness – mapped in

a formal ontology (EMOTIVE, 2015; Marsden, 2013; Sykora et al., 2013). Once filtered through the NLP pipeline, EMOTIVE subsequently processes Tweets through a geolocation module that scrapes them for spatial referents, including coordinates (for natively geocoded Tweets) and other geographical metadata (EMOTIVE, 2015; Marsden, 2013). This allows emotions distilled from Tweets to be spatially aggregated in dynamic 'mood maps' of UK cities that can be used by law enforcement to inform preemptive measures for suppressing the organization and social contagion of public expressions of strife and alienation (for example, blocking off access routes into/out of neighborhoods as an anti-kettling tactic) (EMOTIVE, 2015; Marsden, 2013: no page; Press Association, 2013).

EMOTIVE is a proof-of-concept. But as with neighborhood safety apps introduced in the previous section, what matters for the purposes of this discussion is not so much how many law enforcement agencies have incorporated this particular sentiment analytics engine within predictive policing practices. What is significant is the way in which EMOTIVE is a proof-of-concept for operationalizing a preemptive algorithmic calculus for securitizing the city that is axiomatic in its underlying logic and anticipatory in scope. The instrumentalist utility of the ability to tap into social media streams in real-time is that it extends an ability to intervene not only in the future (by preempting it in the present), but also somehow in a data-determined pre-future, before the contagion of data-latent disaffection may be projected forward in time and space. Data-latent contagion here refers to the propensity of digital phenomena to go 'viral' – i.e., to be suddenly and perhaps without precedent be widely shared by users across digital platforms to the extent that it reaches the status of cultural reference, even if only ephemerally. This preoccupation with contagion and the risks of its materialization as dis/organized behaviors branded 'anti-social' informs not only EMOTIVE but also other sentiment analytics platforms, such as Condor, an earlier example designed specifically for modeling protest dynamics (The Economist, 2012). Condor factors in the

reputation, or clout, of Twitter users in determining the likelihood and viability of public demonstrations. If negative sentiments and/or calls for collective action are shared by users with a large number of followers, they are likely to be re-tweeted (spread) with greater frequency and rapidity, having increased influence in incentivizing demonstration, civic disobedience, etc. (The Economist, 2012).

EMOTIVE seeks to securitize the city against risks of the contagion of negative social affects such as anger and disgust which carry with them the threat of social disintegration, even where such risks exist only in speculative form as codified urban derivatives abstracted from performative content productions reduced to a formal ontology of emotion. Yet although the EMOTIVE security calculus is anticipatory in its orientation, it cannot divorce itself from the historical and enduring socio-spatial inequalities that are anticipated by its algorithmic assembly of cities-to-come. This is because the very inception of the platform is informed by uneven social geographies that are always being negotiated and contested in any public expressions and demonstrations of discontent, such as organized protests. The researchers behind the design of the EMOTIVE platform detail having developed it in the wake of the 2011 protests and subsequent riots which spread through socioeconomically deprived and racial/ethnic minoritized boroughs of London and outwards to other UK cities (EMOTIVE, 2015). They identified the "urban disturbances" of the "fast-moving events of Summer 2011," and the "key role played by social networks" in spurring the spread of socially disruptive behaviors as an event horizon precipitating the development of a sentiment analytics suite to help both city police departments and national security agencies "to predict and monitor selected events" across UK cities (EMOTIVE, 2015: no page). Significantly, the 'urban disturbances' referred to in the framing of the EMOTIVE analytics suite originated in response to the police shooting of an unarmed Black man at point-blank range in what marked the climax of an escalation of simmering tensions between the police

and ethnic-minoritized communities (Lewis, 2011; Newburn et al., 2011). At the time, law enforcement and the press identified mobile social media - in particular Twitter, BlackBerry Messenger, and Facebook – as having enabled the coordination of rioting and subsequent looting and vandalism (see for example Adams, 2011; Press Association, 2013).

Insofar as EMOTIVE 'looks to the future,' it is predicated on an imaginary of cities as tending towards disorder, where disorder itself is a function of socio-spatially stratified urban geographies. Riots, for example, are axiomatically assumed as likely to occur in certain kinds of (socioeconomically deprived) areas, and to be incentivized and performed by certain kinds of (Black, Asian, student, White working class) bodies that are seen to normatively inhabit those spaces. As a mode of algorithmic governmentality oriented towards the securitization of city spaces, EMOTIVE presumes that the urban derivatives (geo-located Tweets distilled to an emotional ontology) projected onto the array of possible futures already carry with them the latency of descent into anarchy, and that this tendency to disorder can be isolated and spatially aggregated by its security calculus (the NLP pipeline and geo-location module). But as with the neighborhood safety apps, the urban derivative cannot be divorced from stratified urban geographies actually-existing on the ground.

Conclusion

Cities are constituted by their data shadows (Graham, 2013). These data do not merely emanate into the ether, but are actively enrolled within contemporary modes of urban governance which privilege data as a fixture and fixation of ordering and organizing persons, places, objects, events, and flows within and across city spaces (Shelton et al., 2015). To date, much of the discussion of the binding of data and urban governance in the literature has been framed in terms of maximizing efficiencies in the 'real-time' smart city.[3] In this paper, I suggest that in addition to understanding big data and urban governance in terms of automated management in 'actually existing'[4] smart cities, we may further make sense of the

appropriation of urban (big) data within modes of algorithmic governance/governmentality as a project of future-ing. This provides a means of making sense of the intensifying relationship between cities, governance, and data beyond the sole discursive rubric of smart urbanism by accounting for the longer-term temporalities and security preoccupations of data-driven algorithmic anticipations of cities-to-come.

The actually-existing city and the anticipated future city are of course co-constitutive. The extensive networks of sensors seamlessly distributed across cityscapes which allow for real-time monitoring and synchronicity simultaneously serve as a highly effective urban surveillance grid; efficiency and security are not antithetical but rather co-implicated. In this paper, I foreground security over efficiency to emphasize the ways in which modes of urban algorithmic governance (as governmentality) are operationalized as a means of controlling for the unfolding of undesirable urban futures by affecting particular kinds of subjects and spaces that redirect, deflect, and spatially contain imminent risks of contemporary urban life latent in urban derivatives. As I have introduced it in this paper, the 'urban derivative' parallels Amoore's (2011, 2014) theorization of data derivatives as the abstraction of individuals into decontextualized encodings which serve as functional inputs to speculative calculi that anticipate particular kinds of subjects who may themselves be positioned (or position themselves) within the remit of said calculi. Similarly, the 'urban derivative' designates the disassembly of cities into discrete codifications of places, denizens, flows, and events reassembled across data flows via an algorithmic calculus that speculates on the imminence of particular kinds of city-assemblages that loom on the horizon of possibility.

I have suggested that such speculative modes of urban algorithmic securitization may be most immediately evidenced at two ends of a continuum of spatial scales of digital practice: that of the individual urbanite body, and that of the city itself. Drawing on the selective example of neighborhood safety apps such as that described in Microsoft's patent

filing for a pedestrian navigation app, algorithmic governmentality of the individual body is operationalized via a routing algorithm that effects the spatial containment of risks of urban encounter. The risks of encountering the racialized other in socioeconomically deprived neighborhoods is technologically ameliorated by an algorithm that circumnavigates these areas. The speculative design of Microsoft's Pedestrian Route Production service axiomatically presumes normative, risk-averse neoliberal subjects who will self-securitize - i.e., participate in their own algorithmic self-governmentality – by intentionally adopting and utilizing the service as a means of mitigating any threats to their safety associated with walking through 'unsafe' neighborhoods. Other instances participating in the 'neighborhood safety apps' class, such as *SketchFactor* and *Ghetto Tracker/Good Part of Town*, assume hyper-responsibilized neoliberal subjects who further contribute to the security calculus by contributing ratings of urban neighborhoods to these platforms. These contributions (reviews and commentaries) are the definition of the urban derivative – decontextualized by virtue of being contributed by individuals whose (race, gender, socioeconomic) positionality is likely obfuscated, and aggregated in the form of seemingly neutral summaries of the relative safety of different urban areas.

Elsewhere, practices of algorithmic governmentality as a mode of securitizing the city against various risks of urban disorder do not necessarily depend on active crowdsourcing but may instead repurpose user-generated content by tapping into continuous flows of piecemeal, non-curated data from social media (Facebook likes, Tweets, etc.). This method is evident in urban sentiment analytics approaches to preemptive urban securitization, which in this paper I have discussed with reference to EMOTIVE, a proof-of-concept platform for generating real-time 'mood maps' of UK cities. The platform consists of a natural language processing (NLP) pipeline through which Tweets, extracted through Twitter's public streaming API, are processed in real-time at a rate of 2,000 per minute. The NLP algorithmic reduces

unstructured strings of texts and emoticons in the content of a Tweet to an ontology of discrete emotions which are then geolocated on the basis of geographical referents and Tweet metadata. The speculative utility of EMOTIVE is latent in its purported ability to distill the emotional pulse of a city, which can inform various kinds of material interventions - such as increased surveillance or stepped-up police presence – enacted to preempt and spatially contain not only risks of urban anarchy bound up in collective expressions of strife and disaffection, but the very contagion of sentiments deemed negative.

EMOTIVE is furthermore interesting insofar as it is demonstrative of the ways in which corporate and state forms of governance (and governmentality) are increasingly difficult to separate as data and security have become progressively imbricated in an ever-intensifying '(big) data-security assemblage' which privileges and enables data-driven forms of securitization (Aradau and Blanke, 2015). EMOTIVE may have been designed for state actors (urban law enforcement) as end users, but its operationalization is entirely dependent on the presence of public entities (social media companies) whose products generate flows of content made available to third parties through public use of their APIs. This is a defining feature of emergent modes of state-enacted signals intelligence activities crystallizing around big data, of which the public has been made aware of through the release of the Snowden documents and subsequent revelations (Amoore and Piotukh, 2015; Aradau, 2015; Crampton, 2015b; Leszczynski, 2015; Lyon, 2014). These include the interception of deep-sea fiber-optic cables owned and operated by commercial interests, the mass collection and retention of communications metadata from telecom firms, and more recent (though to date unsuccessful) efforts of some securities services at breaking mobile operating system encryption.

These intricacies notwithstanding, following Aradau (2015), the 'signature' of big data security is that it is anticipatory in scope - securitization is operationalized by

speculating on data-driven futures assembled across content flows and rendered actionable in the present. As modes of algorithmic governmentality deployed within and across city spaces assemble the city by appropriating data derivatives within a calculus of risk, what kind of a city do they anticipate? In order to answer this question, I have examined how the anticipatory ethos of big data security informs enactments of algorithmic governmentality that address, respectively, both individual bodies in cities and city spaces themselves. In the instance of Microsoft's patent for a speculative pedestrian navigation app, the design of the service is predicated on an urban imaginary of city futures that are always-already raced and classed, and spatially segregated along those lines. These racially and socioeconomically stratified urban geographies represent imminent risks of encounter that may be redirected for privileged subjects by routing them around 'unsafe' neighborhoods.

Moving from the scale of the individual body to that of the city, the very design of the sentiment analytics platform EMOTIVE is a response to uneven urban geographies. By 'response,' I do not mean that it represents an effort to ameliorate forms of urban segregation. Rather, it is a technologically solutionist reaction that betrays a commitment to an imaginary of the city as a socio-spatial assemblage always teetering on the brink of descent into disorder and disarray. The propensity towards urban anarchy is latent within data derivatives which encode urban disaffections abstracted from highly individualized data productions distilled to a formal ontology of emotion. Securitization is achieved by rendering urban spaces algorithmically isolated as hotspots of civic strife ripe for preemptive material interventions. Yet the calculus which informs this determination understands disaffection as something fomented in particular kinds of urban (working class, ethnic-minoritized) area by certain kinds of (student, classed, racialized) subjects.

Insofar as (urban) big data looks to the future, it cannot *but* anticipate socio-spatially stratified cities. This is because the security calculus is dependent on the urban derivative

which, contra Amoore's (2011, 2014) theorization of the data derivative, is *not* indifferent to actual conditions on the ground. The urban derivative abstracts extant inequalities into algorithmic projections of possible urban futures, such that enactments of algorithmic governmentality reassemble the city in its own geographically uneven image. As a project of future-ing, big data in the service of security seeks to securitize the city *against* the future by contending with the uncertainty posed by the future as a radically open set of possibilities. The material realities of the ways in which uneven urban geographies propagate through and are projected onto the array of possible futures via enactments of algorithmic governmentality operationalized in and across city spaces destabilizes utopian narratives of urban big data solutionism.

In the vein of such utopianism, Nigel Thrift (2014) has recently suggested that big data will reduce urban poverty by making it visible (prominent as a trend in the data) and thereby less amenable to obfuscation. There is evidence to support his conjecture about the visibility of inequality. A recent study using anonymized mobile phone records for Rwanda found that an individual's digital footprints derived from mobile phone transactions – locations where individuals are placing and receiving mobile calls – was a strong predictor of their socioeconomic status, accurately reproducing maps of extant geographies of relative socioeconomic deprivation (Blumenstock et al., 2015). At the same time, however, such optimistic pronouncements ignore the deep-seated inequalities that are echoed in urban big data productions themselves. While mobile devices and now smartphones are ubiquitous presences on city streets worldwide, the adoption of and participation on social platforms is led by youth and young adults (see Leszczynski, 2015 for a summary of relevant reports). As such, elderly urban residents living below the poverty line are unlikely to own a smartphone and participate in generating content about their everyday mobilities, such that they "do not [necessarily] register as digital signals" in content flows (Crawford, 2013; Crawford et al.,

2014: 1667). This problem of (under)representation plagues any attempts at algorithmically distilling real-time knowledge of the emotional pulse of a city by scraping sentiment from social media data. Content generated across social platforms is not only highly performative in nature (Wilson, 2015), but indeed has been contributed by a highly select and self-selecting segment of any urban population. The result is that determinations of real-time urban affects cannot be generalized to the scale of the city as EMOTIVE purports to do because the samples from which any algorithmic aggregations are made is simply not representative. This does not even begin to address the polemics of the axiomatic assumption that the algorithmic distillation of an individual's emotional state from highly unstructured, decontextualized strings of text is valid, desirable, or in any way meaningful or indeed ethical.

In other words, it is not only the outcomes of analytics that are questionable. The analytics themselves are also fraught. Urban informatics may indeed allow "phenomena like [urban] poverty [to] become real to more people" (Thrift, 2014: 1264). But as Bowker (2014) points out, this is likely a best-case scenario. Socioeconomic disparities may certainly be rendered more immediately material for those who embody privileged subjectivities and inhabit privileged spaces of the city, but only when these trends in the data actively inform policies that intervene in the production of urban inequality. This however is contingent on the ability of policymakers to make sense of data. Data is easy enough to appropriate, but valid analysis and meaningful interpretation of results are another matter. The coder behind some of the US National Security Agency's (NSA) analytics suites has for example publicly stated that the agency's fixation on intercepting, amassing, and collecting vast swathes of data is actually hindering its surveillance efforts; the agency is simply awash in too much data (Angwin, 2013).

It is for this reason that Bowker (2014) suggest that in the worst case scenario, "and most commonly," big data may deny that urban inequalities exist in refusing "that there are indeed broad social forces" by rendering what are outcomes of intense, continuous negotiations and contestations of urban geographies to be the neutral outcomes of big data analytics in which data have spoken for themselves (1797). Bowker is not articulating a deterministic claim about the inherent deleterious social consequences of big data. It is not big data *per se* but the logics and intentions which inform how data are appropriated and operationalized, and to what societal ends, that is important. These may either effect the reproduction of socio-spatial inequalities or disrupt them. Examples of the latter do exist, such as the nonprofit Invisible Institute's[5] recent release of a comprehensive dataset of 56,000 reports of police misconduct involving 8,500 Chicago police officers over a five-year period (Arthur, 2015). Assembled as part the Citizens Police Data Project, this dataset inverts the power imbalance inherent in practices of predictive policing by providing Chicago residents with a rich data resource for predicting incidences of bad policing (racial profiling, over-policing, physical aggression and violence) in their city (Arthur, 2015).

The arguments made in this paper is not that urban big data are inherently pernicious nor that widening divides between the urban rich and poor would be absent if not for enactments of algorithmic governmentality latent in a patent application for a speculative pedestrian routing service or a proof-of-concept for a sentiment analytics platform. Rather, the argument is about the very material nature of urban inequalities and the persistence of their geographies, both actual and anticipated, from which the urban derivative cannot be divested. The effect is that as urban big data looks to the future through the lens of an algorithmic security calculus, it seeks to securitize contemporary urban life against the risks of uncertainty latent in the radical openness of possibilities, which include amongst them scenarios of personal harm, anarchy, and disorder. In so doing, it projects the certainly of

what is - the characteristic unevenness of the contemporary social geography of cities – forward in time and space, anticipating equally uneven cities-to-come.

Notes

[1] Burrows and Ellison (2004).
[2] Individuals not linked by any social ties or connections, as expressed through their social graphs.
[3] Kitchin, 2014b.
[4] Shelton et al., 2015.
[5] http://invisible.institute/police-data/

References

Adams WL (2011) Were Twitter or BlackBerrys Used to Fan Flames of London's Riots?, *Time* (Online), 8 August. Available at: http://content.time.com/time/world/article/0,8599,2087337,00.html (accessed 3 December 2015).

Amoore L (2007) Vigilant Visualities: The Watchful Politics of the War on Terror. *Security Dialogue* 38: 215-232.

Amoore L (2011) Data Derivatives: On the Emergence of a Security Calculus for Our Times. *Theory, Culture & Society* 28: 24-43.

Amoore L (2013) *The Politics of Possibility: Risk and Security Beyond Probability*. Durham, NC and London: Duke University Press.

Amoore L (2014) Security and the Claim to Privacy. *International Political Sociology* 8: 108-112.

Amoore L (2016) History, Algorithm, Ethics. Paper presented at the Association of American Geographers Annual Meeting, 29 March – 02 April, San Francisco, CA.

Amoore L and Hall A (2009) Taking people apart: digitised dissection and the body at the border. *Environment and Planning D: Society and Space* 27: 444-464.

Amoore L and Piotukh V (2015) Life beyond big data: governing with little analytics. *Economy and Society* 44: 431-366.

Anderson B (2006) Becoming and Being Hopeful: Towards a Theory of Affect. *Environment and Planning D: Society and Space* 24: 733-752.

Anderson B (2007) Hope for nanotechnology: anticipatory knowledge and the governance of affect. *Area* 39: 156-165.

Anderson B (2010) Preemption, precaution, preparedness: Anticipatory action and future geographies. *Progress in Human Geography* 34: 777-798.

Anderson B (2014) *Encountering Affect: Capacities, Apparatuses, Conditions*. Farnham, Burlington: Ashgate.

Angwin J (2013) NSA Struggles to Make Sense of Flood of Surveillance Data. *The Wall Street Journal* (Online), 25 December. Available at: http://www.wsj.com/articles/SB10001424052702304202204579252022823658850 (accessed 20 December 2015).

Aradau C (2015) The signature of security: Big data, anticipation, surveillance. *Radical Philosophy* 191: 21-28.

Aradau C and Blanke T (2015) The (Big) Data-security assemblage: Knowledge and critique. *Big Data & Society* July-December: 1-12. doi: 10.1177/2053951715609066

Arthur R (2015) How To Predict Bad Cops In Chicago. *FiveThirtyEight Politics,*15 December 2015. Available at: http://fivethirtyeight.com/features/how-to-predict-which-chicago-cops-will-commit-misconduct/ (accessed 19 December 2015).

Barreneche C (2012) Localizing the media, locating ourselves: a critical comparative analysis of socio-spatial sorting in locative media platforms (Google and Flickr 2009-2011). Doctoral thesis, University of Westminster.

Bertolucci, J (2013) Big Data Analytics: Descriptive vs. Predictive vs. Descriptive. *Information Week*, 31 December 2013. Available at: http://www.informationweek.com/big-data/big-data-analytics/big-data-analytics-descriptive-vs-predictive-vs-prescriptive/d/d-id/1113279 (accessed 16 December 2015).

Biddle, S (2014) Smiling Young White People Make App for Avoiding Black Neighborhoods. *Valleywag*, 7 August. Available at: http://valleywag.gawker.com/smiling-young-white-people-make-app-for-avoiding-black-1617775138 (accessed 14 December 2015).

Blumenstock J, Cadamuro G and On R (2015) Predicting povety and wealth from mobile phone data. *Science* 50: 1073-1076.

Bowker GC (2014) The Theory/Data Thing. *International Journal of Communication* 8: 1795-1799.

boyd d and Crawford K (2012) Critical Questions for Big Data. *Information, Communication & Society* 15: 662-679.

Buntin J (2013) Social Media Transforms The Way Chicago Fights Gang Violence. *Governing*, October 2013. Available at: http://www.governing.com/topics/urban/gov-social-media-transforms-chicago-policing.html (accessed 16 December 2015).

Burrows R and Ellison N (2004) Sorting Places Out? Towards a social politics of neighborhood informatization. *Information, Communication & Society* 7: 321-336.

Cheney-Lippold J (2011) A New Algorithmic Identity: Soft Biopolitics and the Modulation of Control. *Theory, Culture & Society* 28: 164-181.

Crampton JW (2015a) Assemblage of the Vertical: Commercial Drones and Algorithmic Life. *Geographica Helvetica,* Under review. Available at: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2693625 (accessed 30 November 2015).

Crampton JW (2015b) Collect it all: National Security, Big Data and Governance. *GeoJournal* 80: 519-531.

Crawford K (2013) The Hidden Biases in Big Data *HBR Blog Network,* 1 April. Available at: http://blogs.hbr.org/2013/04/the-hidden-biases-in-big-data/ (accessed 6 October 2014).

Crawford K, Miltner K and Gray ML (2014) Critiquing Big Data: Politics, Ethics, Epistemology. *International Journal of Communication* 8: 1663-1672.

de Goede M and Randalls S (2009) Precaution, preemption: arts and technologies of the actionable future. *Environment and Planning D: Society and Space* 27: 859-878.

de Souza e Silva A and Frith J (2012) *Mobile Interfaces in Public Spaces: Locational Privacy, Control, and Urban Sociability*. New York; Abingdon, Oxfordshire: Routledge.

de Waal M (2014) *The City as Interface: How New Media Are Changing the City*. nai010 publishers: Rotterdam.

EMOTIVE (2015) Emotive. Available at: http://emotive.lboro.ac.uk/ (accessed 20 December 2015).

Dodge M, Kitchin R and Zook M (2009) Guest Editorial: How does software make space? Exploring some geographical dimensions of pervasive computing and software studies. *Environment and Planning A* 41: 1283-1293.

Foucault M (1991) Governmentality. In: Birchell G, Gordon C and Miller P (eds) *The Foucault Effect: Studies in Governmentality*, Chicago: University of Chicago Press.
Grabianowski E (2013) West Point's ORCA software knows if you're in a gang. *i09*, 24 December. Available at: http://io9.com/west-points-orca-software-knows-if-youre-in-a-gang-1488752018 (accessed 27 December 2014).
Graham M (2013) The Virtual Dimension. In: Acuto M and Steele W (eds) *Global City Challenges: Debating A Concept, Improving The Practice*, London: Palgrave.
Graham M and Zook M (2013) Augmented realities and uneven geogrpahies: exploring the geo-linguistic contours of the web. *Environment and Planning A* 45: 77-99.
Graham SDN (2005) Software-sorted geographies. *Progress in Human Geography* 29: 562-580.
Haggerty, KD and Ericson RV (2000) The surveillant assemblage. *British Journal of Sociology* 51: 605-622.
Hecht B and Stephens M (2014) A Tale of Cities: Urban Biases in Volunteered Geographic Information. In: Adar E and Resnick P (eds) *Proceedings of the Eighth International AAAI Conference on Weblogs and Social Media*, Palo Alto: AAAI Press.
Introna, L. D. (2015) Algorithms, Governance, and Governmentality: On Governing Academic Writing. *Science, Technology, & Human Values* Forthcoming. doi: 10.1177/0162243915587360
Kinsley S (2012) Futures in the making: practices to anticipate 'ubiquitous computing'. *Environment and Planning A* 44: 1554-1569.
Kitchin R (2014a) *The Data Revolution: Big Data, Open Data, Data Infrastructures and Their Consequences*. London, Thousand Oaks, New Delhi, Singapore: SAGE.
Kitchin R (2014b) The real-time city? Big data and smart urbanism. *GeoJournal* 79: 1-14.
Kitchin R (2015) Continous Geosurveillance in the "Smart City". *DIS Magazine* (Online), February. Available at: http://dismagazine.com/issues/73066/rob-kitchin-spatial-big-data-and-geosurveillance/ (accessed 21 February 2015).
Kitchin R and Dodge M (2011) *Code/Space: Software and Everyday Life*. Cambridge, MA, London: The MIT Press.
Kitchin R and Lauriault TP (2014) Towards critical data studies: Charting and unpacking data assemblages and their work. In: Eckert J, Shears A and Thathcher J (eds) *The Geoweb and Big Data*, Omaha: University of Nebraska Press.
Kitchin R, Lauriault TP and McGardle G (2015) Knowing and governing cities through urban indicators, city benchmarking and real-time dashboards. *Regional Studies, Regional Science* 2: 6-28.
Leszczynski A (2015) Spatial big data and anxieties of control. *Environment and Planning D: Society and Space* 33: 965-984.
Lewis P (2011) "Tottenham riots: a peaceful protest, then suddenly all hell broke loose" *The Guardian* (Online), 7 April. Available at: http://www.theguardian.com/uk/2011/aug/07/tottenham-riots-peaceful-protest (accessed 6 July 2014).
Lyon D (2014) Surveillance, Snowden, and Big Data: Capabities, consequences, critique. *Big Data & Society* July-December: 1-13. doi: 10.1177/2053951714541861
Mattern S (2014) Interfacing Urban Intelligence. *Places* April. Available at: https://placesjournal.org/article/interfacing-urban-intelligence/ (accessed 28 April 2016).
Mattern S (2015) Mission Control: A History of the Urban Dashboard. *Places* March. Available at: https://placesjournal.org/article/mission-control-a-history-of-the-urban-dashboard/ (accessed 29 April 2016).
Marsden R (2013) Emotive: Mapping the Mood of a Nation. *The Business of Emotions*, 09

October. Available at: http://businessofemotions.org/2013/10/09/emotive- mapping-the-mood-of-a-nation/ (accessed 28 July 2014).
Massumi B (2007) Potential Politics and the Primacy of Preemption. *Theory & Event,* 10. Available at: https://muse.jhu.edu/journals/theory_and_event/v010/10.2massumi.html (accessed 22 November 2015).
Mayer-Schonberger V and Cukier K (2013) *Big Data: A Revolution That Will Transform How We Live, Work and Think*. London: John Murray.
McCann E (2011) Veritable inventions: cities, policies and assemblage. *Area* 43: 143-147.
McCann E and Ward K (2011) Cities assembled: space, neoliberalization, (re)territorialisation, and comparison. In: McCann E and Ward K (eds) *Mobile Urbanism: Cities and Policymaking in the Global Age*, Minneapolis: University of Minnesota Press.
McEnry T (2014) New app will keep you away from 'sketchy' areas. *Crain's*, 07 August. Available at: http://www.crainsnewyork.com/article/20140807/TECHNOLOGY/140809904/new-app-will-keep-you-away-from-sketchy-areas (accessed 8 August 2014).
McFarlane C (2011a) Assemblage and Critical Urbanism. *City* 15: 204-224.
McFarlane C (2011b) The City as Assemblage: Dwelling and Urban Space. *Environment and Planning D: Society and Space* 29: 649-671.
McGuirk P (2011) Geographies of Urban Politics: Pathways, Intersections, Inventions. *Geographical Research* 50: 256-268.
Monahan T (2008) Editorial: Surveillance and Inequality. *Surveillance & Society* 5: 217-226.
Narula SK (2013) The Real Problem With a Service Called 'Ghetto Tracker'. *The Atlantic* (Online), 6 September. Available at: http://www.theatlantic.com/technology/archive/2013/09/the-real-problem-with-a-service-called-ghetto-tracker/279403/ (accessed 7 September 2013).
Newburn T, Lewis P and Metcalf J (2011) A new kind of riot? From Brixton 1981 to Tottenham 2011. *The Guardian* (Online), 9 December. Available at: http://www.theguardian.com/uk/2011/dec/09/riots-1981-2011-differences (accessed 6 July 2014).
Press Association (2013) New computer program analyses Twitter to map public sentiment *The Guardian* (Online), 6 September. Available at: http://www.theguardian.com/technology/2013/sep/06/computer-program-twitter-public-mood-emotive (accessed 6 July 2014).
Roche S (2014) Geographic Information Science I: Why does a smart city need to be spatially enabled? *Progress in Human Geography* 38: 703-711.
Roche S (2015) Geographic Information Science II: Less space, more places in smart cities. *Progress in Human Geography,* Forthcoming. doi: 10.1177/0309132515586296
Sadowski J and Pasquale F (2015) The spectrum of control: A social theory of the smart city. *First Monday,* 20. Available at: http://firstmonday.org/ojs/index.php/fm/article/view/5903/4660 (accessed 29 November 2015).
Shelton T, Zook M and Wiig A (2015) The 'actually existing smart city'. *Cambridge Journal of Regions, Economy and Society* 8: 13-25.
Sutko D M and de Souza e Silva A (2010) Location-aware mobile media and urban sociability. *New Media & Society* 13: 807-823.
Sykora M, Jackson TW, O'Brien A and Elayan S (2013) EMOTIVE Ontology: Extracting fine-grained emotions from terse, informal messages. *IADIS International Journal on Computer Science and Information Systems* 8: 106-118.

Tashev IJ, Couckuyt JD, Black NW, et al (2012) Pedestrian route production. Microsoft Corporation. Available at: https://www.google.com/patents/US8090532 (accessed 6 December 2015).
Taylor AS, Lindley S, Regan T and Sweeney D (2014) Data and life on the street. *Big Data & Society* July-December: 1-7. doi: 10.1177/2053951714539278
Thatcher J (2013) Avoiding the Ghetto through hope and fear: an analysis of immanent technology using ideal types. *GeoJournal* 78: 967-980.
The Economist (2012) The science of civil war: What makes heroic strife *The Economist* (Online), 21 April. Available at: http://www.economist.com/node/21553006 (accessed 11 July 2014).
Thrift N (2014) The promise of urban informatics: some speculations. *Environment and Planning A* 46: 1263-1266.
Wilson MW (2015) Morgan Freeman is dead and other big data stories. *cultural geographies* 22: 345-349.