Article | **From self-tracking to smart urban infrastructures:** Towards an interdisciplinary research agenda on Big Data

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Abstract

Recent debates on surveillance have emphasised the now myriad possibilities of automated, software-based data gathering, management and analysis. One of the many terms used to describe this phenomenon is 'Big Data'. The field of Big Data covers a large and complex range of practices and technologies from smart borders to CCTV video analysis, and from consumer profiling to self-tracking applications. The paper's aim is to explore the surveillance dynamics inherent in contemporary Big Data trends. To this end, the paper adopts two main perspectives concerned with two complementary expressions of Big Data: (1) the individual use of various techniques of self-surveillance and tracking and (2) the simultaneous trend to optimise urban infrastructures through smart information technologies. Drawing upon exploratory research conducted by the authors, the paper shows that both expressions of Big Data present a range of common surveillance dynamics on at least four levels: agency, temporality, spatiality and normativity. On these grounds, the paper highlights a series of important issues to explore in future research.

Introduction

Recent debates in policy circles and academic studies have emphasised the growing possibilities of automated, software-based data gathering, management and analysis in the 'information age' (Castells 1996). One of the many terms used to describe this development is 'Big Data'.

Although there are quite different interpretations of Big Data in terms of normative stance, assumed benefits and main focus (Gold 2012), it is possible to identify a series of common foci around which most approaches and discussions are centred. Discourses surrounding Big Data usually refer to the ever increasing possibilities of gathering, interconnecting and analysing huge amounts of data relating to a wide range of fields and domains of everyday life. Thus Big Data is neither seen as something fundamentally new, nor is it related to one particular field of application only. Rather, Big Data is portrayed as a gradual evolution of the possibilities that now exist to interconnect different data sources situated on multiple geographical scales, and to process and analyse the hence generated data in increasingly automated ways (Giffinger et al. 2007: 10; Hollands 2008). Big Data includes all kinds of so-called 'smart' possibilities of data-management through code which have emerged from the increased and improved usage of information technology in the present-day world, from self-tracking devices to smart urban infrastructures.

Thus at their very core, practices and techniques included under the term of Big Data imply a world of IT-mediated ordering and regulation-at-a-distance that relies fundamentally on computer software (Haggerty and Ericson 2000; Lyon 2007; Graham 2004, 2005). Yet such processes of ordering and software sorting are never neutral, whether the collection, classification and analysis of data aim at greater efficiency, convenience or security. They depend on codes that are used to assess and orchestrate everyday social life (Graham 2005: 562). These codes constitute often invisible processes of classification and prioritisation, which may affect the life-chances of individuals or social groups in ways that are often unseen by the public and that easily evade conventional democratic scrutiny. The surveillance dynamics inherent in Big Data thus raise a series of critical issues that need careful consideration.

Aim

The aim of this paper is to explore the surveillance dynamics inherent in current Big Data trends. Surveillance is commonly defined as the 'ensemble of practices and techniques aiming at the focused, systematic and routine attention to personal details for purposes of influence, management, protection or direction' (Lyon 2007). In this paper we ask (1) 'what particular modalities and logics of surveillance do novel developments in the field of Big Data imply?' and (2) 'how do these developments in turn challenge our very understanding of the functioning, objects and aims of surveillance in the present-day world?'

To this end, the paper adopts two main thematic perspectives concerned with two complementary expressions of Big Data. These are related to the individual use of various techniques of self-surveillance and tracking, as well as to the simultaneous trend in public policies to optimise urban infrastructures through smart information technologies. In terms of how and where information is generated, the two perspectives constitute the opposite ends of the Big Data spectrum, distinguishing between individual (micro) and infrastructural (macro) sources of data generation. The two perspectives thus differ in gradual rather than in fundamental terms. As this paper shows, we find not only a whole system of exchanges and supports between them but also a range of common features and principles, revealing the cross-cutting surveillance dynamics implied in contemporary Big Data developments. Furthermore we believe that the distinction between the two perspectives achieves a certain operational force inasmuch as it allows the identification and discussion of a range of fundamental issues and questions that need addressing from a Surveillance Studies perspective in future research.

Perspectives

In our endeavour to study the surveillance dynamics implied by contemporary Big Data developments, we do not aim to develop a coherent theoretical framework. Rather, our discussion draws upon a range of existing conceptual tools, amongst which Michel Foucault's theorisation of power and governmentality (Foucault 2007) as well as Bruno Latour's Actor-Network Theory (Latour 1987, 2005) are used most prominently, in order to explore how Big Data 'works' and what problems it implies.

The main reason for why we use Foucault and Latour in our study of the surveillance dynamics implied by Big Data is one of conceptual perspective. Foucault, on the one hand, reiterates again and again that power must be approached through the study of its mediating techniques and discursive regimes, rather than as the property of specific actors. Latour, on the other hand, foregrounds the mediating role of human and non-human entities in the relational constitution of specific actor networks. Thus concurring in their overall relational and mediation-centred posture, both Foucault and Latour invite for the study of how surveillance in the field of Big Data functions and acts, in its inherent relationality and processuality. This is exactly what we want to explore in the present paper.

Before starting this analysis, however, it is necessary to describe in further detail the two chosen thematic perspectives on Big Data, relating to self-surveillance and tracking and to smart urban infrastructures.

Individual focus on Big Data

Our first perspective relates to those gadgets and self-surveillance applications that are increasingly being developed and used by individuals themselves for tracking, quantifying, and documenting everyday life activities. Especially health and fitness devices such as GPS-enabled sports watches are well-known and popular, but self-surveillance practices can be found across many domains including culture, food, learning, work and general living. Individuals use tools and techniques to track themselves, thereby translating their own habits, bodies, moods, and thoughts into objects to scrutinise and transform. In addition, self-tracking is often coupled with social interaction and sometimes framed as entertainment or games. Such quantification practices using monitoring technologies become co-producing when individuals constitute themselves as subjects engaging in self-tracking, self-care, and self-governance. The idea of a 'smart' process presupposes technologies that work seamlessly and automatically in the background. However, when this is not the case due to technical failures, misuse, or other reasons, this self-quantification may be affected in both its functioning and implications.

Household technologies for self-surveillance of personal health are certainly not a new phenomenon, as simple body scales, tape measures, training diaries and other traditional tools have helped individuals to monitor weight, body changes, training improvements and other relevant data for many years. Likewise, electronic devices such as digital blood pressure monitors have been affordable and widely available for personal use for decades. In general, such resources provide overviews by translating everyday life activities into data for purposes of studying, evaluating and planning. In recent years however, the introduction of ever 'smarter' and increasingly networked self-tracking technologies and practices has opened up new questions relating to surveillance, privacy, ethics, and the self, some of which will also be outlined in this paper (see also Albrechtslund 2013; Albrechtslund and Lauritsen 2013).

Infrastructural focus on Big Data

Our second perspective is concerned with Big Data as a trend that influences a number of IT-driven public policies dealing with the key infrastructural networks that underpin everyday urban life, from motorways to electricity grids and from water pipelines to public transport. Our interest here relates to the surveillance dynamics and implications deriving from the increasing digitisation and software-based management of urban systems and infrastructures, which are often praised to become 'smarter' or more 'intelligent' in the process.

There are extensive literatures emphasising the promises associated with such developments in terms of overall urban management, efficiency and sustainability for example (Giffinger et al. 2007). Furthermore, and going beyond such accounts, an increasingly sophisticated body of research has in recent years explored not only how exactly information gathering and processing techniques work to manage and to accelerate the circulation of mobile people, objects and activities, but also what implications this has for urban life (Kitchin and Dodge 2011; Graham 2005). Traditionally, this research is concerned mainly with how information technology permeates the various systems and infrastructures underpinning everyday life, an emphasis that has been confirmed on various grounds and from various perspectives (Debrix 2001; Wekerle and Jackson 2005). In this paper, we further develop these investigations from a specific Surveillance Studies perspective.

Analytical axes of the paper

Mobilising and bringing together the two aforementioned perspectives, our aim is to highlight a series of surveillance dynamics inherent in contemporary Big Data trends. This discussion will be structured into four main axes, relating to agency, temporality, spatiality and normativity. This framework should not be regarded as an exhaustive taxonomy but as an initial attempt to identify and discuss some of the most salient surveillance implications of Big Data today.

We should also state at the outset that we are neither the first to propose a critical, surveillance-focused analysis of Big Data, nor do we feel that what follows is a definitive guide. Instead our contribution is to provide a roadmap that opens up pathways for future work toward a more systematic investigation of Big Data from a Surveillance Studies perspective. We trust that our four analytical axes are complementary and allow for a broad range of social scientific issues and problems surrounding Big Data to be highlighted and analysed. These axes, when integrated, are particularly conducive to an inductive and largely qualitative methodological research strategy.

Agency

Our first axis relates to the Latourian question of where agency is situated in contemporary Big Data developments. This axis connects neatly with the basic logic of the paper which is to distinguish between self-surveillance and infrastructural expressions of Big Data. Whilst the former implies that individuals knowingly participate in their own surveillance, the latter relates to broader trends of managing everyday life through code, which are often unknown to and independent from monitored and 'managed' individuals. This claim is particularly true if we consider that today's world is so deeply permeated by information management that it has become impossible to know everything about what happens to our personal data and how it is used, let alone respond intelligently or imaginatively to it. As Hansen has put it, 'software quite literally conditions our existence, very often outside of the phenomenal field of subjectivity' (Hansen 2000: 17). People cannot be sensitive to all the issues at stake within current Big Data developments if they are unaware about the categorisation and profiling of their everyday life. This of course raises huge issues in agency terms.

Despite this (gradual) difference, the two perspectives share a range of agency-relevant features. We focus in particular on (1) the issue of interconnectivity, (2) the interacting forms of expertise and authority underpinning data analytics and (3) the outsourcing of meaning implied by the automated management of everyday life through code.

Interconnectivity

As mentioned before, the term 'Big Data' accommodates a range of intersecting meanings and efforts which aim to manage everyday life as an ensemble of increasingly interconnected, digitised and 'technologically empowered' (IBM 2010) systems of connections, processes and flows. Yet to reiterate, it is not that efforts towards the increased technological mediation of everyday life are fundamentally new or unique to contemporary Big Data trends. Rather, what is new is that their coalescence into an apparent 'whole' architecture emerges here within an explicit holistic approach.

The emergence of increasingly networked information technologies has introduced new conditions for self-surveillance activities. A wide range of internet-based gadgets and services offer advanced tracking and tools for analysis, predictions or recommendations. For example, the company Withings has developed both a body scale and a blood pressure monitor linked to the internet. The weight, body fat, heart rate and blood pressure data are automatically collected, analysed and presented as an online personal profile to which are attached contextual information and recommendations about health. Experiences from many other domains of everyday life can be tracked using self-surveillance apps and devices including cultural (Goodreads, GetGlue), gastronomical (Evernote Food, Thryve, Vivino), emotional and social (MoodPanda, Cataphora's Digital Mirror), and energy use (Footprint, Green Egg Shopper).

Many of these services offer ways to combine and store data from diverse sources. As most self-surveillance services are available as apps on devices such as smartphones and tablets it is easy to browse across the separate apps or to collect the different data in one place. For example, Withings has also developed a 'health mate' service that integrates and synchronises data from a fitness app (RunKeeper), a

sleep tracking app (Zeo), and a personal goal setting app (StickK). Facilitated by online community and social networking sites, the possibility of collecting and sharing data is a significant feature of these self-monitoring technologies. They all include sharing features where weight, blood pressure, fitness activities, sleep cycles, etc. can be broadcasted, for example as tweets on Twitter or status updates on Facebook. By way of illustration, consider the following quote, taken from the website of Withings' 'health mate' service.

> Your Health Mate *helps* you exercise regularly. Track your physical activity, get funny supporting messages from your butterfly and make sure you exercise as much as you should. […] Sleep does matter and impacts your day to day. Track your sleep *automatically* with our partner devices and check instantly if you're getting enough rest. […] Withings helps you keep a safe eye on your blood pressure. Be reminded to monitor your heart regularly. Store your measurements and *share* them with your doctor and your loved ones.
>
> (Withings 2013, our emphasis)

A very similar trend towards the increased networking of various data sources and applications can be seen on the urban-infrastructure level. To illustrate this point, the IBM *Smarter Cities* programme is an interesting example to consider (IBM 2010). By definition, the projects and efforts surrounding *Smarter Cities* cover a wide variety of interconnected places and phenomena, from policing to city administration and from mobility to energy management and consumption monitoring. These efforts also work on all spatial scales. They are intrinsically woven into the texture of everyday life—from smart building technologies to surveillance cameras and RFID chips in tickets and clothes—and they are embedded in both inner- and intra-urban infrastructures—from electronic ticketing systems to 'intelligent motorways' (Klauser, November and Ruegg 2006). They work through global communication networks (internet monitoring, mobile-phone tracking) and inter- and intra-urban mobility control techniques (border controls, GPS and other location and tracking technologies). All in all, *Smarter Cities* are presented by IBM as the object of a wide range of technologically mediated practices of control and management-at-a-distance based on carefully orchestrated assemblages of computerised systems that act as conduits for multiple cross-cutting forms of data gathering, data transfer and data analysis.

What we see emerging here is a form of geographically, socially and institutionally distributed agency with regard to who controls, processes, uses, etc. the data fused and interconnected in the increasingly complex 'surveillant assemblages' (Haggerty and Ericson 2000) underpinning and managing everyday life. This not only raises major issues in terms of accountability and transparency of the relevant actor networks, but also emphasises that today there is no clear distinction that can be drawn between the 'surveyors' and the 'surveyed'. Contemporary Big Data trends mirror and lead to the use of information technologies in ever-smaller but also in ever-more widely distributed units which permeate everyday life in ever-more complex ways.

Relevant questions to address are[1]: Where and how are data generated and processed? What are the types, levels and purposes of modern surveillance practices in a range of environments? How are these interconnected and how do they blend into wider circuits of information flow? More specifically, to what extent are citizens able, or do they feel able, to influence the degree to which they are surveilled and the surveillance practices they knowingly participate in? How can the levels of popular awareness in surveillance matters be increased? How can greater accountability and transparency of the IT systems underpinning everyday life be achieved?

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[1] See also Cost Action IS0807 2008: 17.

Interacting forms of expertise and authority in Big Data

To understand the distribution of agency in the field of Big Data, we must also consider as a matter of importance the processes, relationships and interests through which current developments (from novel smartphone applications to traffic simulation software) are conditioned and co-produced. There are various questions to address in such an investigation, but two key issues stand out, relating to the interacting forms of expertise and authority in current Big Data developments on the one hand, and to the organisational and geographical settings through which these developments are co-produced on the other. Both will be discussed briefly in what follows.

Both individual and infrastructural expressions of Big Data rely on ever more sophisticated software applications. A first series of issues at stake is thus related to the increasing role of private actors and technical expertise in defining, optimising and managing the 'control by code' (Lyon 2007: 100) implied by Big Data developments. Managing, ordering and governing in this context means to make use of the mediating means and mechanisms (technical expertise, technological means, institutional authority, etc.) involved in coding urban life into software. Thus, authority derives from the expertise necessary for the design and use of computer algorithms needed to control, sort and associate the masses of data generated and processed. The critical issues to address, therefore, relate to the codes themselves. Which codes are involved? How and by whom are these codes developed and applied? And what particular intentions and strategies do the codes aim to fulfil?

Related to this, a second series of issues touches more generally on the institutional and organisational settings in which Big Data developments are embedded, and on the specific mechanisms and interests that are mediating the solutions and novel applications developed in these settings. Current Big Data developments must be viewed as a complex ensemble of processes and projects bringing together a large variety of actors situated in various locations, whose positions are defined by interwoven interests and concerns. Relevant questions to address are: How do particular actors, instruments, forms of expertise and bodies of knowledge relating to novel Big Data applications become authorised to act in particular projects? What are the interests underpinning such projects? Asking and responding to such questions is of great importance if we are to understand the power structures inbuilt in novel smart solutions (for example, the mechanisms of classification and prioritisation in algorithms) with a view to their potential impact upon the life chances of individuals or social groups.

Outsourcing of meaning

The agency problematic relating to Big Data also requires careful consideration of associated issues with regard to the constitution and quantification of the self. Contemporary developments in the field of Big Data involve a substantial outsourcing of meaning to apps and computerised systems, which are based on data gathering and processing. This provides real-time evaluations and recommendations so transforming the apps into 'pocket dictators that are constantly expressing themselves' (Thrift and French 2002: 311).

To quantify oneself is related to describing, signifying or interpreting the self in terms of material facts, verbal and numerical language, and stories and metaphors. The meaning of the self is thus something acquired relationally, between 'self' and 'other than self' (Ricoeur 1995; Sartre 2004). From this perspective, quantification is about modes of presenting and structuring an account of the self, for example as a narrative configuration (Ricoeur 1988) or as an alignment of circulating documents in an oligopticon (Latour and Hermant 1998). This leads to a series of critical issues including sharing collected personal data with peers online, which changes the individual's reasonable expectation of privacy (Ess 2009; Nissenbaum 2010). Issues of ethical responsibilities regarding data ownership, commodification and sharing practices also become pertinent (Fuchs et al. 2011).

Furthermore, the increasing documentation, quantification and broadcasting of the self change the dynamics of performing and producing subjectivity (Papacharissi 2011; Vaz and Bruno 2003; Warner

2005). Quantification practices also challenge the ways in which technology can be conceptualised. If these technologies break down, it defies the purposes of evaluation and management, because the very idea of self-optimisation implies equipment that works seamlessly together. This understanding of technological mediation is reminiscent of what Don Ihde has called a 'dream of totalisation' (1990: 118-123). In the perfect sociotechnical relationship, the artefact is completely in the background, making other things visible whilst being invisible itself.

There are a number of questions to address with regard to the issues raised here: Is there a limit to quantification? Is there a residuum, a non-quantifiable self, and if so, how does this relate to the subjectivity produced by self-surveillance practices and technologies? How do recommendations and predictive analyses influence the production of subjectivity? The critical sociological and philosophical examination of these questions would very much benefit from a historical point of view (Heller 1986; Rose 2010; Boersma et al. 2014).

Temporality

'Software is deferred', Thrift and French write, 'it expresses the co-presence of different times, the time of its production and its subsequent dictation of future moments' (Thrift and French 2002: 311). The temporality dimension of Big Data thus constitutes the second axis to explore.

Big Data involves certain temporal dynamics in which the relationship between past, present and future manifests itself in a specific way. The real-time accumulation of empirical knowledge about various phenomena is central to a process of documentation, which continually transforms the perception of temporal relations by providing modified goals and recommendations for achieving these. In this sense, past, present and future are connected in a way where the continuous documentation and reconstruction of everyday life is the basis for relevant predictions and recommendations for the future.

For example, a central part of self-surveillance is to acquire and analyse empirical knowledge about 'invisible' phenomena such as emotions, experiences and moods. This is done by a process of self-documentation that brings together and translates social, spatial and temporal aspects of everyday life into measurable data. In this respect, it is highly relevant to study further the complex and co-constitutive relationship between individual and social identities in the context of space, location and time quantifications. This involves the question of how location-based self-tracking technologies participate in creating spaces with layers of meaning, for example by augmenting place (Manovich 2006), and how this mediation contributes to forming the self. Furthermore, it opens up the question of how self-documenting practices transform perceptions of the relationship between past, present, and future. For example, when the processes in which subjective experiences of sleep, workouts, and moods are translated into measurable registrations presented in a spatio-temporal order, it becomes pertinent to examine further how this translation shapes and transforms individual bodily and emotional awareness, memory processes and sense of places and geography.

In a similar way, smart urban infrastructures rely on and work through documentation, predictions and recommendations. They rely on predefined codes that are used to assess people's profiles, risks, eligibility and levels of access to a whole range of spaces and services, thus installing a new kind of 'automatically reproduced background' to everyday life (Thrift and French 2002: 309). As Kitchin and Dodge have put it:

> Automated management is the regulation of people and objects through processes that are *automated* (technologically enacted), *automatic* (the technology performs the regulation without prompting or direction), and *autonomous* (regulation, discipline, and outcomes are enacted without human oversight) in nature.
>
> <div align="right">(Kitchin and Dodge 2011: 85)</div>

Thus code, as 'grammar of action' (Galloway 2004; Kitchin and Dodge 2011), not only implies automated, but also anticipatory governmentality (Foucault 2007; Amoore 2007; Budd and Adey 2009). Consequently, there are a number of questions emerging here not only with regard to how code regulates and 'acts' in real time, based on continuous documentation and analysis of the past, but also, and perhaps more importantly, with regard to how (and to what effects) code anticipates and indeed performs the future.

Spatiality

Many of the aforementioned surveillance-logics and implications of Big Data also find a spatial expression. Our third axis thus relates to the spatialities of surveillance, implied by contemporary Big Data trends. A range of scholars now explore the surveillance-relevant role of space, and, in turn, the space-producing role of surveillance. This research suggests that high-tech surveillance tends not only to relate to specific persons or social groups (Lyon 2003), but also to select, differentiate and automatically manage and produce space (Thrift and French 2002). The functions and logics of surveillance operations, their scope, their impact and the risks they pose cannot be understood without referring to the spaces concerned and created by their deployment and performance.

More specifically, after a long period in which the discussions of the imbrications of surveillance and space have been channelled mostly through concerns with spatial enclosure and fixity—relating to the surveillance of particular buildings (Benton-Short 2007), wider spatial enclaves (Coaffee 2004; Klauser 2010), access and border control, (Franzen 2001) etc.—a growing interdisciplinary literature is now exploring the complex spatialities of surveillance relating to the control and management of different types of mobilities and flows (Amoore 2006; Wood and Graham 2006; Côté-Boucher 2008).

The digitisation of everyday life invites a reflection that brings these viewpoints together. There is a crucial need, we believe, to analyse, to problematise and to conceptualise the complex and intertwined spatialities of contemporary surveillance relating to enclosures *and* circulations, to fixity *and* fluidity, to separations *and* connections (Klauser 2013a).

Drawing on the two perspectives that feature in this paper, additional detailed comments will be necessary in order to highlight the complex spatial expressions and dynamics of Big Data. We will touch on two key issues in particular, relating to the 'automated production of space' on the one hand, and to the 'management of circulations' on the other.

The automated production of space
As mentioned before, current technological developments have huge implications for the orchestration of everyday life, most notably through processes of social sorting (Thrift and French 2002; Graham 2005). However, software not only impacts on social and economic life, but also organises and produces space in ever more automated and autonomous ways (Hinchliffe 1996; Thrift and French 2002). A number of spaces, such as airports, motorways, supermarkets, etc. are now completely dependent on software-driven technologies, a phenomenon that Kitchen and Dodge (2011) have termed 'code/space'.

> Code/space occurs when software and the spatiality of everyday life become mutually constituted, that is, produced through one another. […] For example, a check-in area at an

airport can be described as a code/space. The spatiality of the check-in area is dependent on software. If the software crashes, the area reverts from a space in which to check in to a fairly chaotic waiting room.

(Kitchen and Dodge 2011)

Yet the key point here is not only that code produces space, but, furthermore, that code does so in standardised and automated ways.

We can say that it [software] consists of rules of conduct able to be applied to determinate situations. But these rules of conduct operate at a distance, so that too often the code seems to have little to do with the situations in which it is applied. […] In a sense, what software is able to achieve is a standardization and classification of urban situations in ways that were formerly impossible.

(Thrift and French 2002: 325-326)

Thus the questions to ask are: How does software mediate the organisation and production of particular places (Dodge, Kitchin and Zook 2009)? What are the associations and tensions between different spatialities of surveillance that combine different geographical scales and spatial logics? How, in turn, does space mediate the exercise of surveillance?

Managing circulations
The second point which we would like to emphasise relates to what Côté-Boucher has called an emerging 'programme of government of movement' (Côté-Boucher 2008). Whilst the world of software sorting is certainly not a world without borders, as many studies show (Franzen 2001; Klauser 2010), we believe that an often forgotten key question is how contemporary 'surveillant assemblages' (Haggerty and Ericson 2000) embrace and manage circulations (Klauser 2013b).

For example, smartphones and other self-tracking devices work through the continuous localisation of mobile people and objects (Dodge and Kitchin 2007; Buhr 2003). Many of these devices then offer place- user- and practice-specific information and services, thus organising, guiding and regulating flows and presences of people and objects on the move.

In the field of smart urban infrastructure, a similar spatial dynamics can be found, responding to the need to manage the 'city' as a system of connections, processes and flows. What matters is the regulation and management of circulations, rather than the fixing and enclosing of particular places, people, functions and/or objects. Michel Foucault, in his conceptualisation of 'apparatus of security' (Foucault 2007) grasps the spatiality of this kind of surveillance with unequivocal clarity:

[The problem] is no longer that of fixing and demarcating the territory, but of allowing circulations to take place, of controlling them, shifting the good and the bad, ensuring that things are always in movement, constantly moving around, continually going from one point to another, but in such a way that the inherent dangers of this circulation are cancelled out.

(Foucault 2007: 65)

Future research should further pursue this reflection, so as to provide more detailed accounts of how exactly emerging geographies of regulation-at-a-distance work to align the circulation of mobile bodies, data, objects and services with localisation, identification, verification and authentication controls, and of how the practices and techniques of surveillance engage with the key infrastructural networks that aim to channel and filter movements within and between cities.

Normativity

Often, surveillance is understood as being externally imposed, controlling, disciplining and thus rigid in focus and functioning (Norris and Armstrong 1999; Foucault 1977; Fuchs 2008; Gandy 1993; Lyon 2001). Whilst this conception can be appropriate for studying surveillance in specific fields—from policing and military drilling to school and prison discipline—it is challenged with current Big Data developments, as we show in this fourth axis, relating to normativity.

Consider recent developments in the field of smart urban infrastructures which are channelled through visions of technology-induced progress and efficiency, sustainability and comfort. As IBM states in the context of its *Smarter Cities* programme,

> [W]ith recent advances in technology, we can infuse our existing infrastructures with new intelligence. By this, we mean *digitizing* and *connecting* our systems, so they can *sense*, *analyse* and integrate data, and respond *intelligently* to the needs of their jurisdictions. In short, we can revitalize them so they can become smarter and more efficient.
>
> (IBM 2010, our emphasis)

The quote exemplifies IBM's vision of the promises associated with the increased possibilities of digitisation, interconnection, analysis and integration of urban systems. To reiterate, what matters is optimisation and increased efficiency, rather than merely security and risk management.

A very similar comment can be made with regard to self-tracking and self-surveillance. Adaptable to individual conditions, goals and progress, contemporary self-tracking applications are part of a broader trend of self-optimisation and self-cultivation, framed often in terms such as 'the good life', 'sustainable lifestyle', 'healthy living', 'good learning', and 'work productivity'. Self-tracking developments are thus part of an 'individual management agenda' or of an 'enactment of selfhood-problematic', which, fundamentally, produce novel forms and formats of subjectivity.

From this standpoint, reality (i.e. urban systems in the case of *Smarter Cities* and personal behaviour in the case of self-tracking) is approached as an ensemble of perfectly intelligible, analysable and manageable patterns and regularities, which constitute the basic entities and conditions of contemporary 'governing through code' (Klauser 2013b). Rather than imposing a rigid normative model onto a given reality, regulation and management thus start from the decipherment and analysis of reality itself. This decoding of reality relies on the rapidly increasing digitisation of everyday life, thus allowing the integration and interconnection of ever-wider circuits of information flow.

This means that normalisation does not start from a predefined distinction between the permitted and the prohibited, but from the study and identification of the different 'normalities' (i.e. patterns, in IT jargon) characterising a given reality. Consider by way of example the aim of smart electricity grids: what matters is not to prohibit or to prescribe the use of electricity at a given time in a rigid and predefined way. Rather, regulation works through techniques of data gathering, processing and analysing that aim to identify the existing patterns of electricity consumption and production, so as to optimise the balance between and synchronisation of the two. The point is to make the consumption and production of electricity function better in relation to each other.

This type of regulation is very different to the one of discipline, in a Foucauldian sense, which breaks down given multiplicities (of activities, flows, people) into individual entities, so as to make them correspond as fully as possible to a predefined normative model (Foucault 2007; Klauser 2013b). Rather, surveillance and normalisation in the vision of *Smarter Cities* and self-tracking aim at the management of multiplicities (of circulating people, of tracked activities, etc.) as a whole, through techniques that 'work

within reality, by getting the components of reality to work in relation to each other, thanks to and through a series of analyses and specific arrangements. […] The norm is an interplay of differential normalities' (Foucault 2007: 47, 63).

There are two interrelated implications to highlight here. Firstly, this means that the relevant level and objective of regulation is not the individual entity—the detail—but a given ensemble of activities, circulations, etc., governed, optimised or 'revitalised' as a totality. Of course, the level of the detail is still instrumental in this apparatus of power, in that it forms the starting point from which explanatory patterns (normalities) are derived through data analytics. But it is not the actual *telos* of regulation.

Secondly, this regulatory apparatus does not postulate a perfect and 'final' reality to be fully achieved, but a constant process of optimisation derived from and taking place within a given reality, whose aims and conditions are constantly readapted and redefined, depending not only on the ever changing parameters of reality itself, but also on the shifting context and conditions of regulation (cost calculations, availability of novel control techniques, etc.). This form of regulation relies on a 'multivalent and transformable normative framework' (Foucault 2007: 20). It implies a mode of normalisation that is (1) derived from reality, rather than imposed, (2) relative, rather than absolute, (3) flexible, rather than rigid and (4) plural in scope and scale, rather than individual. A crucial task for future research will be to further develop this reflection and to address it by empirical means.

The Five Bs: What does Big Data mean for surveillance?

Our four axes reveal in complementary ways some of the most salient cross-cutting features of, and issues about, the Big Data problematic, which need further critical attention. We now want to ask what this means for our understanding of the very nature, scope and functioning of surveillance in the present-day world. From this viewpoint and stemming from the previous discussion, the article's final section develops a reflection structured around five Bs (beyonds): surveillance beyond single technologies, beyond organisations, beyond humans, beyond risk and beyond rigidity. Ultimately, this discussion invites a reconceptualization of surveillance from a contemporary Big Data perspective.

Beyond single technologies
There are many authors who emphasise the normality and depth of increasingly automated 'smart' forms of surveillance in all aspects of everyday life. Surveillance Studies have highlighted a number of critical issues arising from such developments, including the effects on privacy, social trust, human behaviour and public space; the depth of accountability and transparency; the risks associated with information sharing; the role of private interests in urban public policies; the cost-benefit and effectiveness of technological systems; and the prevalence of errors in such systems, etc. (Cost Action IS0807 2008).

Yet despite these academic engagements, little attention has been paid to how the very disparate aims and modalities of technological mediation of everyday life are coalescing into apparent 'whole' smart systems. As argued before, the Big Data problematic invites the study of precisely this issue. Emphasis should be placed on how current efforts to manage individual life and collective city systems are combined within an explicitly holistic approach, bringing together different technologies, purposes, actors, scales, etc.

Beyond organisations
A major trajectory in Surveillance Studies is the understanding of surveillance in the context of organisations with the purpose of identification and categorisation, 'to sort and classify, to determine eligibility, to qualify and to disqualify, to include and to exclude' (Lyon 2001: 70). In a similar vein of thinking, Oscar Gandy (1993) has argued that surveillance carries a potential for discriminatory practices. The panoptic sort is an apparatus that works in people's everyday lives by generating information about consumption, shopping, work, political views, religious beliefs, sexual orientation, etc., which can be used

to profile and categorise individuals. When these many streams of information flow together, they form a 'data double' (Poster 1990) which can be a powerful tool in the hands of corporate business and government (Fuchs 2008; Fuchs et al. 2011).

It is a main assumption of this organisational perspective that surveillance is an influence external to the individual, one which seeks to control and discipline, entailing a risk of exploitation and privacy invasion. Two challenges emerge here in the context of Big Data. Firstly, when individuals proactively use and engage with self-tracking technologies for reasons ranging from optimisation to social interaction, it is necessary to develop an understanding of surveillance as something intrinsically relating to individual experiences, motivations, and perceptions. Secondly, to shift the focus from an organisational to an individual perspective also implies a shift in the understanding of the individual as a passive receiver of surveillance to that of an active initiator. The individual engaging in self-surveillance differs greatly from the supervised prisoners of the panopticon structure described by Foucault as always being objects for information, but never subjects in a communication (Foucault 1977: 195-228). In that sense, we must consider the individual not only as an object of surveillance but also as an acting subject. This path of thinking has only just started to be explored in recent years (Albrechtslund 2008; Ball 2009; Koskela 2006; Zureik 2007).

Beyond the surveillance of humans

As mentioned before, surveillance is commonly defined as an 'ensemble of practices and techniques aiming at the focused, systematic and routine attention to personal details for purposes of influence, management, protection or direction' (Lyon 2007). Relevant literatures are thus concerned almost exclusively with the collection of personal details relating to both individuals and social groups. Yet as we have shown, Big Data, in many ways, also incorporates parameters relating to non-human phenomena, from smoke detection and micro-climate modelling to the monitoring of electricity grids and water pipes.

Data on human *and* non-human phenomena present important differences, but also many parallels and interconnections, which, on examination, shed light on the broader mechanisms, interests and relationships lying behind the current recalibrations of surveillance. Thus, this paper also contributes to challenging the very understanding of surveillance in terms of the monitored 'object', carving out a space in which to analyse the dynamics and mutual imbrications of surveillance relating to people and things, presences and flows.

Beyond risk

It is often acknowledged that surveillance not only responds to risk and security issues, but also to broader administrative, organisational, commercial and political rationales (Lyon 2007). Yet, very few scholars have considered in detail how different purposes of surveillance can be distinguished conceptually, with a view to interrogating the mutual imbrications of different forms, functions and problems of surveillance.

Our analysis of Big Data not only emphasises that we need to think in more systematic ways about surveillance in relation to optimisation relating not only to issues of urban sustainability and infrastructure efficiency, but also to goals of self-management and self-cultivation. It also reiterates the need to investigate in much more empirical depth how disparate aims and modalities of the technological mediation of everyday life coalesce into apparent 'whole' architectures and systems.

Beyond rigidity

As shown, the aim of surveillance with Big Data is to manage activities, flows, etc. in flexible, differentiated and adaptable ways. This brings to the fore one of the most fundamental conceptual problems that needs more attention in future debates across Surveillance Studies (also see Lyon and Bauman 2013). It relates to the need to further explore and conceptualise the fluidity and flexibility of contemporary governing through code (both in spatial and normative terms). In this respect, we agree with

David Lyon that Zymunt Bauman's 'liquid modernity' (Bauman 2000) could offer one privileged conceptual viewpoint to mobilise in the theorisation of 'the ways in which surveillance, once seemingly solid and fixed, has become much more flexible and mobile, seeping and spreading into many life areas where once it had only marginal sway' (Lyon and Bauman 2013: 3). A second very promising tool box and framework for any such endeavour, we believe, could be found in Michel Foucault's conceptualisation of 'security', as outlined above.

In conclusion, moving beyond traditional research foci on the surveillance of humans, on single control technologies, on the risk problematic and on surveillance in its rigid, disciplinary logics, the paper opens up a range of novel terrains for investigating the agents, practices and spaces of surveillance in the present-day world. It would be possible, we believe, to make these programmatic comments the starting point for a more sustained and systematic enquiry into the nature and functioning of contemporary software-based forms and techniques of surveillance. Such a 'programme of reflection' would also represent a push towards revisiting our very understanding of the scales and scopes of contemporary forms and formats of surveillance. The four analytical axes distinguished here—agency, temporality, spatiality and normativity—could be one organising framework for such enquiry.

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