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What Does It Mean To Govern With Algorithms?

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24 years have passed since the publication of what has become the world's most highly cited scientific paper on the design of algorithms for acting upon a body of data. In 1993, IBM computer scientist Rakesh Agrawal and his Almaden lab colleagues, wrote that "organizations have collected massive amounts of data on customer transactions" (Agrawal et al. 1993). This 20th century interpretation of the opportunities of large-scale data led the authors to "present an efficient algorithm that generates all significant association rules between items in the database". What would ultimately become the basis for IBM's Intelligent Miner group of algorithms began life in the prosaic basket data of transactions on bread, butter, sausages, and mustard. In the conditional associating together of items in the formulation "if … , and … , then … ", however, the paper represents much more than a ground-breaking advance in algorithms for data mining. Rather, it presents a way of logically governing uncertain human actions and behaviours through the relations between data elements.[1] When Agrawal and colleagues (1993) present their algorithm's "thresholds of support and confidence", they actually present to the world a novel way of deciding *what matters*, *which associations* can be acted upon, *which itemsets* should be "pruned out". More than a computational and scientific novelty, this is the condition of possibility for a novel way of governing population, a means of acting upon uncertain futures, and a form of politics (Amoore 2013; Goffey 2008; Parisi 2013).

[1] As Tarleton Gillespie describes, "for the makers of algorithms, the term refers specifically to the logical series of steps for organizing and acting on a body of data" (2016:19).

In the context of a 21st century acceleration and intensification of algorithmic forms of governing, it is perhaps more important than ever that we specify which of the vast and limitless array of specific algorithms we are addressing. I am tracing the story of a specific family of algorithms here, engaging the traces of their emergence across different spheres of state, economy, and society. The contemporary claims about the volume and velocity of "big data" are more thoroughly situated when one reflects on their genealogy: how volumes of relatively unstructured transactional data were transformed from a governmental problem of what could not be grasped and known into a means of precisely governing the unknown and uncertain. Staying with our story, after the US terrorist attacks of September 11 2001, Rakesh Agrawal's algorithms appeared again, this time in defining what the mathematical sciences could contribute to homeland security. The itemsets of consumer products of the 1990s had been replaced with what Agrawal (2004) describes as "the features we are interested in", said to be "things like financial support, Islamic leaders, travel patterns and so on". Thus, through the association rules mined from large databases, new proxies for categories of race, gender, and ethnicity enter the calculative tools of governing, signalling "what is of interest" in a nebulous war on terror.

Yet, to confine our understanding of what it means to govern with algorithms to rules-based algorithms would be to neglect a significant strand of the story I am tracing here. In a 2015 interview, Agrawal describes a paradigm shift in the algorithms used for mining data. Setting the scene of the late 20th century data mining algorithms, he suggests: "the prevailing model of decision making was that somebody would make a hypothesis, test if the hypothesis was correct, and repeat the process". In contrast to this deductive logic, he depicts an inductive mode that re-emerges with a resurgent use of neural networks and other machine learning techniques. "The decision making process changed", Agrawal (2015) reflects, so that "now, algorithms generate all of the possible rules, and then debate which is valuable". This paradigm of the generative or open-ended induction of knowledge from a data-stream characterises much of the algorithmic forms of governing in our present. As Luciana Parisi (2013:2) writes: "it is not by chance that the age of the algorithm has also come to be recognized as an age characterized by forms of emergent behaviour that are determined by continual variation and uncertainty". It is precisely from the contingencies and uncertainties

of data elements that machine learning algorithms such as convolutional neural networks extract and generate their outputs.

What, then, does this computational paradigm mean for one of the questions animating this forum: how we can best attend to spaces of governing where algorithms operate and are contested? I will address this problem via three short reflections: how algorithms govern futures; how algorithms act as instruments of perception; and, finally, what the limits of algorithmic governing might be.

Governing Possible Futures

It is all too easy to be dazzled by the apparent mathematical wizardry that is so often associated with the very idea of algorithm. Pedro Domingos' popular science account of the quest for the ultimate machine learning algorithm, for example, promises that "the master algorithm can derive all knowledge in the world–past, present and future–from data" (2015:5). Yet, in his account of how the insights of five distinct families of machine learning algorithms might yield his "master algorithm", Domingos documents the statistical and probabilistic assumptions embodied by each model. Perhaps inadvertently, at least to my reading, he reminds us that his master algorithm actually has a more mundane genesis in the histories of governing through statistics, probability, and the norms and patterns of society. Understood in this way, human geography–indeed, the social sciences and humanities–is replete with detailed accounts of governing populations with statistics and probabilistic devices. Just as Ian Hacking's (1975) account of the rise of the statistical average man of the 18th and 19th centuries documents how the Gaussian distribution, or bell curve, came to govern societal norm and anomaly, so in our present we need situated accounts of how, for example, predictive algorithms govern population on a horizon of possible futures. As contemporary algorithms appear to break with the statistical logics of normal distribution, finding new ways of amplifying emergent properties in the "tail" of the curve, we need more than ever to find ways, in Donna Haraway's (2016) terms, of "staying with the trouble" of giving partial accounts of algorithmic forms of governing.

Governing Perception

It is of profound concern to geographers to understand how algorithms differently map, visualize, spatialize, and project the world (Gregory 2011; Kinsley 2014; Kitchin and Dodge 2011; Rose 2016). Though the visual domain has been a key aspect of inquiry–particularly with regard to the interfaces and mediation of algorithmic devices (Galloway 2012)–there is a longstanding interest, particularly in the humanities, in the embodied, haptic, and entangled relations of humans and algorithms (Hayles 2012; Riskin 2007). When the designers of algorithms address their relation to their algorithmic counterparts, they readily speak of the feelings of surprise or wonder they experience when "playing with" their neural nets. As they make subtle changes to the weightings in the layers of the algorithm, they acknowledge that the algorithm does have a certain life of its own. That is to say, they do not always know how, exactly, a small change in input data, for example, is effecting change in the output. As Tarleton Gillespie (2016: 20) has put the problem:

> Most common algorithms produce no certifiably "correct" results at all but only turn out results based on many possible pathways. Algorithm designers are not pursuing correctness; they're pursuing some threshold of operator or user satisfaction–understood in the model, perhaps, in terms of the percentage of correctly identified human faces from digital images.

Understood in this way, algorithms are instruments of perception, in Henri Bergson's terms, surfacing only the thing "of interest" from "an incalculable multitude of elements".[2] To be clear, algorithms such as neural networks do contain within them an incalculable multitude of elements. They hold together the possibility of multiple pathways, and yet they are fundamentally attuned to action and, thus, they reduce the multiplicity to the one: the output of interest.

[2] See Amoore and Piotukh (2015) for an extended discussion of algorithms as instruments of perception and action.

The Politics of Algorithmic Governing

Finally, it is important to me that I try to carry with me, in the course of research on algorithms, a sense of the limits of computability. That is to say, amid commercial and technical claims of "fully automated decisions" and "real time" analysis, to remember the intuitive actions and judgements that are folded into the way the algorithm governs. For me, here lies the politics of governing with algorithms. As mathematician Alan Turing wrote in his letters to Max Newman,[3] mathematical reasoning requires two faculties–intuition and ingenuity. The "necessity" for using the "imaginative" faculty of intuition, argued Turing, "is greatly reduced by setting down formal rules" (ingenuity). Despite the subsequent 60 years of advances in algorithms, the faculties of intuition and ingenuity remain in a complex mutual relationship. As algorithms enter the governance of every domain of life, still the intuitions of police, border guards, consumers, surgeons, financial traders, and so on–in intimate communion with the intuitions of algorithm designers–are folded into the ingenuity of the algorithm. As machine learning algorithms derive their learning from vast bodies of training data, much of it the transactional debris of our daily lives, we all become intimately implicated in how algorithmic governing will take place.

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[3] See http://www.turingarchive.org/viewer/?id=152&title=2b (last accessed 18 May 2017).

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