Researching Algorithmic Institutions

RESEARCHING ALGORITHMIC INSTITUTIONS

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Like any research centre that today investigates the media conditions of social organization, the Institute for Culture and Society modulates functional institutional governance with what might be said to be, operatively and with a certain conscientious attention to method, algorithmic experiments. In this essay we convolve these terms. As governance moves beyond Weberian proceduralism toward its algorithmic automation, research life itself becomes subject to institutional experimentation. Parametric adjustment generates sine wave-like ripple effects in the allocation of time, labour, thought and practice. Reflexivity, long an imperative of social research, now demands attentiveness to how these entwined forces of governance and experimentation produce the research subject.

Modes of governance within institutional settings are increasingly shaped by algorithmic architectures of organization. Algorithmic governance details not only the application of computational procedures to issues of operative management, control and decision-making but it further describes the re-engineering of organizations to the demands of those procedures. In idealised terms, algorithmic governance begins with a problem that is first tested and formalized within the parametric constraints of a model.[2] As Tarleton Gillespie explains, the problem is first articulated through the model in mathematical terms, then operationalized as a procedural task performed by an algorithm. As algorithms are amended, hacked, refined or substituted, the fidelity of the model to a mathematical proceduralism divorced from environment signals how modes of governance frequently collapse in the wild. Needless to say, formalistic variability does not contradict the core thesis that we develop in this essay, namely that algorithmic governance produces an essentially *experimental* condition of institutionality. That which becomes available for 'disruption' or 'innovation' — both institutional encodings — is equally prescribed within silicon test-beds that propose limits to political possibility.[3] Experiments privilege the repeatability and reproducibility of action. This is characteristic of algorithmic routines that accommodate variation only through the *a priori* of known statistical parameters. Innovation, in other words, is merely a variation of the known within the horizon of fault tolerance.

Experiments in algorithmic governance are radically dissimilar from the experience of politics and culture, which can be understood as the constitutive outside of passion and affect that infiltrates models in the process of designing parameters that inform the operational rules of algorithms. Once operationalized as algorithms, politics is enacted as a procedural routine and culture is made accountable within metrics of calculation. Both instances necessarily externalize experience. Too often economics takes command. As an analytical mode, conversely, political economics does not take command often enough. The contemporary demarcation of politics and culture from the economy itself exhibits a nostalgia for pure power or an unpolluted aesthetics — affective modalities which, against a collective despair over the obdurate and thoroughly determined state of the economy, seem plausible escape routes, and which in mass-form return as devices for the securitization of institutional control.

A tension continues to persist between experiment and experience in the generation of new institutional forms immanent to algorithmic modes of governance. If invention subsists and foments within the phenomenal realm of experience, then experiment is akin to laboratory life that verifies knowledge incrementally under controlled conditions.[4] Where experience is expansive and contingent, experiments are necessarily harnessed to the pursuit of procedures and realization of rules. Experiments lend themselves to the goal-oriented world of algorithms. As such, the invention of new institutional forms and practices would seem antithetical to experiments in algorithmic governance. Yet what if we consider experience itself as conditioned and made possible by experiments in algorithmic governance?

Surely enough, the past few decades have seen a steady transformation of many institutional settings. There are many studies that account for such change as coinciding with and often directly resulting from the ways in which neoliberal agendas have variously impacted organizational values and practices. Our focus is on the struggle of governance immanent to the relation between experience and experiment, algorithm and institution. What, in short, are the propagating effects of algorithmic governance as a routine complex of institutional practices?

This essay examines computational conditions that organize the world and, increasingly, life. We ask how the operational logic of digital technology might furnish concepts of power able to describe and explain the empirical world. Specifically, the essay focuses on how power is generated within and by digital infrastructures, systems, operations and practices. The broader objective here — one beyond the scope of this present essay — is to establish empirical co-ordinates that provide an analytical basis for populating disciplines in the humanities and social sciences with a conceptual vocabulary coextensive with contemporary technological conditions. For the purposes of this essay we consider the data centre — also known as server farms, colocation centres or the cloud — as the infrastructural core that governs the production of space, time, subjectivity and economy. Off-the-grid computing aside, most data will at some point and time traffic through a data centre.

1 Thanks to Paul James for suggestions on phrasing and framing.

2 See Gillespie, T 2016, 'Algorithm', in B Peters (ed.), *Digital keywords: a vocabulary of information society and culture*, Princeton University Press, Princeton, pp. 19–20.

3 For an analysis and critique of 'testing' and 'demoing' of 'solutions' to address crises (urban, financial, health, and environmental, etc.), see Halpern, O, LeCavalier, J & Calvillo, N 2017, 'Test-bed urbanism', *Public Culture*, vol. 25, no. 2, pp. 273–306. See also Halpern, O, Mitchell, R & Geoghegan, BD 2017, 'The smartness mandate: notes toward a critique', *Grey Room*, no. 68, pp. 106–29.

4 See Neilson, B & Rossiter, N 2006, 'Towards a political anthropology of new institutional forms', *ephemera: theory & politics in organization*, vol. 6, no. 4, p. 394, viewed 1 May 2019, http://www.ephemerajournal.org/contribution/towards-political-anthropology-new-institutional-forms.

SOVEREIGN MEDIA, TERRITORIALITY AND THE TRAFFIC OF DATA

We occasionally have a sense that our quotidian decisions are governed by algorithmic architectures humming away in the background. Mostly, we are resigned to machinic authority taking command of the extraction of value and monetization of computational life generated from the surfeit of data. Certainly, the last few years have brought greater attention to power exercised by algorithms, without yet producing much by way of a counter-power that can refuse or deflect the assertion of control. Whether it is social media routines, digital accounting systems, military operations in theatres of war or governing populations and migration across geographic scales and sovereign spaces, there is a transactional logic that attends the traffic in data. Blockchain technologies manage data transactions through a distributed public ledger. High-frequency trading, by contrast, buries millions of financial derivatives and credit default swaps, resulting in the 'social abstraction of risk'.[5] Well-documented in a scholarly literature, even in a mode of critique blockchains and HFT evoke a shared awe and dread of the technological sublime. Less attended to are the enduring consequential IT banalities of administrative Excel formulas, JavaScript functions and database procedures that calculate hourly rates, leave accruals and performance indicators. Alongside global blockchains, microwave data broadcasting and neural networks, twenty-year-old software architectures help administer organizations and run the world.

The non-representational architectures that underscore many computational transactions unsettle a politics of intervention predicated on the visibility of things. Yet neither is there a panacea to be found in making transactions of data visible. The often moralistically imbued calls for data transparency and accountability are no less vulnerable at functional, operational levels to unforeseen crashes, hacks or inexplicable events that may result in economic stress for many. For all the transactional visibility of distributed public ledgers such as Bitcoin, the now frequent security breaches and 'disappearance' of the crypto-currency from exchanges should be sufficient enough of a prompt to caution against at least a first-order valorizing the merits of openness.[6]

Digital infrastructures such as data centres are chief among the milieu of technological forms in which transactions in data impact on a world external to the operational logic of signals, transmission, processing and storage. Hosting the servers that support the software and data analytics of 'the cloud', data centres can be considered as the invisible shadow of institutional forms such as universities, banks, social media companies, logistical firms, among many others. Indeed, data centres provide the operational core of institutional practices dependent on the transactions in data. Similarly, the algorithmic procedures that organize data in ways that make action possible are central to the governance of institutions.

From the purview of algorithmic governance, subjectivity and the presence of human personnel are merely functionaries to be managed. A peculiar form of technological unconscious also defines the relation between machine and subject. This is despite critiques of algorithmic governance that consider managers and gestures of leadership as indistinct from the parametric horizon of algorithms. Without the distinct activity of human labour expressed through computational systems the machine-as-institution is a soul depleted of the substance upon which its data operations depend.[7] Yet this human vessel of unsubstantiated yearning may be just an interval that terminates with social accommodation of the fully automated organization.

Part media-infrastructure and part locus of algorithmic decision-making, the data centre indicates one possible form of such organization. The territoriality of data centres carves out new geographies of power, giving rise to forms of infrastructural sovereignty that contest, intersect, multiply and depart from the modern sovereign power of the nation-state.[8] But how do we specify the operational logic of data centres? Our response is to return to an analysis of its computational architecture, which here are represented by parallel processing frameworks: obscure yet indispensable parts that make possible, for example, neural networks, machine learning and artificial intelligence applications. We consider this intervention in part as constituting a genealogy of power tied to computational architectures. And in distilling an infrastructural object such as the data centre to computational operations specific to parallel processing, we are also suggesting that there remains an unavoidable necessity to consider technological forces of determination. This genealogy takes us back to an operational core from which we can begin to make sense of the structuring of the world not reducible to black box impenetrability. There is no *tabula rasa* upon which fantasies and fears may be projected.

THE LOGISTICS OF DATA

Despite a tendency within business and academic circles to think on 'global' scales, digital operations are not as planetary, or as totalizing, as critics like Benjamin Bratton would have it. Indeed, the computational metaphor of the 'stack' is a tempting but limited metaphor for the current reconfiguration of organizational life through algorithmic governance. While not exclusive to the digital, Bratton's model of 'The Stack' refers to planetary-scale technical infrastructures consisting of Earth, Cloud, City, Address, Interface and User layers. Bratton's insistence on interoperability across and between these sectional layers provides the conceptual schema needed to then propose The Stack as a model of planetary computation, which he assumes as

5 See LiPuma, E & Lee, B 2004, *Financial derivatives and the globalization of risk*, Duke University Press, Durham.

6 For a critique of the celebration of openness, see Tkacz, N 2015, *Wikipedia and the politics of openness*, University of Chicago Press, Chicago.

7 As Stefano Harney quips in an interview with Michael Schapira and Jesse Montgomery, 'most managers have already been replaced by machines … We know they work not only within the parameters of an algorithm but with its predictions and prescriptions. They are only there to implement and call it leadership'. Schapira, M & Montgomery, J 2017, 'Stefano Harney (Part 1)', *Full Stop Quarterly*, 8 August, viewed 1 May 2019, http://www.full-stop.net/2017/08/08/interviews/michael-schapira-and-jesse-montgomery/stefano-harney-part-1/.

8 On the geography of data centres, see https://cloudscene.com/.

'a coherent totality'.[9] It is on the basis of this totality that Bratton then proposes The Stack as inaugurating a new political geography that multiplies sovereign power beyond the Westphalian state. 'Platform sovereignty' and 'infrastructural sovereignty' are the two primary modes of technical power resulting from The Stack.

We don't deny that sovereign power is multiplied beyond and not limited to modern state polities. The Stack is not required as a heuristic device or infrastructural condition to explain the transformations to state sovereignty wrought by economic and technological globalization. Sovereign power in any case is always contested. And this is the key point overlooked by Bratton, whose predilection for totalization produces a significant analytical and political oversight. Namely, that interoperability between systems (layers) is never absolute. Protocological conflicts, technological propensities, geological properties and institutional disputes — to say nothing of social struggles — prevail across networks of relations that, frequently enough, are *notworking*.[10] The failure of interoperability not only unsettles the totalizing if contingent logic of sovereign power Bratton attributes to The Stack but also makes for a considerably more complicated operation of power and conceptualization of the political at the current conjuncture.[11] Moreover, digital capitalism in some sense depends upon this constitutive gap between fantasy of control and reality of breakdown. Such gaps 'ask', indeed, to be cleverly exploited, to manufacture the customer 'need' and to introduce new disruptions and innovations in response. At a global scale, Tesla, one of the finest exponents of need-production, exists precisely to bridge present carbon and future renewable energy economies. Such bridging, in turn, produces new operative fissures. Academia is of course not immune to the relentless detection of *notworking* in action, and, as it finds its new place as a junior partner to corporatism, has become increasingly adept at translating gaps in the literature to gaps in the market.

Analytically, algorithmic governance denotes the conjunction of models that limit just as much as they open up political possibilities, a conjunction that, in turn, produces a phantasmic situation of total control (Bratton) or, through its failures, re-admits contingency into a new, computationally mediated dialectic of determination and possibility. Refusing the neoliberal characterizations of such a data politics as inherently open, transparent and liberatory has become the *de facto* means of strategic operation for its actors: the significant shifts over the past few years have practically confirmed this point.[12] The rush to securitize data infrastructures through physical borders and barricades, privacy regulation and appeals for Internet regulation — amazingly, from the heart of Silicon Valley itself — makes no secret any more of a privatized and explicitly political re-territorialisation of what, already, appears to us not as an object of a present or near-future, but through the form of nostalgia — a digital public sphere.[13]

At such junctures it is tempting to withdraw to the inner salons of what György Lukács once described, in reference to the first generation of the Frankfurt School, as the Grand Hotel Abyss.[14] Accommodation that today, precisely through the affordances of digital social media, is available to nearly everyone at Airbnb rack rates. We prefer to turn toward the resources afforded by the computational architectures themselves — less the salons occupied by an erudite and déshabillé commentariat, and rather the warehouses, rack rooms and 'non-places' of cool alienation within which, perversely, hum the machines of twenty-first century politics.

The stacks which operate here can indeed be described as Bratton suggests: they are layers of cabling, network protocols, servers, operating systems, databases and, in a gesture that would appear to reaffirm its privilege at the uppermost level of this architecture, the algorithm. Yet this characterization is limited in its technical precision as much as in its political terminology. Indeed, the stack can never accomplish very much without a fine-grained articulation of operations within and between its specific layers, and these operations turn out to be as or more significant, both in the determination and contingency of governance, than the coarse-grained organization of the entire data apparatus itself. In short, alternate forms of algorithmic governance must today intervene at the level of parameters as much as at the level of the coal and rare-earth mines that power and produce the materials for algorithmic operations.

Each of these layers contain their own historical unfoldings. The 'model/algorithm' distinction offers a nice point-in-time encapsulation, but does little to convey the historical reconfiguration over time of the algorithm itself. Today, precisely as terms like 'algorithmic governance' appear to register a certain new confluence of power/knowledge, the algorithm is undergoing substantial reconfiguration.[15] In machine learning, algorithms are constituted by other algorithms, through *a posteriori* statistical patterning rather than *a priori* models. In data centres, the algorithm is turned inside out, defined and distributed according the physical and logical arrangement of data rather than by the model's idealization.

9 Bratton, BH 2015, *The stack: on software and sovereignty*, MIT Press, Cambridge, p. 375.

10 See Lovink, G 2005, *The principle of notworking: concepts in critical internet culture*, public lecture, Hogeschool van Amsterdam, 24 February. Available at http://networkcultures.org/blog/publication/the-principle-of-notworking-geert-lovink/.

11 See Mezzadra, S & Neilson, B 2019, *The politics of operations: excavating contemporary capitalism*, Duke University Press, Durham.

12 An earlier draft of this paper was presented as Magee, L & Rossiter, N 2016, 'Operationalising the data centre: algorithmic platforms and the distribution of computational labour', *Crossroads in Cultural Studies*, Sydney, 14–17 December, http://crossroads2016.org/.

13 See Zuckerberg, M 2019, *The internet needs new rules: let's start in these four areas*, 31 March, https://www.facebook.com/zuck/posts/10107013839885441.

14 See Jeffries, S 2016, *Grand Hotel Abyss: the lives of the Frankfurt School*, Verso, London.

15 See Rouvroy, A & Stiegler, B 2016, 'The digital regime of truth: from the algorithmic governmentality to a new rule of law', trans. A Nony & B Dillet, *La Deleuziana*, no. 3, pp. 6–29, viewed 1 May 2019, http://www.ladeleuziana.org/wp-content/uploads/2016/12/Rouvroy-Stiegler_eng.pdf and Amoore, L & Raley, R 2017, 'Securing with algorithms: knowledge, decision, sovereignty', *Security Dialogue*, vol. 48, no. 1, pp. 3–10.

Algorithmic *parallelization* — running a software implementation of an algorithm concurrently on multiple processors or machines — is one example of this restructuring. Parallel processing can be applied to tasks that are independent, where, for instance, one task is not dependent upon the results of another. Parallel processing encompasses processing systems for serving web content, registering user clicks and 'likes', tabulating and storage of smart city sensor-generated data, image analysis of photo streams and trend analysis of financial transactions. These systems are widely deployed within the data infrastructures that support what has been termed 'platform capitalism': this includes data centres operated by Google, Facebook and independent business exchanges (or IBX) such as those run by Equinix in the inner-city suburb of Alexandria in Sydney.[16] Parallelized pipeline architectures run on top of clusters of machines housed within these data centres, making it possible for these computational resources to be used efficiently.

Despite its affordances, enabling algorithms to operate in a parallel rather than serial fashion can be a complex, specialized and expensive task.[17] Strategies to do so typically enlist an approach of 'divide-and-conquer', redesigning or refactoring the software implementation of an algorithm to separate and process data inputs independently, before joining or merging their outputs. The occasion of refactoring can substantially alter the properties of the algorithm itself.[18] Conventional use of parallelized algorithms also requires detailed knowledge of the operating environment: the type of machines the algorithms will run on, how datasets need to be partitioned and how the network is configured to enable copies of the algorithm to communicate progress.

The arrival of cloud computing represents the commodification of the expertise and resources required for managing enormous circuits of data. As the volume of the data processed increases, cloud computing permits the algorithm's operation to span multiple machines automatically. Increases in computational power are paid for by the hour or by other discrete quantities, and without the intervention of human labour to add machines, install software and configure networks. This commodification is facilitated through software frameworks, or 'middleware', that mediate between the hardware facilities of the data centre and performance of the algorithm. Major cloud companies such as Amazon and Google have produced such frameworks — one of which, Apache Beam, we describe in detail below — to simplify the process of redesign and ease configuration of parallelized algorithms on their cloud-computing platforms. Frameworks such as these make possible the parametric adjustment of algorithms, producing the property of 'elasticity' famously associated with cloud computing: that is, the ability to add or subtract computing resources dynamically in response to demand, budget, dataset size and other constraints.[19]

If our understanding of digital economy, society and the production of subjectivity is to come to terms with this expansiveness and elasticity, a critique of data politics and algorithmic institutions needs to register the techniques, processes and operations special to media infrastructures. The technical, energy and commercial constraints of parallelized architectures articulate a data grammar of these operations, a set of essential verbs of platform capitalism: mapping, reducing, cutting, filtering, partitioning, sequencing, transforming, flattening, merging and piping. Enumerating, rehearsing and evaluating the elements of this grammar across hardware and software platforms establishes a baseline from which the determining force of data politics is made discernible, at least in preliminary ways. Operations and techniques such as these define the parameters within which action protrudes into the world. In the next section, we transition to a more technical mode of description, to pursue the algorithm through the process of parallelization.

EXPERIMENTS IN PARALLEL COMPUTING

In the world of parallel computing, the term 'pipeline' is used to describe the conduits that link data sources, transformations and outputs. Like the UNIX pipe operator used in terminal commands ('|'), pipelines funnel data through input/output sequences (shown in Table 1 below). Parallel computing frameworks employ the metaphor of pipes and pipelines to describe the distribution the data processing across multiple copies of a given resource. These include the multiple cores of a central processing unit of a single machine, or the combined capacities of multiple machines on a network. Pipes funnel inputs across these resources and reassemble outputs produced by their processing.

Such plumbing metaphors extend to the very naming of parallelisation frameworks. One example is *DataFlow*, a project developed by Google, and later contributed by the company as an open-source project, now renamed as *Beam*, to the Apache Foundation, a consortium that describes itself as 'the world's largest open-source foundation'.[20] The process of migrating software developed by companies for internal use to open source is common. It is a means for building corporate goodwill in the wider software development community and also for establishing *de facto* standards that help to realise other organisational objectives. Apache's projects, members, licensing arrangements and its often-informal decision-making processes — conducted on publicly accessible mailing lists — provide a glimpse into the confluences and complex relations of open-source software and cloud computing companies. The projects accepted by the Apache Foundation (Table 1) map schematically the history of web computing over the past quarter century: they range from content servers that deliver web pages and images, to systems that enable big data management, virtualization, security and parallelization.

16 See Srnicek, N 2017, *Platform* capitalism, Polity, Cambridge.

17 See Blelloch, GE & Maggs, BM 1996, 'Parallel algorithms', *ACM Computing Surveys (CSUR)*, vol. 28, no. 1, pp. 51-54.

18 Blelloch & Maggs, 'Parallel algorithms'.

19 See Herbst, N, Kounev, S & Reussner, R 2013, 'Elasticity in cloud computing: what it is, and what it is not', *Proceedings of the 10th International Conference on Autonomic Computing (ICAC 2013)*, San Jose, CA, 24-28 June.

20 See http://apache.org/#.

Beam operates like a virtual machine, translating data-processing requests made by software into instructions that can be executed in diverse operating environments. Algorithms on *Beam* can be tested on a single computer, deployed to a localized distributed computing environment or uploaded to a cloud-computing platform, where computing time is purchased by the hour. Running a simple example algorithm that extracts word frequencies from text, supplied as part of the *Beam* framework, showed several distinctive features of parallelisation. First, the code for the algorithm requires a specific operational logic: the text input is loaded from files; the word frequencies are calculated; the output containing the frequencies is formatted; and, finally, the output is written or 'piped' to a file. A conventional implementation of an algorithm might adopt this same procedure, but would not be required to do so. The second feature shows why this logic is necessary: when the parallel implementation is executed on a laptop machine, it runs several concurrent copies of the software, each of which processes separate parts of the data input. The third feature is that the same code, configuration and data executes identically on a laptop machine and on Google's *Cloud Platform*, on which we had established an account for testing purposes. This is significant due to the quite different operations that are performed in each case.

On a single machine, the code executes on multiple processors, typically limited to two or four. On the cloud, multiple copies of the code may instead run on many machines, limited only by budget. The promise of *Beam* framework seems partly fulfilled so long as an algorithm conforms to the requirements of the framework, it is scaleable on multiple processes and machines, and running seamlessly between both personal and cloud computing environments. While ostensibly an open-source project, *Beam* facilitates developers to publish their software on commercial services like Cloud Platform, advertised as helping applications to 'grow from prototype to production to planet-scale, without having to think about capacity, reliability or performance'.[21] In other words, *Beam* lays down the pipes that take the entrepreneur from the garage to the globe.

Despite the promises of Google's platform, our experiment still generated practical examples of *notworking*: conflicting software libraries and essential steps that are undocumented and are only discovered through educated guesswork and trial-and-error. Rather than an idealized path from model to execution, the automation of scalable procedures requires all-too-human qualities of literacy, persistence and faith in the telos of computational reason. In the spirit of Gmail's decade-long *beta* status, everything remains provisional. It is stitched together not in a seamless web of interoperability but through numerous iterations copy-and-paste, trial-and-error, and searches through mailing lists and Q-and-A forums. Equally, we note that once the code ran successfully, determining whether to run it on a local machine or on Google's cloud is merely a case of changing parameters and territorial scale — even modified code is automatically recompiled and uploaded to the cloud, making for what has been termed a 'No-Ops' (or no technical operations) environment.

Table 1: History of Major Apache Projects

YEAR(S)	SELECTED APACHE PROJECTS	WEB COMPUTING ARCHITECTURES
1995	*Apache Web Server* (Brian Behlendorf and others, 1995)	Web Servers Data Centres largely local ISPs
~2000	*Apache Tomcat* (Sun Microsystems, 1999) *Apache Struts* (Sun Microsystems, 2000) *Apache Xerces* (IBM, 1999) *Apache Lucene* (2001) *Apache Software Foundation* *Apache Software License* (2000)	Middleware, enterprise computing Dynamic web content XML Text Indexing Open-source software committees – including corporations as good tech citizens Open source (permitting commercial derivatives)
Mid-2000s	*Apache Web Services* (formerly *Apache SOAP*, *Axis*) *Apache Hadoop* (Google, Yahoo, 2006)	Web services Elastic computing, distributed algorithms
2010s	*Apache CloudStack* (contributed by Citrix, 2011) *Apache CouchDB* (2008) *Apache Spark* (2013) *Apache Kafka* (2011)	Cloud computing Alternative (NoSQL) databases Machine learning, parallel processing Stream processing
2015/6	*Apache Beam* (contributed by Google, 2016)	Parallel stream processing

21 Google Cloud Platform, https://cloud.google.com/.

Our wider interest here is to interrogate the cloud-computational architecture that now mediates the abstract work of algorithms on data, and their spatial instantiation inside the data centre. Critical inspection neither 'unboxes' the 'black box' hypothetically common both to the algorithm and to the data centre, nor seeks to reify it as a happily unknowable technical artefact. Rather, it rehearses aspects of the technical conditions under which machinic interoperability as well as inoperability are performed. As the transfer of labour from human to the machine continues, this amounts to a renovation of the kind of inquiry into conditions of work on the factory floor that once preoccupied the social analysis of labour.

ALGORITHMIC CRITIQUE

The exercises we conducted here are inspired by the soporific use-cases of tutorials and training guides. Outputs are of course not the point. Rather, the development of datasets, code examples and cloud configuration illustrates the purpose of otherwise obscure investments by companies like Google in parallel-processing frameworks. Such investments belong to a long history of strategic corporate contribution to open-source software, and today these serve to pave the way for the outsourcing of labour and infrastructural needs to data centres and cloud services that in turn support the rise of large scale data accumulation, processing and analysis. One predictable consequence is the deterioration of in-house IT staff that defined the preceding eras of mainframe and client-server computing. The incremental erasure of labour borne by the ongoing march of industrial modernity is coupled with a displacement of institutional autonomy by the sovereign media of platform capitalism and the automation of organizational routines. Alienation returns. Memory is further exteriorized to the machine.[22]

How to re-engineer the black-box of algorithmic apparatuses? What does a knowledge of computational rules and procedures tell us about the governance of labour and life, economy and society? Notable research in the nascent field critical algorithm studies has identified the political economy of Google's PageRank and its capture of living labour to produce 'network value', crowd work on Amazon Mechanical Turk and the 'crowd fleecing' of drivers that underscores the growth model for Uber.[23] Despite the attention in these studies to algorithmic power, the actual architectures often remain elusive and this is not just because computer scientists are not on the scene to lend a critical hand. As Trebor Scholz notes, 'While people are powering the system, MTurk is meant to feel like a machine to its end-users: humans are seamlessly embedded in the algorithm. AMT's clients are quick to forget that it is human beings and not algorithms that are toiling for them — people with very real human needs and desires'.[24]

When humans become indistinguishable from machines, what does this mean for a politics of operation? Does a critical dissection of algorithms, for instance, provide a point of entry into organizing networks of digital labour? For Scholz, the answer is 'no', at least not in any exclusive sense. Instead, Scholz advocates 'platform cooperativism' as a consortium model that clones and adapts technologies of the sharing economy, making use of web apps such as Loomio (Occupy, Podemos) and blockchain technologies such as Backfeed, D-CENT and Consensys for the autonomy of labour organization and social movements.

Frank Pasquale is not as quick in letting go of net-neutrality claims by internet giants. He maintains that algorithmic methods of extracting value from data, devising criteria for automated decision making and governance, and calculating procedures for finance capital must be subject to systematic critique and reorientation if society is to resist total submission to algorithmic authority.[25] In a similar spirit, we suggest black boxes are demystified and indeed made more knowable once their operations are rehearsed, simulated, observed and replicated. Virtualization, containers and parallelization have become integral mediating technologies between the abstraction of the algorithm and the fortification of data centres. They belong, in other words, to a new grammar of algorithmic governance.

MULTIPLYING ALGORITHMIC INSTITUTIONS

The analysis above of Apache Beam registers two key features of emergent algorithmic institutions. First, it describes a shift in the operations of algorithms made possible by parallel architectures adaptable to a range of hardware and network configurations. Second, this seemingly banal feature illustrates the lack of totality and closure within a single operative environment. Driven by what appear to be solely technical considerations — precisely, in other words, through a desire for mastery and control — contingency is reintroduced to the algorithmic situation. The link from algorithmic parallelization to experimental modes of governance is one that is, of course, at best suggestive. Nonetheless, this parallelization forms part of the 'infrastructuring' that has already realised WikiLeaks, BitCoin and other digitally led forms of what political scientists Cui Zhiyuan in dialogue with Charles F. Sabel and Jonathan Zeitlin have termed 'experimental governance'.[26] While a highly conciliatory view of experimentation, with elements of 'Third Way' exuberance retrieved from a decade marked, not coincidentally, by dot-com mania, there is nonetheless some critical and conceptual purchase to be had from considering algorithmic institutions as test-beds of computational modes of governance.

22 See Stack Overflow, http://stackoverflow.com/.

23 See, respectively, Pasquinelli, M 2009, 'Google's PageRank algorithm: a diagram of cognitive capitalism and the rentier of the common intellect', in K Becker & F Stalder (eds), *Deep search: the politics of search beyond google*, Studien Verlag, Innsbruck, pp. 152–62; Irani, L 2015, 'Difference and dependence among digital workers: the case of Amazon Mechanical Turk', *South Atlantic Quarterly*, vol. 114, no. 1, pp. 225–34; and Scholz, T 2017, *Uberworked and underpaid: how workers are disrupting the digital economy*, Polity, Cambridge.

24 Scholz, *Uberworked and underpaid*, p. 20. See also Munn, L 2018, *Ferocious logics: unmaking the algorithm*, Meson Press, Lüneburg, https://meson.press/books/ferocious-logics/.

25 Pasquale, F 2015, *The black box society: the secret algorithms that control money and information,* Harvard University Press, Cambridge.

26 See Sabel, CF & Zeitlin, J 2012, 'Experimentalist governance', in *Oxford handbook of governance,* Oxford University Press, Oxford, pp. 169–83.

Neither top-down autocracy, nor bottom-up anarchy, but 'directly deliberative polyarchy', the emphasis on 'recursion' signals a form of governance indebted to characteristics of the algorithm. Despite an idealised affinity with the experimental culture of the start-up or indeed the iterative cultural logic of 'fail fast' typical of R&D for platform monopolies such as Google, Facebook and Amazon, we acknowledge the vastly different political and historical context in which this discourse on experimental culture is situated in the case of China and its laboratories in governance across provincial cities and spaces. How to cultivate and instil aspects of democratic politics within political systems and market economies stemming from socialist and communist models of collective ownership is an especially delicate and complex challenge, one that is further complicated since the fall of Bo Xilai and demise of the 'Chongqing experiment'.[27] In the spirit of wilful adaptation and the redesign of terms and ideas harnessed to experiments in modes of governance, we might endorse a certain accelerationist logic that invites further amplification of algorithmic transformation of institutional practices as a force of technical failure.

Close to home, the cognitive jolt or shock that accompanies systemic breakdown could be sufficient to question how, for instance, universities govern the production of knowledge in ways not submissive to the tyranny of metrics and calculation of 'performance'. Such endorsement comes with its own political complications, as recent histories of shock therapy, from Jeffrey Sachs' re-engineering of national economies to Žižek's endorsement of far-right 'disruptive' politics as a precursor to a revolutionary alternative, have been either ruinous or irrelevant. Nothing yet in the history of the Internet, which consists of an endless series of shocks (from modem disconnection and browser incompatibility to Cambridge Analytica), suggests that 'shock therapy' works. Academia's version of Facebook's dictum — to 'move fast and break things' — have, often enough, motivated retreat towards even more forbidding levels of governance, performativity and risk management.

At an organizational level, such governance becomes exteriorized in the cloud, or, more precisely, outsourced to the combined processing power of computers owned and operated by Big Tech corporations. Yet this tendency toward homogenization and standardization contains, as it were, seeds of its own demise. As organizations become increasingly reliant on off-the-rack technical 'solutions', the qualities that distinguish one organization from the next steadily disappear. When organizational requirements become retro-fitted to software capabilities with little variation or minimal 'customization' from one organization to the next, the prospect of a crisis of legitimacy is waiting just around the corner.

Together, both technical operations and organizational cultures make evident the contours delineating the territory of contemporary data politics. This combinatory model of data-and-institutional organization extends to the governance of logistical populations. One key example can be found in the recent challenges faced by the Australian Bureau of Statistics (ABS), which in 2014 confronted a very public institutional crisis of legitimacy based on a perception of computational failure. This crisis was precipitated by the multiplication of sites and points of data agglomeration: the 'monopoly of knowledge' (Innis) enjoyed by the ABS for many years has now become rivalled by a diversity of institutional actors who also have considerable computational capacity to produce knowledge that bears upon how economies and populations are understood. This has been accelerated by cutbacks in the operating budget of the ABS from successive governments, which needs to be seen in the context of a two-fold move toward, first, the marketization of governance enabled by computational processes, and second, the reintegration of markets through progressive regulation into a more dispersed but comprehensive system of control.

This is not only a case of the state increasingly outsourcing a once sacrosanct responsibility to private service providers. The multiple diffusions and aggregations of population data throughout a heterogeneous computational and institutional network means that the 'database' is no longer physically or conceptually containable within the borders of a single institution. The era of distributed computing, of virtualized clusters of machines and software that can co-operate to resolve queries over structured data on heterogeneous network and computational topologies, have been paralleled by questions of the sovereignty of singular guardians of population data. Over the past fifteen years an array of new paradigms for arranging, connecting and querying data — the Semantic Web, Linked Data, service-oriented architectures (SOA) and software-as-a-service (SaaS) — continue to bring into question claims over institutional legitimacy.[28]

The increasing dependency by policy makers on the generation of numbers by machines is symptomatic of the automation of decision making. Such is the institutional over-reliance on the pure power of computation. No matter how many manual double-checks and regulatory procedures may comprise the repertoire of techniques deployed to guard against the sort of institutional risk exposed by the ABS debacle, the scale and distribution of computational calculation in the production of knowledge will most likely result in an increasing jostling for legitimacy among institutional actors seeking government contracts related to policy development. Implicit in this jostling is a challenge to closed-world assumptions which accompany the traditional relational database form and, by association, the single institution that manages such infrastructure.[29]

Rival claims, multiple perspectives and contradictory or indeterminate datasets

27 See Cui, Z 2011, 'Partial intimations of the coming whole: the Chongqing experiment in light of the theories of Henry George, James Meade, and Antonio Gramsci', *Modern China*, vol. 37, no. 6, pp. 646–60. See also Frenkiel, E 2010, 'From scholar to official: Cui Zhiyuan and Chongqing's local experimental policy', Books & Ideas, 6 December 2010, https://booksandideas.net/From-Scholar-to-Official.html.

28 See Magee, L & Rossiter, N 2015, 'Service orientations: data, institutions, labour', in I Kaldrack & M Leeker (eds), *There is no software, there are just services,* Meson Press, Lüneburg, pp. 73–89, http://meson.press/books/there-is-no-software-there-are-just-services/.

29 See Edwards, PN 1996, *The closed world: computers and political discourse in cold war America*, MIT Press, Cambridge.

form the new territory of informational contestation. The case of the ABS offers an optic into the emergence of such struggles. Our claim is that this is less a story about decentralization and privatization of government within a neoliberal paradigm (although these are without doubt key forces), and more an instance of the technical logic of databases and distributed computing resulting in an unsettling of modern institutional authority. What are the implications for public institutions as they relate to the supply of knowledge on national populations when the technologies of insight have become distributed and increasingly unaccountable across a range of actors? And what affordances does this present for the disruption of parametric politics, or the establishment, at the very least, of alternative parameters though which political life can be constituted?

Despite the extensive literary, artistic and musical expressions on the maelstrom of modernity, and without questioning the barbarism of war and colonial violence, there nonetheless remained a peculiar continuum of relative institutional stability or at least semblance of coherence across the modern epoch.[30] Church, state, union, factory, firm. These were chief organizational forms that comprised the institutional rhythms of daily life and economy. The current conjuncture of institutional disaggregation and computational geopolitics is in some ways a logical — even digital — 'output' stemming from the modern experience of a transformed world. As algorithmic modes of organizing decision-making and practices of governance increasingly remake modern institutional settings while simultaneously giving rise to 'platform' organizations and largely non-governable apparatuses such as high-frequency trading systems, a corresponding redefinition of authority, expertise, subjectivity (manifest especially as a crisis of masculine identity) and indeed political-economic hegemony is currently underway. This institutional transformation holds not only political-economic and geopolitical implications, the details of which we can observe on a daily basis in the innumerable accounts of an automated world accompanied by a shift in the global axis of power.

A more mundane, less 'measurable' adjustment is also at work in the process of computational systems integrating with social life and economy. The cognitive tendencies of the brain and psycho-physiognomic composition of subjectivity and its body of flesh are also steadily, even quite rapidly, undergoing change. A data politics of the present is defined not only by battles of proprietary platforms, by extractivist economies and by claims of legitimacy over the right to govern.[31] Data politics within social life, engineered by parametric designs and managed by forms of nonconscious cognition, is also about the invention of autonomy severed from terms of agreement. Data politics insists on disagreement as a condition of computational cultures.

30 The classic text here remains Berman, M 1983, *All that is solid melts into air: the experience of modernity,* Verso, London.

31 For a collection of essays that address these issues, see Bigo, D, Isin, E & Ruppert, E (eds), 2019, *Data politics: worlds, subjects, rights,* Routledge, London.