Governance by Algorithm:
China's Social Credit System

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Abstract

This paper is concerned with China's Social Credit System (SCS), and more generally with the theoretical domain of algorithmic governance. Existing theorisations of the SCS place heavy reliance on standard law and economics approaches, and have not sufficiently examined the SCS as a form of governance using new technologies, in particular 'code' involving machine-learning algorithms. To meet this gap, this paper develops a theory of algorithmic governance and applies it to the understanding of the SCS. It argues that the SCS has the potential to create a new model, 'governance by algorithm', which exploits features of big data and artificial intelligence (AI). This new model could influence not only China's 1.3 billion people and numerous corporations, but also be referenced by law makers concerning a range of regulatory issues in Europe, Africa, and North America.

The paper will show that 'governance by algorithm' is, in practice, a hybrid consisting of four distinct modes of governance—social norms, laws, numbers and code. They are layered in terms both of their historical evolution and current inter-dependence. Their evolution describes a movement—the 'algorithmic turn' of governance from social norms to laws, from laws to numbers (or statistics), and from numbers to code (computational algorithms). In this process, governance has become increasingly algorithmic in its reliance on computation, while expanding its scale effects over populations and territories. However, this 'scaling effect' is countered and constrained by a 'layering effect': each successive layer is conditioned by those preceding it. Thus today's 'code' is cognitively layered by reference to statistics, laws and social norms, thereby exhibiting institutional path-dependence. 'Learning' code can only function by using statistical analysis; statistics, in turn, is defined by reference to non-computational frames, including those of laws and social norms. To achieve complementarity and overall effectiveness in governance, law makers should be aware of the different nature and limitations of each mode, and consciously avoid potential freezing or lock-in effects induced by over-reliance on just one (in particular 'code' and 'numbers.')

Having outlined this hybridised model of 'governance by algorithm', the paper begins the process of applying it to China's SCS. It delineates the different branches of the SCS and identifies their respective nature according to the four modes of governance. It analyses their various 'scaling' and 'layering' effects, and shows that machine-learning code and similar computational approaches adopted in the SCS are likely to be more effective in solving governance problems when they are coordinated with complementary systems of social and legal institutions present in society.

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I. Introduction: China's Social Credit System as a New Model of Governance

This paper is concerned with China's Social Credit System **(SCS)** (Dai, 2018; Baker, 2018; Mac Síthigh and Siems, 2019), and more generally with the theoretical domain of algorithmic governance (Hildebrandt, 2016, 2018, 2020b; Danaher et al., 2017; Yeung, 2018; Coglianese and Lehr, 2019; Engstrom and Ho, 2020a, 2020b).

The SCS is a 'governance modernisation' project (Xi, 2020) intended to increase the 'level of trust' in society with the help of modern technology (State Council, 2014). It could influence not only China's 1.3 billion people and numerous corporations, but also be referenced by law makers concerning a range of regulatory issues in Europe, Africa, and North America (Mac Síthigh and Siems, 2019; Jili, 2019).

Algorithmic technologies based on Machine Learning **(ML)** and Deep Learning **(DL)** play a key part in this pursuit. As ML/DL algorithms have come to replicate aspects of human and institutional decision-making processes, they have been increasingly adopted in the SCS to evaluate the 'social credit' of individuals and businesses, and thereby to regulate their future behaviours.

In 2015 Ant Financial developed a smartphone application called 'Sesame Credit', using so-called **'FinTech'** techniques based on ML/DL codes. Sesame Credit algorithms analyse consumer behavioural data and generates a predictive score indicating the creditworthiness of an individual or business in their future transactions and social interactions. A high score indicates a good reputation, which can in turn bring one tangible benefits (Dai, 2018; Ahmed, 2017a).

Subsequently, the same FinTech techniques were applied in local governance: in 2016, the Hangzhou city government and Sesame Credit worked together to create a city score that was intended to foster social trust and automate applications of market regulations (Ma, 2018). Many other municipalities built similar systems but with local quantified indicators (Ohlberg et al., 2017). Even in rural localities like Qingzhen, big-data and block-chain technologies were being experimented with (Dai, 2018).

Similar scoring techniques have been adopted in the context of compliance. Regulatory agencies have moved beyond traditional statistical systems, using **'RegTech'** (Regulatory Technology) methods to analyse corporations' past compliance data and thereby predict their future compliance risks, in areas including corporate registration and food and drug safety (Sun, 2017, 2018). Recently, China's State Council (2019) and Central Committee (2020, S5:7) further demanded the 'acceleration of the SCS' by 'building a new regulatory mechanism centred around credibility'.

While progress has been rapid, the nature and consequences of using scoring systems based on ML/DL technology in the SCS have not been sufficiently examined. Is the SCS innovating a new model of governance with the help of modern technology? As our societies are increasingly governed by algorithms, will state-enforced laws be replaced by self-executing computational code? Or can the rule-of-law and rule-of-code operate in complementarity with each other to form a new model of governance?

The SCS directs our inquiries into the nature of law as a foundational mode of governance in modern capitalist societies, in and beyond China. My ultimate goal and contribution is to bridge the gap in our current understanding on law's functioning in societies facing the rise of algorithmic governance, a need which is urgent.

This paper intends to fill this gap by developing a theory of algorithmic governance, and use it to examine the working mechanisms of the SCS. I start by introducing the paper's method of theoretical synthesis. This synthesis is located in governance theory and institutional law and economics, and clears the ground for the empirical case studies which will form part of the wider thesis (Part II).

The methods section is followed by a literature review of the SCS. It will argue that existing theorisations of the SCS place a heavy reliance on somewhat rigid law and economics assumptions, and have not adequately examined the SCS in the frame of governance theory, or as a case study in the emergence of new technologies (Part III).

Then I draw on a series of works to formulate an institutionalist theory of algorithmic governance. I unearth an 'algorithmic turn' of governance evolution: from norms to laws, from laws to numbers, and from numbers to code. I identify the scaling and layering effects in each transition, and argue that code and statistics must be coordinated with laws and social norms to achieve positive complementarities and avoid negative freezing in governance (Part IV).

Finally, I begin the process of applying this framework to the analysis of China's SCS. A review of the initial evidence suggests that different branches of the SCS adopting ML/DL code are limited by layering and freezing effects. They have only achieved beneficial scaling when coordinated with socio-legal institutions. By way of preliminary conclusion, I suggest that the SCS is emerging as a hybridised model of algorithmic governance (Part V).

II. Methods

In developing a framework for understanding the SCS, this paper adopts the method of theoretical synthesis. It aims to contribute to a theory of governance by synthesising a series of interdisciplinary works that share a legal realist and institutionalist tradition.

This tradition goes back to Commons (1924, 1932, 1950) and Williamson (1979, 1998, 2002, 2005) on institutionalist governance, Macaulay (1936) on social norms and non-contractual relations, Pound (1922, 1923) on an engineering interpretation of legal history and Llewellyn (1947, 1960) on law as 'craft'. This tradition is updated here by drawing on Aoki (2010) and Hodgson (2015) on evolutionary law and economics, Deakin (2015, 2017) on legal institutionalism and evolution, Howarth (2013) on law as engineering, Supiot (2007, 2017) on legal anthropology and governance by numbers, and Hildebrandt (2016, 2018, 2020a, 2020b) on law as computation.

The underlying ontological assumption being made here is one common to legal realist and institutionalist approaches, namely that certain social referents, termed 'institutions', have sufficiently stable properties to enable them to be the focus of systematic study. More specifically, as in the modern evolutionary tradition, institutions are seen to have properties of emergence, self-organisation, and holistic or systemic 'complexity' (Aoki, 2010). Such institutions are cognitively open, and operate by interrelating and evolving with external environments, achieving an approximate, asynchronous and often fragile degree of 'fit' with their context (Deakin, 2015, 2017).

The term 'governance' is understood to refer to an organised mode or practice, associated with institutions of varying degrees of formality, through which modern capitalist societies and market economies are constituted. Thanks to the emergent, systemic and co-evolutionary features of contemporary modes of governance, institutions should be understood not merely as rules, but as practices which define the cognitive foundations and prevailing values of a society. Governance in this sense is not merely about efficiency, but also about the norms, legitimacy, and sustainability of social order—or in Supiot's words, the 'habitat' of a society (2007).

Secondly, this paper proceeds through a ground-clearing approach, by developing a second, parallel synthesis between algorithmic governance and the SCS. It draws on both secondary sources and publicly available archives, in order to pave the way for the beginning of an empirical research project examining the SCS, based on the institutionalist approach to governance, which will be developed more fully in the wider thesis. Genealogical methods (Deakin, 2001; Adams, 2019, 2020) are also used to delineate the trajectories of different strands of institutional developments in the SCS.

III. China's Social Credit System: A Literature Review

Existing bodies of literature on the SCS have mainly focused on (1) various socio-legal concerns over the SCS; (2) SCS's general and potential impacts, efficacy and legitimacy; and (3) theorisations of state strategies and the reputation mechanisms in terms of law and economics. These literatures have not sufficiently examined the SCS systematically as a new model of governance using emerging technologies, particularly ML/DL.

1. Miscellaneous socio-legal approaches to the SCS

Many scholars have focused on aspects of socio-legal concerns arising from the SCS. For example, Ahmed (2017a, 2017b) examines some cases of FinTech adoption in the SCS such as Sesame Credit, although her main focus was on its data transfer and privacy implications. Chen and Cheung (2017) also zoom in to identify data privacy flaws in China's privacy regulations concerning the SCS. Meissner (2017) instead focuses on the SCS's potential enabling effect with respect to China's economic regulatory capabilities and the resulting impact on domestic and foreign business compliance practices. Hoffman (2018) discusses the SCS's compliance implications in jurisdictions outside China. These literatures did not intend to capture a full picture of the SCS, nor explained the workings and impacts of technological governance in details.

2. Assessments of the SCS's impacts, efficacy and legitimacy

In contrast, a number of studies have provided more general discussion on the SCS's impacts, efficacy and legitimacy. Some claimed that the SCS is a technology-driven tool to exert social control and surveillance. For example, Creemers (2016, 2018) understands the SCS as a practice of control to stabilise the state. Loubere and Brehm (2018) theorise the SCS as a 'coercive surveillance infrastructure' and the 'financialisation of governance' with a repressive logic.

On the other hand, Liang et al. (2018) have recently argued that the SCS is a state surveillance infrastructure, but one which 'focuses primarily on financial and commercial activities rather than political ones.' This is echoed by Mac Síthigh and Siems (2019), who understand China's SCS as a 'specific instance in a wider phenomenon' of the global rise of algorithmic 'grading and ranking' systems. They compare the SCS with similar practices of reputational and quantitative scoring systems around the world, asking if China's SCS could be a model for other countries. In addition, Backer (2018) argues that the SCS is part of the global shift of the focus of public law's 'from constitution and rule-of-law to analytics and algorithm', foreshadowing a future evolution in global normative orders. Relatedly, Kostka's empirical study (2018) shows that Chinese public opinion predominantly supports the SCS, seeing it as an instrument for improving the 'quality of life' and upgrading governance.

Notwithstanding these different views and approaches to the SCS, the existing literature has one feature in common: generalising on the roles and rationales of the SCS, without sufficiently examining its working mechanisms and consequences. Moreover, a significant omission is close analysis of the ML/DL technologies underlying the SCS.

This gap also exists in Chinese scholarship. Since the late 1990s, Chinese scholars in economics, finance and computer science have been studying western financial credit-rating techniques and institutions, with the aim of building the SCS. Their analyses, however, were focused on the technology and on the economic rationales for the SCS, within specific disciplinary boundaries (Yu et al., 2015; Lin, 2012). Only in the past few years have Chinese legal scholars joined the debate on the SCS.

These legal discussions are mostly concerned with offering doctrinal analysis with a view to preventing the SCS from giving rise to potential abuses of the law (Shen, 2019). They offer some general analysis of the efficacy and legitimacy of SCS, but have not sufficiently examined its detailed institutions—how different branches of the SCS work and what their empirical limits are (Shen 2019; Wang, 2018). This leaves an opening for an in-depth theorisation and analysis of the working mechanisms of the SCS, paying close regard to its relationship to ML/DL code as modes of governance.

3. Theorisations of state strategies and reputation systems: law & economics

One of the most comprehensive examinations of the SCS is provided by Dai's paper 'Toward a Reputation State' (2018). He argues that the 'reputation society' is heading towards the 'reputation state': a more state-centred interventionist model of governing societies. Four major state strategies were identified in the SCS (illustrated in a 2x2 matrix) to formulate this reputation state, in which laws and regulations compete with other measures such as private ranking and scoring.

Dai's framework was influenced by Strahilevitz (2008, 2011), who proposes a 'reputation nation' theory, using information microeconomics, to analyse law from an economic perspective. This understanding follows a Chicago School 'law and economics' tradition—assuming that state-enforced laws are like 'products' competing with other normative measures on a 'market' of norms.

Writing within the 'law and economics' tradition, Dai assumes that the different branches of the SCS have the same natures and working mechanisms, and are therefore comparable to one another in a 2x2 matrix (Table 3.1, p. 13).

	Private sector information	Public sector information
Private actors' decisionmaking	regulation	searchlight
Public authorities' decisionmaking	incorporation	institutionalization

Table 3.1: Four paradigms of government strategies to use reputation

Figure 1. Dai's 2x2 matrix for the theorisations of state strategies in the SCS

He regards financial credit rating systems as equivalent in this sense to blacklist regulations, and see them as competing reputational instruments in governance. This approach ignores very real differences between FinTech-based techniques, on the one hand, and traditional state power of legal enforcement and punishments, on the other; these are distinct modes of governance with very different institutions, logics and evolution trajectories. Dai (2018, p. 61) frankly admits that his paper is focused on sketching a general analytical framework, leaving unresolved the empirical evidence needed to fully support his claims, along with and their normative implications for future studies.

Another theorisation of the SCS in terms of state-adopted reputation systems is that of Mac Síthigh and Siems (2019). They compare western ranking and grading systems with the Chinese SCS, seeking to understand them in a shared analytical framework with eight key factors— 'drafter', 'user', 'aim', 'scoring', 'application', 'algorithm',

'enforcement' and 'accountability'. These factors were mapped against the level of state intervention in different reputation systems: from low, to medium to high. These two sets of variables form the basis of the 8 x 3 matrix as a conceptual framework (2019, Table 1, p. 1046).

Table 1. Degree of interventionism in rating systems

	Low	Medium	High
1) Drafter	Private	Co-drafting	State
2) User	Choice	Strong incentive	Mandatory
3) Aim	Specific	Socio-economic	General
4) Scoring	Multiple	Main and sub-indicators	Single
5) Application	Flexible	Comply or explain	Uniform
6) Algorithm	Transparency	Controlled transparency	Protected
7) Enforcement	Market	Stages of enforcement	State
8) Accountability	Oversight body	Review possible	Immunity

Figure 2. The 8x3 matrix by Mac Síthigh and Siems, 2019

Utilising this framework, they argue that China's Social Credit System provides a useful reference point for other countries. As such it should be studied by the US and EU legislators, not as a template or counter-model, but as 'illustrations of the implications of today's emphasis upon quantification and reputation across a range of domains, personal and official.' (p. 1070; Table 2, p. 1047; Table 3, p. 1054).

Table 2. Interventionism in selected rating systems

	Credit ratings in many countries	UK research excellence framework	Sharing economy platforms
1) Drafter	Low	High	Low
2) User	Medium	Medium	Low
3) Aim	Low/Medium	Low	Low
4) Scoring	Medium	Medium	Medium/High
5) Application	Medium/High	High	High
6) Algorithm	Medium	Medium	Low/Medium
7) Enforcement	Low	Medium	Low
8) Accountability	Low	Low	Medium

Figure 3. Mac Síthigh and Siems use the matrix for a comparison of 3 rating systems

Table 3. Degree of interventionism in the Social Credit System (so far)

	China-wide blacklists	Pilot cities	Financial institutions
1) Drafter	High	High	Low
2) User	High	High	Medium
3) Aim	Medium	Medium	High
4) Scoring	Low	High	High
5) Application	High	Medium	Medium
6) Algorithm	Low	High	High
7) Enforcement	High	Medium	Low
8) Accountability	High	Low	Low

Figure 4. Mac Síthigh and Siems use the matrix for a comparison of 3 SCS branches

Compared to Dai's reputation state theory, Mac Síthigh and Siems do not resort to an explicit law and economics approach. Nevertheless, they also assume that laws and regulations are on a par with market-based reputation systems—with the major difference being their 'interventionist' level.

These initial theorisations are good starting points to understand the workings of China's SCS in relations to its western counterparts and the global adoptions of reputation mechanisms in governance. However, they put to one side the nature of the SCS as a form of governance by algorithm, a point of view which raises wider questions than can be addressed through the logic of reputation alone. A more flexible and comprehensive theory of algorithmic governance, embedded in institutional history, can enrich the debate.

IV. Governance by Algorithm: From Norms to Laws, Laws to Numbers, and Numbers to Code

This paper proposes an institutionalist framework for the study of algorithmic governance, drawing together and synthesising a series of works. Its first contribution is to distinguish four distinct modes of governance inter-related to each other: social norms, laws, numbers and code. It will show how these different modes of governance are linked, both in the historical sense of one emerging from the other, and in the practical or functional sense of them being layered in their contemporary mode of operation.

This approach is to be distinguished from the outset from the view that law could be ultimately replaced by code (Alarie, 2016). This is because governance through code cannot function without the framing effects of other, anterior modes of governance, including law. It also rejects the standard law and economics approach to governance which views laws through the prism of price theory, analogising law to a 'product' competing with other regulatory modes in a market of norms (Dai 2018). Rather than law being subject to such meta-competitive forces, it is law which provides the conditions of possibility for these forces to operate.

Historically, the process has been one of evolution from social norms to laws, from laws to numbers (statistics), and from numbers to code (computational algorithms). This evolution has been characterised by an 'algorithmic turn' in modes of governance, which has intensified with each successive stage in the process. The algorithmic turn produces a 'scaling effect', according to which the more computational modes of governance become, the greater their potential for governing populations and territories on an ever-larger scale.

Nevertheless, code and numbers can also reinforce and lock in negative impacts of laws and social norms, thereby exhibiting institutional path-dependence of a kind associated with negative or pathological effects. More algorithmic modes of governance, 'code' and 'numbers', are cognitively layered in the sense of presupposing, and building on, their less algorithmic predecessors—laws and social norms.

I will argue that scaling and layering are crucial parameters for law-makers when seeking beneficial complementarities in algorithmic governance. Different modes of governance must be carefully coordinated to avoid institutional lock-in and freezing effects with negative consequences.

1. Concepts: Governance by Algorithm

1.1 Governance: norms, laws, numbers and code

(1) Definition

The term 'governance' has been widely adopted in various disciplines since the 1990s.[1] These uses include 'corporate governance' (since the 1990s)[2], 'global governance' (since the 2000s)[3] and 'algorithmic governance' (since the 2010s; B. Williamson, 2014; Danaher et al., 2017; Coglianese and Lehr, 2019; Engstrom and Ho, 2020a, 2020b). But the concept of 'governance' itself has not been well-defined or consistently applied across different disciplines (Boyer 1990; Rhodes, 1996, 1997, 2007; Kooiman, 2003; Rodrik, 2008; Offe, 2009). Only a few scholars have recently tried to build a unified governance theory (Fukuyama, 2013; Bevir, 2013; Supiot, 2017).

Some international organisations have provided practical definitions of governance, for example, the UN Global Compact (2020) defines governance as 'the systems and processes that ensure the *overall effectiveness* of an entity–whether a business, government or multilateral institution'. With specific reference to public governance, the OECD (2011) refers to 'the formal and informal arrangements that determine how *public decisions* are made and how public actions are carried out, from the perspective of *maintaining a country's constitutional values* when facing changing problems and environments.' These practically-orientated definitions focus on the goal of governance: maintaining the effectiveness of systems and the constitutional values of nation-states.

A theoretical definition of governance was recently offered: 'all processes of governing, whether undertaken by a *government, market, or network*, whether over a family, tribe, formal or informal organization, or territory, and whether *through laws, norms, power or language*.' (Bevir, 2013, p. 1). This concept articulates (1) the governing actors—not limited to governments, (2) the governed objects—social organisations, and (3) the means of governance—including laws, norms and languages, that is both natural language (encoding norms and laws) and artificial languages (such as numbers and binary code). This conception differentiates governance from government 'in that it focuses not only on the state and its institutions but also the creation of rule and order in social practices.' (Bevir, 2013, p. 1). It has a decentralising philosophy with an emphasis on network theory as the core approach to understanding of social organisation (Bevir, 2013, Ch. 7-8).

(2) An institutional approach to governance

By contrast, the seminal studies of governance by John R. Commons from the 1930s (1932, 1950) did not have such a strong decentralisation emphasis. Instead of focusing attention away from the state and legal institutions, 'governance' originally had an institutionalist orientation, one emphasising the importance of formal institutions in economic organisation and governing processes.

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[1] *See*, google Ngram, the usage of the word 'governance' started to grow since the 1980s, and showed exponential growth since early 1990s.
[2] *See*, google Ngram, growth in 1980s, and exponential growth since1990s.
[3] *See*, google Ngram, exponential growth since 1990s.

Commons' early work (1932, p. 4) defined economic governance in terms of its 'three principles of conflict, mutuality and order'. His definition emphasised the continuity of mutual exchange relationship and the rules that governed transactions with a view to generating order out of conflict. Meanwhile, the dominant paradigm of orthodox economics was increasingly taking shape as a 'science of choice', studying how equilibrium is reached as a result of the choices of utility-maximising consumers and profit-maximising firms (Reder, 1999, p. 48). Commons (1950, p. 21) criticised the orthodox paradigm on the grounds that economics should instead centre on 'transactions and working *rules*, on problems of *organization* and on the ... [ways] the organization of activity is ... stabilized.'

This institutionalist tradition was taken on by Oliver E. Williamson from the 1970s. Williamson (2002, p. 439; 2005, p. 3) defined governance as 'the means by which to infuse *order*, thereby to relieve *conflict* and realize *mutual gain*.' Based on the triple principle of 'conflict, mutuality and order', Williamson (1979; 1998, p. 58) argued that the *transaction* is the basic unit of economic organisation, and that *rules*, including *laws,* are essential for stabilising transactions in order to form reciprocal and continuous exchanges through time.

Subsequently, this institutionalist approach to governance was enriched by Elinor Ostrom's study of polycentric governance (2005, 2010). 'Polycentricity' here refers to governing decisions that are made through multiple loci, each operating with some degree of autonomy. Ostrom (2010) claimed to develop a model of governance beyond the dichotomy of market and state, in which complex economic systems are governed by a hybridised framework of diversified rules, established by both state and non-state institutions.

This institutionalist tradition echoes with a legal realist understanding of law as 'engineering' (Howarth, 2013). Seen as organised knowledge of 'engineering' (Pound, 1922, 1923) or as 'craft' (Llewellyn, 1942, 1960) with tacit knowledge (Polanyi, 1960), law solves practical governance problems and operates in ways that are similar to engineering devices which fulfil certain systematic functions (Howarth, 2013). Legal realism is thus 'an effort at more effective legal technology' (Llewellyn, 1960, pp. 9-10), and is more recently updated with new information technologies (Susskind, 2008, 2017; Howarth, 2013).

In summary, an institutionalist tradition understands governance in terms of (1) its practical objectives and functions, namely to to infuse social order, resolve conflicts and facilitate mutual gains, and (2) the various means or institutions by which these functions come to operate, that is the different *modes of governance*, including law.

(3) Modes of Governance: social norms, laws, numbers and code
By 'mode' is to be understood the 'mode of existence' (Latour, 2013), so that 'modes of governance' are synonymous with the ways in which governing processes operate or exist (Hildebrandt, 2016, 2018). I will argue that in an institutionalist approach, there are four principal modes of governance: governance by (i) informal social norms, (ii) state-enforced laws, (iii) statistical calculations and (iv) computational algorithms.

Norms, laws, numbers, and code**,** have long been recognised as four distinct ways of regulating individual behaviours (Cohen, 2012; Supiot, 2017). For present purpose, it can be seen that they function as four principal media for governance. Each medium has self-reinforcing properties that create independent systems of governing and related modes of existence. Identifying the different qualities of each of these four modes of governance is the first step in understanding the nature of algorithmic governance.

(i) 'Governance by norms' means using social norms as the main medium for governing. Social norms are informal rules and customs developed through repeated interpersonal interactions in communities. They are often seen as customary or private arrangements without the aid of state or other central coordinator (Hayek, 1973; Ellickson 1994; Ostrom, 2005, 2010).

(ii) In contrast, 'governance by laws' refers to a case in which the main mode of governance is by using formal institutions underpinned by the state, implying a realm of public ordering and centralised design. This mode still relies on and works in conjunction with social norms, but requires formal law-makers to act as institutionalising agents and final arbiters under the general ambit of the rule-of-law state (Deakin et al., 2017; Supiot, 2007).

(iii) 'Governance by numbers' means using quantified measures and statistical calculations as the main media of governing. While relying on mathematical techniques rather than the interpretation of texts, governance by numbers is still derivative of governance by laws in the sense of inheriting the basic institutions and structures of the state, including a formal legislature and judiciary (Desrosières, 2002). It has a particular focus on administration (public and private), formal regulation and planned policy-making; it is often characterised by the transplanting of the formal logic of the market, above all the price mechanism, to all public institutions including the legislature, judiciary and public administration. In its ubiquitous use of statistical modelling, employing the 'artificial' language of numbers, it is distinct from laws and social norms, which are based on the use of natural language for communication (Supiot 2007, 2017).

(iv) 'Governance by code' is an extension of governance by numbers, but with qualitatively higher sophistication both in the 'learning' capacity of computations and calculations aimed at replicating human decision-making processes (Hildebrandt, 2020a, 2020b, Markou and Deakin, 2020), and in the 'hyper-reflexivity' with which it seeks to use self-adjusting algorithms for prediction and modification of human behaviours (Zuboff, 2015, 2019). At the core of code is the use of advanced computational algorithms written in binary numbers (0-1) and operated on computers, often involving machine-learning and deep-learning techniques that self-adjust or 'learn' through repeated iterations with the data on which they are 'trained'. Once entrenched, computer algorithms of this kind generate a self-enforcing technological architecture which shapes the cognitive and physical environment of human interaction (Lessig 2006). Because they are generated and enforced through a kind of automation, these algorithms exert immediate and material restraints; they are hyper-reflexive in the sense that they both predict and shape human behaviours in real-time. Learning and hyper-reflexivity are features which endow governance by code a uniquely powerful place among the four modes of governance (Hildebrandt, 2018, 20201, 2020b).

1.2 Algorithm: The 'algorithmic turn', scaling, and layering

(1) Definition

An 'algorithm', generally put, is a 'step-by-step procedure for solving a problem or accomplishing some end.'[1] The term is often associated with the rise of computer science, where an algorithm is 'informally, … any *well-defined computational procedure* that takes some value, or set of values, as input and produces some value, or set of values, as output. An algorithm is thus a *sequence of computational steps* that transform the input into the output.' (Cormen et al., 2009, p. 5).

'Computational' denotes 'involving the use of computers'[2], and a computational procedure means it must be readable and operable by a physical computer. This restrains the operation of computational steps within the material hardware of the computer machine, that is, the physical transistors placed on silicon chips that process binary electric signals following Boolean algebra under the logic of 'if this then that' (IFTTT) (Hildebrandt, 2020b; Markou and Deakin, 2020).

These general definitions of algorithms share two key components, that is, an algorithm must (a) have 'problem-solving' as the goal, which assumes a well-defined problem at hand, i.e. a gap between a current position (coded as input values) and a desirable future position (coded as output values); and (b) provide a 'step-by-step' *or* 'computational' procedure, which could instruct an agent, either human or machine, to move from the current problematic position (input) to the desired position (output). We could, therefore, say that any process that consists of these two elements be called 'algorithmic', or a process decided by algorithm.

(2) The 'Algorithmic Turn' in governance.

Linking this general notion of algorithm to governance, all four modes of governance can be argued to be 'algorithmic' to various extents. As long as social norms, laws, numbers and computer code provide a step-by-step *or* computational procedure, they could all be understood as **'governance by algorithm'**: the processes of solving governance problems using different algorithmic means.

Nevertheless, the four modes of governance have varying degrees of algorithmic features situated in their institutional history. As we move from norms to laws, to numbers and to code, the modes of governance become more algorithmic, and at the same time more explicitly computational. I conceptualise this evolutionary path as the **'algorithmic turn'** in governance.

To start with, (i) governance by norms and (ii) governance by laws can be algorithmic, but only to a very limited extent. They are partly algorithmic, because they fulfil the definition of involving *some* 'step-by-step' or computer-readable procedures in order to solve *some* well-defined goals of governance. Nevertheless, they both maintain ambiguous concepts, principles, and goals that are intrinsically impossible to be expressed in purely numerical or binary computational terms. Laws and social norms

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[1] https://www.merriam-webster.com/dictionary/algorithm
[2] https://www.macmillandictionary.com/dictionary/british/computational, and
https://dictionary.cambridge.org/dictionary/english/computational

maintain a non-calculable and non-algorithmic element that cannot be programmed into machine-readable code (Supiot, 2007, 2017; Markou and Deakin, 2020). On the other hand, as between laws and social norms, law could be deemed as more algorithmic because it is often by definition more formalised with better-defined concepts and instructions (Deakin et al., 2017; Chen and Deakin, 2015).

In contrast, (iii) governance by numbers and (iv) governance by code are much more algorithmic, or that is to say computational, in that they both follow a highly mathematical step-by-step procedure to solve problems. For example, regulatory ranking and credit-rating systems operate on step-by-step instructions to evaluate compliance performances and risks using statistical calculations. Some of these numerical calculations could thus be easily programmed into, for instance, FinTech or RegTech algorithms that are run on computers (Hurley and Adebayo, 2016; Sun 2017; Dai, 2018). Meanwhile, code in the form of ML/DL algorithms that decide credit scores or criminal sentencing and probation periods are readily operated on computers to solve computational problems following computational steps (Hurley and Adebayo, 2016; Kehl et al., 2017). These codes are purely computational and constitute the narrow definition of algorithm, which will be further discussed later in the section 'from numbers to code'.

(3) Scaling and Layering

I argue that this 'algorithmic turn' from norms to laws, to numbers and to code has two defining qualities—scaling and layering. First, '**scaling**' denotes that the more algorithmic modes of governance become, the greater their potential for governing populations and territories on an ever-larger scale with at a smaller or similar social cost. This can be explained by their greater capacity in processing larger amount of data to facilitate complex division of labours and dispute resolutions.

The concept of scaling originates from the idea of 'economies of scale' in microeconomics, which refers to the cost advantages that enterprises gain as a result of their increasing scale of production (Alfred, 1977). It can be traced back at least to Adam Smith's idea of gaining higher production returns by adopting the division of labour (Smith, 1776). In the context of governance, that scaling is not purely about producing more cheaply, but rather on expanding the general scale of governed territory and population in a sustained order that realises mutual gains, without inducing disproportionate social costs in resolving new conflicts.

Scaling happened in history when major societies shifted their predominant mode of governance towards more algorithmic ones and expanded governing scales. For instance, a variety of informal social norms like repeated trading, reputation and interpersonal trust first assisted the transition to impersonal trade in the west (North and Thomas, 1973; North, 1990). Yet the rise of modern contract law and the market economy based on numerical calculation are widely identified as among the most important defining institutional developments that led to the dominance of the global north (Ferguson, 2012; Cooter and Schaefer, 2013). Moreover, the rise of digital technologies including those based on algorithmic 'learning' is potentially bringing

governance to a larger civilisation scale—creating a new information civilisation (Zuboff, 2015).

However, this scaling effect is limited by the **'layering effects'** of governance by algorithm. This means that the more algorithmic/computational modes of governance are cognitively layered on their less algorithmic predecessors. These complementarities often thus reinforce or lock-in negative features of existing governance modes with path-dependency, which can 'cool down' or freeze the open and dynamic interactions in societies (Supiot, 2007, 2017; Hildebrandt, 2020).

Therefore, the layering effects of algorithmic governance refute claims such as those involved with the 'legal singularity' (Alarie, 2016), which asserts that computer code is functionally better than laws so that it will eventually replace laws to operate on its own. It will be argued that even governance by code involving machine-learning algorithms, which seeks to replicate aspects of human decision-making, cannot function without modes of governance which are logically and historically anterior to it—norms, laws and numbers.

This view also rejects a teleological view claiming that the historical turn to numbers and code necessarily means social progress. In other words, the emergence of governance by code—the most purely algorithmic or computational form of governance—is not necessarily the historical end-point of the process. Nor is governance by code necessarily superior (in the sense of being more just, efficient or self-sustaining) to laws or social norms.

Over-reliance on numbers and code in governance can lead to negative reinforcements like lock-in, cooling and freezing. Therefore, to achieve complementarity, law makers must be aware of the different natures and limitations of each mode of governance, and consciously choose among these modes of governance to solve complex problems. Most likely, all four modes of governance must be maintained for societies to preserve systematic openness and diversity.

The following three parts will spell out the details of this theory of governance by algorithm. It examines the scaling and layering effects in each stage of the 'algorithmic turn' in governance, and provides a theoretical framework to analyse the social credit system.

2. From Norms to Laws: institutionalism, rule-of-law state, and path-dependency

The turn from norms to laws in governance could be summarised by the two ontological claims of 'Legal Institutionalism' (Deakin et al., 2017). (1) Firstly, law institutes modern capitalist society by involving the state and qualitatively turning away from social norms. A key reason for this turn is the scale effects acquired in governance by laws (p. 189). (2) Secondly, modern law involves both the state *and* social norms. It relies on social norms as its cognitive foundation (pp. 188-190). This foundational role of social norms is further elaborated in the work of Supiot (2007, 2017). State-enforced laws must align to at least an approximate (if precarious and somewhat asynchronous) extent with social norms to achieve hybridity, in order to fulfil its instituting and scaling effects (Deakin et al., 2017, p. 198; Pistor, 2013, p. 322).

2.1 Legal Institutionalism

The importance of informal social norms in governance has long been evidenced. Repeated trading, reputation and interpersonal trusts have been effective in, for example, the governance cases of non-contractual relations in businesses (Macaulay, 1963), informal property disputes resolutions between neighbours in California (Ellickson, 1994), and the medieval long-distance commerce among religious communities like the Jewish Maghribi traders (Greif, 1993).

Nevertheless, some scholars claimed that (1) such norms *without* the aid of a state or other central coordinator are sufficient to support complex modern governance, and (2) the law is a mere epiphenomenal expression of or could be reduced to these customary norms or private ordering (for discussion of these views see Deakin et al. 2017, p. 189).

Legal Institutionalism rejects these views, arguing that (1) firstly, law institutes modern capitalism with large scale of cooperation, whereas customary norms can only uphold limited scales of governance with less complexity and uncertainty; and (2) secondly, law must always involve both public/designed (state intervention) and private/spontaneous ordering (social norms) (Deakin et al., 2017, pp. 189-191, 198).

Legal institutionalism first argues that there are 'limitations of a purely spontaneous conception of law' (p. 198). The 'high degree of complexity and uncertainty in large, developed economies' requires standardised legal institutions involving the state, a realm of public ordering and enforcement that supports division of labour at greater scale (pp. 189, 198). In contrast, businesses in societies under the rule-of-norm often resort to means such as 'clan or family ties, shared religion or ethnicity, bureaucratic co-option and corruption …' (p. 189). These social norms are often formed on interpersonal trust and local networks that are costlier when the scale and complexity of governance increase. Hodgson (2015) goes so far as to claim that the *most* important factor in the historical emergence of capitalism is the constitutive role of law and the state.

At the same time, emphasizing the rule-of-law state does not belittle the importance of social norms in modern governance. Legal institutionalism's (2017) second ontological claim is that state laws work with social norms in a complementary way. This point of view follows the early argument of Commons (1924) that law's enforcement must be founded on beliefs—the wide perception of law's reasonableness, appropriateness and fairness.

Law essentially needs to conform with, or at least not depart too fundamentally from, social norms in order to be accepted and enforced. For example, Chen and Deakin (2015) argue that one of the most important social norms that upholds the state and legal enforcement is the concept of a 'rule-of-law state' itself, understood as a social practice and simply a formal, constitutional principle. Basing their argument on evolutionary game theory, they claim that with repeated games at large scale, social agents *collectively recognise* law's capacities such as accessibility, neutrality and stability, that facilitate sustainable economic development (pp. 132-134). This shared recognition and respect becomes a focal point or common knowledge among actors in

a society, which is a cognitive meta-convention supporting the functioning of the state and laws (pp. 134, 135).

These two claims can be elaborated by linking legal institutionalism to two key concepts in algorithmic governance—scaling and layering.

2.2 Scaling: the rule-of-law state and modern capitalism

Scaling of governance happened when societies historically adopted law as their predominant medium for governing. First, many scholars related the rise of capitalist societies to the emergence of rule-of-law states. Hodgson (2015) explains how law and state instituted modern capitalism in eighteenth-century Europe with the first development of financial institutions in England, particularly concerning the law of property as collateral and the basis of transactions based on debt. Pistor (2013, pp. 322, 323) argues that the way in which law institutes modern financial systems gives rise to an 'essential hybridity' between both public (state) and private (market) ordering. She claims that: 'Indeed, the *scale* of today's transnational financial markets would not be feasible without their legal backing'. Law's use of legal language and fictions makes it possible to 'code' material assets like land and debts into capital, thereby constituting '*a code for the globe*' (Pistor, 2019, Ch. 6).

These scale effects are recently evidenced in emerging economies like China, where the state and law gained increasing centrality in governance replacing informal social norms. This contributed to China's rapid industrialisation and growth since the 1990s. As Chen and Deakin argue (2015, p. 11), social norms such as *guanxi* in China provided valuable interpersonal trust networks for businesses to access financial resources, secure property rights, and enforce informal contracting. Nevertheless, these social norms of *guanxi* are often formed in tacit and common understandings among business parties and local communities, which limits the scale of governance and hence exchange. For example, China's FDI in the 1990s was concentrated in the coastal areas whose dense *guanxi* networks enabled them to grow, in the process generating inequalities between regions. *Guanxi*-based norms confined benefits to members in closed networks and led to local corruption (pp. 11-13).

Chen and Deakin (2015, pp. 12-13) argue that when these deadweight costs of the *guanxi* system began to outweigh the benefits, state-enforced laws started to grow as the dominant mode of governance. Formal legal institutions like new commercial laws securing contract and property rights enforced by courts have helped China's economy grow at scale since the 1990s and 2000s. Their claims are supported by quantitative analysis (2015, pp. 137-141) providing evidence that legal transplants of shareholder protection have supported financial developments in emerging economies. Qualitative fieldwork in China also provides evidence that in product markets, 'business relations are increasingly characterised by a mix of trust-based transacting and legal formality' (Chen et al., 2017, pp. 18-22).

In short, both in advanced and emerging economies, formal legal institutions have brought scale effects to governance. This pattern will recur in the later two stages where modes of governance turned from laws to numbers, and from numbers to code.

2.3 Layering: path-dependency, reinforcement and cooling effects

Legal institutionalism's second ontological claim reveals the layering and path-dependence of laws on social norms (North, 1990). The centrality of law in modern capitalist governance depends not only on the public state but also on private social norms, especially in the case of legal transplants and reforms (Chen and Deakin, 2015).

Alain Supiot's works on legal anthropology further explain the layering effect of law with a more philosophical approach. He argues (2007, pp. 79-83; 2017, pp. 52-67) that every civilisation or society has certain founding *beliefs*, and that the modern nation-state, with its particular understanding of law, is no exception. These beliefs are the widely accepted and respected social norms, which may have been taken for granted or implicit. Laws are like surface-level rocks that have 'cooled down' from the magma—the social norms. Laws are thus layered upon social norms and reinforce their basic structures.

For example, Supiot claims (2007, pp. 27-29, 95) that the modern western formal laws and states require an epistemic foundation of an essential belief in a 'third party as guarantor of identity'. When applied to governance, these collective social norms become a search for an impersonal arbiter, who gives perfect judgements without human arbitrariness (2007, pp. 86-100; 2017, pp. 19-25, 67-73). Related notions like justice, trust and equality, are all parts of the 'magma' that forms the epistemic foundations of law (2007, pp. 13-29; 2017, p. 1).

This kind of path-dependency can lead to negative reinforcements due to 'concept drift' (a term borrowed from computer science, Gama et al., 2014; Žliobaitė et al., 2016). While social norms change in social interactions rapidly, the more static legal forms sometimes lag behind. Law's inter-temporal and asynchronous qualities often reinforce past social norms which might have already drifted, and thus can 'cool down' the evolving social dynamics in communities. Such cooling effects bring incompatibilities and conflicts between the rather stationary law and the more dynamic social norms. (Supiot, 2007; Deakin, 2015).

Therefore, the emergence of the rule-of-law state as the exterior layer of governance by social norms does not necessarily equate to social progress. Laws are not intrinsically more effective than social norms in every governance situation. Law must often fade into the background (Chen and Deakin, 2015), provide room for local private autonomy, and keep adapting to evolving social practices at appropriate times to avoid cooling effects[1]. The coevolution and complementarity between laws and social norms are crucial for their functioning as different but layered modes of governance.

In conclusion, in the shift from social norms to laws, governance became more formalised and step-by-step (that is, somewhat more algorithmic) in order to achieve scale effects. However, the layering and path-dependence of laws upon norms could bring negative reinforcements and cooling effects. As we shall see in the next section, Supiot's historical and ontological account of *Governance by Numbers* (2017) further unearths the evolution of governance from using laws to relying on quantification and statistics.

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[1] E.g. in the case of margin of appreciation. Benvenisti, 1998.

3. From Laws to Numbers: statistics, cybernetics, and the erosion of rule-of-law

Similarly to the turn from norms to laws, the transition from laws to numbers also made governance more algorithmic and computational. This 'algorithmic turn' achieved scale effect by adopting statistics and quantified measures in governance.

Yet still, this beneficial scaling is limited by the layering quality of mode of governance. Governance by numbers relies on statistical analyses, which are themselves defined by reference to non-numerical frames of reference, including those of law and social norms. Over-reliance on numbers can erode the rule-of-law state and cause negative lock-in effects due to institutional path-dependence.

3.1 Statistics: Law Geared to Numbers

(1) Numbers from Law

Governance by numbers is an institutional extension of governance by laws, in which number-based statistical analysis becomes the main medium for governing, adopted by either public or private actors (Supiot, 2017). Its functioning is mostly dependent on the basic structures of the state and formal legal institutions (Desrosières, 2002), yet the major medium of governing shifts from legal interpretation to statistical analysis. Statistical techniques are increasingly used by nation-states in legislative, public administrative and judicial decision-makings. They are also adopted by corporations in governing online transactions, disputes and moreover, carrying out state administrative functions like compliance ranking and grading (Supiot, 2017, pp. 78-102; Mac Síthigh and Siems, 2019). Similarly, in global governance, statistics is adopted by decision-making bodies in international organisations, or is directly applied by private entities (Supiot, 2017, pp.160-163).

(2) Numbers v. Law

Governance by numbers differs from governance by laws in its nature of using statistical analysis in place legal interpretation. Statistics is 'the science of using information discovered from collecting, organizing, and studying *numbers*.' These numbers are, in essence, mathematical representations of (a) empirical facts and (b) hypotheses on the relations between such facts. The empirical facts are measured and structured into numerical data sets, and the hypotheses are 'formulated in terms of probability distributions over possible data sets' (Romeijn, 2017). Statistics is thus also defined (Upton and Cook, 2008) as 'the science of collecting, displaying, and analysing *data*.' It uses probability for decision-making in the face of uncertainty (Moore, 1992).

This nature of statistical analyses, as mathematical abstractions of both empirical facts and their relating hypotheses, made governance by numbers more computational compared to governance by laws. It is empowered by number-based mathematical language with high levels of disambiguation and completeness. Problem-solving by statistics more closely follows the binary logic on which computers operate. Calculations using statistical methods can thus be automated by machines. In contrast, the law relies on text-driven legal concepts. Although these concepts are also

abstractions of social entities and their relations, they use natural language that has more ambiguity and room for re-interpretation.

(3) Numbers replaces Law

The history of statistics begins with probability theory in the seventeenth century, and culminated in twentieth-century applied econometrics (Desrosières, 2002). Desrosières's conceptual exploration of statistics is deepened in Supiot's *Governance by Numbers* (2017). Supiot reveals how these statistical methods based on numbers dethroned laws and became the predominant medium for governance.

He first explains how numerical quantification was already put into normative use in accounting, managing, judging and legislating (2017, pp. 78-102), and how later they transformed into statistical methods that subjected law in a range of societies (pp. 103-143). In advanced capitalist societies, in particular, law lost its isonomic function as a 'shared reference valid for everyone', and was downgraded to becoming merely 'legislative products which compete on a global market of norms.' (p. 121). In the process there was a loss of the belief that state and laws are the precondition of the calculations which, according to classical economics, for achieving social harmony in governance. (pp. 103-104).

Supiot claims that (pp. 121-143) neoclassical law and economics contributed to this process. He argues that game theory, agency theory, the Coase Theorem (1960), and the new comparative analysis (La Porta et al., 1998) all constituted a concerted effort to transform governance into a statistical calculation process.

The result is that statistical analysis further dominated governance in various national and global contexts. Governance by numbers aimed at bringing beneficial scale effects, but according to Supiot, did not last for long before undermining its own foundations—state and laws. Such scaling and layering effects are examined below.

3.2 Scaling by cybernetics

The scaling of governance by numbers could be described in a logic of 'cybernetics', as asserted by Supiot (2017). Cybernetics helped enlarge the scale of social cooperation through managing more material and human resources in real-time feedback mechanisms. Yet it sees each social agent as atomised and indifferent to others. In the cybernetic conception of society, each agent, driven by subjective calculation of personal interests, instantly reacts to stimuli transmitted by statistical indicators in feedback loops to self-adjust their behaviour in order to achieve systematic stability and efficiency (2017, pp. 1-13, 25-31).

Supiot (2017, pp. 153-156, 193-196) argued that the New Public Management Movement since 1994 demonstrated how the statistical-cybernetic knowledge originated from corporate management quickly penetrated national public administration practices across the globe. In addition, numbers used in financial markets and the accounts of corporations also became main media of corporate governance since the 1980s.

Moreover, for global scaling, Supiot argued (2017, p. 160) that the IMF mainly used quantified indicators in its financial assistance programmes—the structural adjustment

plans—to regulate countries in Latin America, Africa and later the Eurozone. These quantified criteria include macro-economic variables which measure the success of the assisted countries in attaining agreed statistical objectives, in order to achieve IMF's global governance goals.

Moreover, EU and the World Bank have used similar numerical indicators for other large-scale global governance projects. They adopted the same 'conditionality' mechanisms with the IMF. They provided quantified objectives as the conditions for their aids to poor countries, and these statistical indicators later evolved into the 'human development index' in 2011. Furthermore, quantitative targets and tradable rights for national CO_2 emissions also became the dominant means of governance of global warming issues (Supiot, 2017, pp. 161-162).

Besides public institutions, private actors such as rating agencies also use statistical measurements to scale up global governance. These agencies generate risk indicators of 'a country's actual or projected financial performances, and the trustworthiness of its debt securities.' They are only regulated by a non-legally binding code of conduct adopted in 2003 by a private body, the International Organisation of Securities Commissions (Supiot, 2017, p. 162).

Nevertheless, Supiot (pp. 162-163) argues that this scaling of governance by numbers is unsustainable in the long-run, as revealed by the 2008 crisis. This is so because statistics and cybernetics gave disproportionate amount of power to those who construct the numbers. The attempt to use quantified analysis to provide a neutral façade for political decision-making is eventually self-defeating. Since the 2008 financial crisis, EU for example, has gone back on its self-regulatory attitude towards the credit-rating industry and established a European Securities and Markets Authority in 2010 to tighten its legal checks on private rating-agencies. This setback of governance by numbers can be further explained in the layering effects.

3.3 Layering: Statistics and the erosion of the rule-of-law state

(1) Ontology of Statistics

As demonstrated above, governance by numbers largely inherits the basic structures of the state and formal legal institutions (Desrosières, 2002). After all, statistics, as the main medium for governance by numbers, originated as a 'science of the state' or 'political arithmetic', derived from the German word *Staatistik* in the 18th century referring to a 'descriptive and not quantitative knowledge of the state' (Supiot, 2017, p. 78; Desrosières, 2002). Governance by numbers, in this sense, has an inherent non-quantified or non-calculable element, which must be defined by reference to laws and social norms.

This layering is revealed in two notions crucial to statistics: data and measurement. 'Data are characteristics or information, usually *numerical*, that are collected through *observation*.' (OECD. 2008. p. 119). These numerical observations, or data, must involve *measurement*, defined as 'the assignment of a *number* to a characteristic of an object or event, which can be *compared* with other objects or events.' (Pedhazur et al., 1991, pp. 15–29; International Bureau of Weights and Measures, 2008, p.16).

Statistical analysis, by its very nature, uses numbers to describe social phenomena and makes comparisons of these numbers. The social phenomena themselves must be first pre-defined as categories in natural language before they can be counted and compared. This can be seen in concepts such as 'employee' which have a shared juridical and statistical foundation. Statistics, through its use of numbers, achieves mathematical completeness and disambiguation only by taking conceptual categories which have origins in natural language and roots in laws and, ultimately, in social norms and practices. This implies that even statistics contains a layering quality.

The complete and disambiguated quality of mathematical language is not all positive. It means statistical concepts are more closed by nature and less open to reinterpretation in the light of changing social circumstances than is the case with legal concepts. Text-based legal concepts, such as 'employee', can drift through time with new interpretations, and thus include new samples and populations which were not previously defined within these categories (e.g. incorporating new kinds of employment relations of the gig-economy, and counting corporations as legal persons). This natural linguistic ambiguity provides law with an open texture which permits re-interpretation (Deakin, 2015; Markou and Deakin, 2020).

In contrast, statistical concepts/indicators like p-values, confidence intervals, or normal distributions, have to be stable in order to maintain mathematical completeness. These statistical concepts cannot themselves deal with problems like the conceptual drift involved in legal evolution (Deakin, 2015). They can only absorb new data once it has been manually reconstructed with new measurements of empirical facts. Statistics requires the mapping of numbers on to social categories be consciously updated according to new situations, whereas legal ideas can be re-interpreted through the flexible operation of interpretive legal techniques.

(2) The erosion of the rule-of-law state and lock-in effects

Layering effects give rise to path dependencies which can lock-in the negative aspects of pre-existing laws and social norms. Especially when public and private actors become over-reliant on numbers and ignore the legal foundations of governance, governance by numbers can become too self-referential and erode its foundational rule-of-law state.

For example, Supiot claims (2017, pp. 150-152) that for financial markets, state deregulation allowed exponential expansions of new financial products through self-referential securitisation and credit derivatives at national and global level, where stock price statistics dominated corporate behaviours. Around the same time, major countries including those in the EU, deregulated accounting standards by delegating them to a private body, the International Accounting Standard Committee, in order to achieve greater scale effects. They inverted the logic of accounting from state regulation under the principle of prudence to the concept of 'fair value'. This transformed the meaning of the numbers on the account from the responsibility a corporation holds towards third parties ('accountability'), to 'an instrument for measuring a company's market value in comparison with its competitors' (2017, pp. 152-153).

Supiot (pp. 84-85, 193-203) argues that the deregulation of financial markets and accounting standards, as well as excessive reliance on the rating agencies, were ultimately unsustainable ways to achieve efficient governance at large scale; instead they led directly to the *Enron* accounting scandal and the 2008 financial crisis. The logic of governance by numbers eroded the public-private divide and thus undermined the foundation of the legal institutions on which effective market governance depended.

In contrast to this process, Supiot demonstrates that historically, governance by numbers worked well when it was coordinated with governance by laws. The rise of modern capitalism, for example, combined both the adoption of formal legal institutions *and* novel statistical methods in governance. The invention of double-entry system of book-keeping by Medieval Italian merchants, which were later stipulated as accounting rules by Italian city authorities, facilitated the expansion of credit and debt in an emerging capitalist market through the state plus statistical method (pp. 80-83). A basic private-public divide to provide state institutions, and conscious updates of socio-legal concepts in the statistical analysis of governance by numbers, were essential to achieve beneficial complementarity between numbers, laws and social norms.

This pursuit of hybridised governance for positive complementarity is further complicated by governance by code. As emerging technologies of ML/DL algorithms become increasingly powerful and adopted by private and public actors in governance, they add another level of scaling and layering.

4. From Numbers to Code: computation, big-data, and freezing

It will be argued in this section that the recent emergence of governance by code represents a further step in the institutional evolution of modes of governance, and specifically away from the anterior mode of governance by numbers. Governance by code, as the most purely computational mode of governance, completes the 'algorithmic turn' from norms to laws, laws to numbers, and numbers to code.

Code can potentially achieve greater scale effects than all preceding modes of governance, largely thanks to big data: the unprecedented amount of data it can process. But such scaling is still restrained by the layering effects which inevitably affect any mode of governance. The data that code depends on are still numerical measurements of empirical facts which cannot be entirely freed from linguistic constructions. Just like numbers, therefore, governance by code has to be cognitively founded on laws and social norms. Over-reliance on code can 'freeze' social interactions, which must be avoided in order to achieve positive complementarity among social norms, laws, numbers and code.

4.1 Computation: From statistics to 'learning' code

Computation is becoming a major medium of governance with the recent breakthroughs in 'artificial intelligence' (AI), which in practice means Machine Learning (ML) and Deep Learning (DL) algorithms. These 'learning' algorithms computed in machines have now gained capacities to replicate human decision-making and solve problems which used to be only comprehensible to humans. In particular, DL is the subset of ML that is responsible for giving machines so-called 'intelligence'

(LeCun et al., 2015). It claims to model or replicate how the human neurons work in the brain, and so far is 'regarded as the best models of perceptual similarity judgments in primates' (Bucker, 2019, pp.1-2).

(1) Code from numbers

Nevertheless, looking into the definitions of ML and DL algorithms, it is apparent that the 'learning' algorithms embedded in computer code originated from statistical analysis, that is, the logic of governance by numbers. **Machine Learning** is defined as 'a family of statistical techniques that uses an algorithm to "learn" over time through the iterative adjustment of mathematical parameters and optimise performance at a task' (MacKay, 2003; Alpaydin, 2016). It 'learns' by using mathematical models of artificial neural networks (NNs) that are *shallow*, in that they are often no more than three to four layers deep (Schmidhuber, 2015).

In contrast, **Deep Learning**, as part of a broader family of ML methods, 'learns' through more layers of NNs—the 'deep convolutional neural networks' (DCNNs) which can contain several hundred layers. This means that DL algorithms simply have more computational stages than shallower ML algorithms, enabling them to perform more complex optimisation tasks (Schmidhuber, 2015).

Therefore, in essence, ML and DL algorithms still use certain 'statistical techniques' that are based on numbers and calculations. They must use 'mathematical parameters' to construct and adjust the NNs in order to optimise task performances. In particular, 'learning or credit assignment is about finding *weights* that make the NN exhibit *desired* behavior, such as driving a car.' (Schmidhuber, 2015, p. 4). This does not go beyond the basic logic of using statistical analyses in governance to achieve optimised outcomes.

In addition, historically code came from numbers and statistical techniques. The basic mathematical models for ML and DL had already been developed in the 1960s and 1970s. Later techniques such as *backpropagation* **(BP)** for error-correction in supervised learning (SL) were already adopted in ML and DL in the 1980s and stayed popular since then (Schmidhuber, 2015, sec 5.5, 5.6; Buckner, 2019, p. 2). In the 1990s, practical applications of DL were already feasible with the breakthrough of unsupervised learning (UL) (Schmidhuber, 2015, sec 5.10**)**.

(2) Code and big-data replace numbers and laws

Yet, it was only after the 2000s that the applications of ML and DL algorithms proliferated in certain business settings, because by then the 'learning' code finally had enough amount of data generated on the internet and personal devices, which could be stored and processed by increasingly powerful computers with greater calculation capacities (Buckner, 2019).

Traditional statistical analysis is more helpful when data scaling is limited. It provides sampling methods and hypothetical probability distributions that harness the limited data at hand for predictions using mathematical techniques, such as the linear regressions widely used in the quantitative social sciences. In contrast, when data scaling is large enough, ML and DL algorithms no longer need to presume certain

probability distributions in their data modelling, and become more flexible in developing complex mathematical models to solve problems (Breiman, 2001). They acquired the 'ability to discover novel solutions directly from problem data', by using for example backpropagation in SL (Buckner, 2019, p. 2). Most ML/DL research and applications are now considered as 'data science', which combines statistics and computer science in practical problem-solving settings using large amount of data (James et al., 2013; McQuillan, 2018).

When the problem-solving capacities of ML and DL algorithms were fully realised with big-data, governance by code came out qualitatively different from other modes of governance and tend to replace them. Some philosophers argued that DL applications, in particular, are qualitatively distinctive from the shallower ML, which requires a new understanding in what computers could achieve in replicating human decision-making processes (Buckner, 2019). For example, Natural Language Processing (NLP) is a DL algorithm that can 'read' natural language, and thus replicate aspects of human decision-making, including legal ones (Young et al., 2018; Deng and Liu, 2018). NLP algorithms now can carry out legal tasks such as predicting legal judgments by analysing past case laws (Aletras et al., 2016; Alarie et al., 2016; Xiao et al., 2018).

Some argue that in the coming decades technological management will 'have superseded legal rules' and become a significant regulatory instrument that co-exists with legal and social norms (Brownsword, 2015). Others examine the possibility of the 'death of rules and standards' by using '*microdirectives*' carried out by feasible predictive technology (Casey and Niblett, 2016). Some even argue that we are marching towards a 'legal singularity' where all areas of laws can be coded into computer algorithms with automatic and smart enforcement (Alarie, 2016).

(3) Code's hyper-reflexivity

Besides its growing problem-solving capacity, governance by code also has a distinctive quality of 'hyper-reflexivity' (Lessig, 2006; Zuboff, 2015, 2019). Granted, statistics, laws and social norms already shape their realities when describing them; but they have no such high reflexive capacity comparable to that of the ML/DL predictive algorithms. As Zuboff revealed (2015, 2019)*,* these 'learning' code can shape social environment and interactions in real-time by monitoring and nudging individual behaviours. Hildebrandt also argued (2016, 2020a) that the increasingly 'smart' environment built by ubiquitous 'learning' technologies will create an 'onli*fe* world', where people's everyday decisions and social interactions are steered real-time by infrastructures 'saturated with artificial, data-driven agency'.

Such use of big-data through 'learning' and hyper-reflexive code can achieve greater scale effects in governance. Yet the layering effects is also magnified. Such layering can bring excessive freezing to societies that are over-reliant on code in governing.

4.2 Scaling: Big Data, Surveillance Capitalism and 'Information Civilization'

The scaling effects of governance by ML and DL code relate to its two distinct qualities: learning and hyper-reflexivity. Zuboff (2015, pp. 78, 85) unearthed how the

adoption of 'learning' algorithms in everyday governance has led to civilisational scale effects in advanced economies, potentially creating a new 'information civilisation' in the century to come.

Such scaling by code and big-data could be more profound than previous global scaling induced by numbers. It scales up governance not only by disrupting the sovereign states and territorial boundaries, but also by reshaping fundamental human nature and agency, according to Zuboff (2019, Ch12, 15, 16).

Zuboff traces (2015, p. 89) this development by analysing two key papers of Hal Varian (2010, 2014). Varian claims that computer code and the Internet provided the 'new general technology' for 'combinatorial innovation' and 'recombinant growth'. Computer-mediated transactions based on code enable 'new forms of contract due to better monitoring', and these transactions provide new tools for governance. These tools can be used to modify users' behaviours at real-time, which Varian argues (2014), open new possibilities for Google and other digital platforms like Uber and Airbnb to realise the full potential of big-data for innovation and growth.

Although Varian's papers focus on the economies of scale provided by code and big-data, Zuboff reveals that they have more general implications for governance. She claims that Google and other digital platforms are in fact creating a new information civilisation under surveillance capitalism. They create ML/DL code under a capitalist logic of accumulation, while simultaneously modify users' behaviours to reinforce such pre-determined capitalistic projection (2015).

Zuboff criticises this *capitalistic version* of governance by code, and argues for a 'hacking' of it: liberating and redistributing the existing computational architectures designed, in order to bring an *alternative version* of governance by code and a new information civilisation that can overcome the exploitative logic of surveillance capitalism (2015, p. 85; 2019).

This can be further examined with the layering effects of governance by code. To do this we will first return to the ontology of these 'learning' algorithms, and then draw on literatures of 'cold start' and 'concept drift' as current limitations in ML/DL, and Hildebrandt's work on code and law.

4.3 Layering: Cold Start, Concept Drift, and Freezing

(1) Ontology of Code

The narrow definition of algorithm refers only to computer code: 'a tool for solving a well-specified *computational problem*.' 'The statement of the problem specifies in general terms the desired input/output relationship. The algorithm describes a specific *computational procedure* for achieving that input/output relationship.' (Cormen et al., 2009, p. 5)

This narrow definition of 'algorithm' requires both the *procedure* and the *problem* being solved to be *computational*. This means that the governance problem must be so well-defined that it could be written in binary code and operate on computers. In this sense, computer algorithms can only solve the subsets of problems in governance that

are computable within the physical limits of computers, following a definitive logic of 'if this then that' (IFTTT) (Hildebrandt, 2020b).

We could therefore draw two ontological claims. First, no matter how 'intelligent' ML/DL algorithms are, they must still fall under the narrow definition of computational algorithms, in other words, their goals achievable in governance are confined within their material limits of the physical transistors wired in computers using mathematical logic.

Second, even if these ML/DL algorithms could replicate some human decision-making processes with unprecedented accuracy, they still cannot escape their nature as computational algorithms and 'statistical techniques', which are rooted in the quantified measurement and numerical calculations but enhanced by big data. In this sense, governance by code involving ML/DL is layered on governance by numbers, which is layered on governance by laws and governance by norms.

(2) Limitations of ML/DL: cold start and concept drift

These ontological claims can be evidenced in two major limitations of ML and DL algorithms so far: 'cold start' and 'concept drift'. They reveal the layering of code based on laws and social norms.

First, cold start is a well-researched problem in algorithmic recommendation systems where new communities, items or users are introduced and the ML/DL code cannot draw any inferences from existing information. 'New community' refers to the situation where almost no users are present and thus the recommendation algorithms have very little information on potential interactions. The 'new item' situation happens when an item is newly added into the recommendation system, which might have content information but no interaction information. The 'new user' problem refers to the situation when a person is recently registered without any interactions yet in the community. Cold start problems manifest the limitations of 'learning' algorithms in dealing with new situations in the future. Their mitigation strategy often is to rely on hybrid recommenders, such as combining collaborative filtering and content-based filtering (Lam et al., 2008; Bobadilla et al., 2012; Wei et al., 2017).

Moreover, another major problem of ML/DL predictive algorithms is 'concept drift'—the change in the relationships between input and output data in the underlying problem. As the meaning of data sets changes over time, the performance and accuracy of predictive models based on historical data often decay. This is because while the concepts and categories of the phenomena being observed often shift and evolve with environments through time, the mathematical models are fixed to assume a static relationship between input and output variables. In novel real-life situations where new data sets are generated, the predictive algorithms are also required to be updated accordingly (Gama et al., 2014; Žliobaitė et al., 2016).

Even more difficult is the situation where the concepts at stake are dependent on some 'hidden context' not explicitly provided in the statistical or predictive features of the model, and usually the cause of the drift in these concepts are unknown (Widmer and Kubat, 1996; Tsymbal, 2004). Compared to governance by numbers, which mainly uses statistical analysis, governance by code has the same limitation in the gap between

its mathematical stationarity and the open nature of social interactions. When social entities and their relations change, they require novel interpretations using text-based natural language in non-numerical frames including laws and social norms (e.g. definition of employment and legal person).

(3) Freezing of the Future

Limitations like cold start and concept drift in ML and DL algorithms reveal the code's layering and path-dependency on laws and social norms. Hildebrandt further argues (2020b) that such layering can lead to the 'freezing of future'.

Compared to text-driven laws that are structured on natural language and speech acts, Hildebrandt argues (2020b) that 'code-driven law' (law written in computer code), has certain constraints in its computational architecture leading to its ineffectiveness in governance. These constraints include the requirement of formal deduction ('if this then that', IFTTT), disambiguate terms and rules, and the incompleteness and inconsistency of computation. They are related to the 'uncertainty that inheres in the future'.

Moreover, she argues (2020b, III.B) that ML/DL algorithms embrace a false assumption that the distribution of past training data can be a close approximation of the distribution of future. In reality, however, the future distribution of data can only be *predicted* rather than *learned* by algorithms.

Hildebrandt claims (2020b, III-C) that it is the 'radical uncertainty' that defines the future instead. This does not mean the future is entirely random or arbitrary, but that it could be underdetermined, especially considering the 'double contingency' raised by Parsons and Luhmann (Vanderstraeten, 2002; Parson 1951; Luhmann, 1976, 1995). The double contingency embedded in natural language makes humans always in the process of anticipating how others anticipate us. We always expect how our actions are *'read'* by others, who link their interpretation of a *text* (stemming from our action) to their interpretation of our *action*, vice versa. This mutual anticipation based on interpretable text—conceived and expressed in natural language—generates radical uncertainty, which demands institutionalisation of specific patterns of behaviours that form consolidation and stabilisation to reduce complexity and uncertainty in social systems.

Not just legal certainty, but also open texture and interpretability, are crucial in this stabilisation process. Laws to some extent provide stable expectations in social interactions, but are more than mechanical applications of disambiguated rules. This hybrid of certainty and open-interpretative nature can balance between radical uncertainty and the need to avoid freezing the future (Hildebrandt, 2020b, IV-A).

In contrast, code-driven law freezes the future by scaling existing data, in that code's temporality cannot adapt to unforeseen circumstances due to its disambiguation quality of computation. The coding efforts will always lag behind the future circumstances, whereas legal concepts with an inter-temporal, reflexive and adaptive nature, can capture the future scenarios through time (Hildebrandt, 2020b, IV). This defeats a teleology that code is always better than laws or social norms in governance, and reveals that governance by code does not necessarily mean social progress.

It follows that the proper functioning of ML and DL algorithms require timely updates on their data inputs that are based on non-computational concepts with reference to laws and social norms. Even the more purely computational 'governance by code' is still historically and logically dependent on anterior modes of governance. This is so no matter how formally complete its 'learning' algorithms could be in terms of replicating human decision-making.

The complementarity between law and code needs to be turned to beneficial ends if negative interdependencies are to be avoided. Law makers, therefore, must be aware of the different nature and limitations of each mode of governance, and consciously avoid potential freezing or lock-in effects induced by over-reliance on code and numbers. Hence, I apply this institutionalist framework to examine the functioning of the SCS that uses algorithmic technologies for governance.

V. Synthesis: The Social Credit System as Hybridised Algorithmic Governance

In this part, the institutionalist theory of algorithmic governance developed in Part IV is applied to China's Social Credit System (SCS), using archival and empirical case study analysis. First, three different branches of the SCS are delineated, by reference to their modes of governance in historical evolution. Then there is a brief outline of scaling and layering effects in and among these different branches of the SCS. It will be argued that these branches together form a hybridised model of 'governance by algorithm' with positive and negative complementarities.

(1) The financial-regulatory branches of the SCS initiated by China's Central Bank (People's Bank of China, PBOC) since the 1990s provide the essential context for this study. What began with governance by numbers turned into governance by code from the 2010s, with increasing cases of FinTech and RegTech applications being introduced by both private and public actors. (2) The rural and urban branches of the SCS, led by local municipalities since the early 2000s, have combined localised forms of interpersonal trust and social norms with emerging technologies. This can be seen in the large scale 'credible cities' pilots across China at this time. (3) Finally, it will be shown that, contrary to certain views of the SCS, the post-2010 branches of the SCS—blacklists and joint-sanctions programmes—are reinforcements of formal legal institutions that already underpinned governance by numbers and code.

1. Financial and regulatory scores: from credit-ratings to FinTech and RegTech

1.1 The rise of numbers

China's SCS is institutionally rooted in early financial credit-rating and scoring systems transplanted from advanced economies in the 1990s by China's Central Bank. They started with simple statistical analysis that predict the estimated risks and creditworthiness of corporations (in terms of their debt payback capacities). The aims were to govern an emerging capital market, prevent financial fraud, and help both state-controlled and commercial banks on their lending decisions (PBOC, 2006).

Meanwhile, emerging private platforms like Alibaba also launched its own online corporate credit-scoring system 'Credible Pass' in 2002—in order to provide better

credit information for the B2B market (PBOC, 2013). In addition, the Central Bank established the Credit Reference Centre in 2006 to 'build, run and maintain' the national Financial Credit Information Basic Database (FCIBD) that aggregates both corporate and individual credit data in China (PBOC, 2006, 2014).

Moreover, these financial scoring techniques were soon introduced into regulatory settings in order to facilitate the prediction of corporate compliance rates (Wang, 2015, pp.103-104). Different ministerial agencies stipulated industry-specific regulations using scoring and rating systems that are similar to the financial credit-rating. In environmental protection and the energy sector, for example, corporations are rated on a statistical scale from CCC to AAA depending on their past compliance behaviours (Wang, 2015; National Energy Bureau, 2017, Article 8). These scores started replacing traditional regulations by law.

1.2 Code introduced

Since 2010, the financial-regulatory credit systems became more computational with the rise of FinTech and RegTech that adopt ML/DL code. In financial settings, the traditional quantified measurements were replaced by big-data indicators; and the statistical analysis were taken over by ML/DL algorithms, such as those in Sesame Credit. The learning algorithms are designed by private corporate platforms like Ant Financial (affiliated to Alibaba) boasting of massive amount of user data, who thereof claimed to have produced more accurate predictions not only on corporate and individual *financial* creditworthiness, but also their *social* trustworthiness (Wen, 2015).

Once again, it is not long before these FinTech applications inspired regulatory agencies to start adopting RegTech for corporate compliance predictions. They were used in sectors such as financial regulations and food safety in order to detect and predict fraud and systematic risks (Sun, 2017, 2018). 'Learning' code and big-data claim to have more potential in aggregating the historical compliance information in order to provide more efficient and accurate regulations.

1.3 Financial scaling; socio-regulatory layering and freezing

Governance by numbers embodied in the Central Bank's financial rating systems achieved scale effects by breaking regional blocks and facilitated a national-wide lending system in China since the 1990s. They provided an alternative to closed interpersonal financial networks based on social norms like *guanxi*, and helped financial resources flow at greater scale (PBOC, 2006). Similarly, Alibaba's 'Credible Pass' also utilised quantified ratings to facilitate the massive amount of transactions on its B2B market since 2002 (Zhong and Peng, 2014). Numbers have proved to function well in governing large-scale financial and commercial transactions, with the support of state and legal institutions.

Moreover, in the 2010s, preliminary evidence shows that scaling was deepened by FinTech techniques involving ML/DL code. The Sesame Credit scoring system developed by Ant Financial, for example, had effectively facilitated lending and commerce at a larger scale in Alibaba's ecosystem (P. Chen, 2020).

Nevertheless, due to layering effects, when it comes to more socially dynamic settings, governance by numbers and code did not function as smoothly as their financial counterparts. This is first evidenced in the setback of Sesame Credit's expansion into *individual* social credit scoring using ML/DL code.

Whereas Sesame Credit, with its ML/DL code, prospered in its *corporate* credit-scoring services, in 2018 it failed to obtain an extended license for its *individual* consumer credit-reporting from the Central bank. The reasoning by the Central Bank was that the consumer side created 'conflict of interests' and 'data islands' (incomplete data) (Qi, 2017). Sesame Credit scores for individuals, since then, have only been narrowly applied in governance. (Dai, 2018; P. Chen, 2020).

It can be suggested, however, that the root cause of this setback is the layering quality of the ML/DL code. Code worked well in financial-commercial settings for *corporate* ratings, because corporations are more unified in their market interactions. Yet, when it comes to evaluating *individual* trustworthiness in social interactions, the code that generates the credit scores can only impose some unifying standards, which profile an average 'trustworthy' Alibaba user, onto a largely diverse population. This inevitably caused the 'freezing' of individual social interactions.

Moreover, compliance scoring systems have also only demonstrated little beneficial scaling or complementarities. Some even argue that regulatory captures and corruptions are caused by these quantification systems (Shen, 2019)[1]. More empirical evidence is needed for further examination of the detailed workings and limits of such compliance scores.

2. Rural and Urban scores: from 'Credible Farmers' to 'City Credit Scores'

2.1 Social norms and laws in rural 'Credible Farmers' programmes

The rural and urban branches of the SCS were originally instituted by local municipalities for attracting private investments and cultivating better business environment. The means was to facilitate interpersonal trust and reinforce social norms such as honesty, integrity, and respecting contractual agreements. The early pilots of these local scoring systems in the 2000s were centred on utilising social norms for the governance of local economy, but later they increasingly adopted statistical indicators similar to those of the financial and regulatory branch of the SCS. (F. Wang, 2012; Ohlberg et al., 2017).

An important precursor is the 'Credible Farmers' programme in Qingzhen, Guizhou Province. It was initiated in 2004 to lift Qingzhen's rural population (around 400,000) out of poverty by forging trust between 'leading enterprises' and 'farmer households'. It was at first largely informal without explicit laws or quantified ratings (F. Wang, 2012; Qingzhen Cultural Office, 2018).

Yet in 2006, after preliminary positive effects had been evidenced, the Qingzhen government started adopting simple but formal ratings to measure different levels of 'trustworthiness'. Such rating systems soon expanded in Guizhou Province, reaching 206 towns, 4484 villages and 27,000 rural groups as of 2011 (F. Wang, 2012).

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[1] *cf,* some U.S. scholars also argued that these regulatory nudging are counter-productive. Ho, 2012.

2.2 The take-over by numbers and code

As these local programmes grew in time and scale, they started to follow more closely the quantification and statistical logic. Qingzhen, for example, only used five general categories to measure trustworthiness in 2006. But in 2011, these categories were specified into the '100 Standards of Credible Farmers'. These standards range from 'supporting community values and caring for others' to 'performing contractual obligations'. Similarly complex ratings systems were further applied to Qingzhen's urban population in 2015—'Credible Farmers' became 'Credible Citizens' (Bai, 2015).

Soon there was greater take up of then emerging technologies including block-chain and big data (Dai, 2018). In 2017, Qingzhen passed a policy to use new technologies for governance combining both 'smart city' and SCS projects. (Qingzhen Municipal, 2017; Qingzhen Cultural Office, 2018).

Other 'city credit score' pilots also adopted various localised quantified measurements and statistical indicators since the 2010s (Ohlberg et al., 2017). Many of them are similar to those used in financial and regulatory rating systems—some even copying the rating scales, for example, from D to AAA (Suqian Municipal, 2018).

In addition, some local governments, such as Hangzhou, adopted new technologies using big data and ML/DL code in their city credit scores with help from private corporations including Ant Financial (Ma, 2018). The adoption of ML/DL code in governance made these rural and urban credit scoring systems even more clearly computational in their approach.

2.3 Explore scaling and avoid freezing

Rural and urban credit scores also have objectives of achieving scale effects by using numbers and code. However, only very few have achieved their goals by coordinating numbers with laws and social norms.

For example, Qingzhen and other municipalities in Guizhou province that instituted the early 'Credible Farmers' programme since 2006 successfully alleviated local poverty by stipulating simple laws and rating systems that reinforced social norms. (F. Wang, 2012). Nevertheless, when the '100 Standards' were further expanded to Qingzhen's urban population, the rating system faced various problems regarding data-collection and data-sharing (Cheng and Zhao, 2017). Moreover, when in 2018 Qingzhen government adopted big-data and block-chain technologies, the freezing effects were manifested. These systems using computer code could not capture the open and dynamic social interactions in the locality (Dai, 2018).

Similarly, other city credit scores developed in the 2010s have demonstrated little beneficial scaling so far. Most of city credit scores for individual citizens have only very limited social applications (Ohlberg et al., 2017). Some even argue that certain local credit scores deteriorated governance efficacy (Shen, 2019).

Nevertheless, early examples of 'Credible Farmers' programmes demonstrated that scaling was achieved in Qingzhen when numbers are coherently layered on local laws and social norms. Similarly, initial evidence shows that the cities focusing on improving business environment and the rule-of-law that reinforces socio-legal institutions can actually facilitate credibility and integrity in market transactions (F. Wang, 2012).

Finally, even though the SCS has centred around governance by numbers and code since its genesis in the 1990s, it was counter-balanced by the rise of the final branches of the SCS—Blacklists and JSPs, particularly since 2014. I argue that, contrary to some views, they are reinforcements of socio-legal institutions that can bring positive complementarity to governance by numbers and code.

3. Blacklists and Joint-Sanctions Programmes: a return to socio-legal institutions

3.1 Reinforcing laws and social norms

The least numerical or computational branches in the SCS are the Blacklists and JSPs. Blacklists are essentially state-enforced databases that record and expose the names of corporations or individuals that have severely violated existing laws and regulations. They are legal institutions often stipulated by either regulatory agencies or courts. They punish non-compliance by signalling the untrustworthy behaviours to the public (Wang, 2017; Dai, 2018; Shen, 2019).

Joint-Sanctions Programmes (JSPs) are in nature the coordinated state punishments based on specific Blacklists. Each JSP is jointly enacted by the National Development and Reform Committee (NDRC) and the regulatory agencies that govern certain related industries. JSPs are promulgated in the form of Memorandum of Understandings together signed by these governmental agencies (NDRC et al., 2016; Dai, 2018).

Blacklists and JSPs are both legal institutions that reinforce existing laws and regulations in certain critical industries, without resorting to statistical analysis or code. Their institutional paths are also distinctly different from the financial and regulatory rating systems, or the rural and urban scores. Blacklists proliferated in China at local levels after since 2004, when the Administrative License Law was enacted, abolishing *ex-ante* licensing. Blacklists became an alternative to *ex-ante* license by providing *ex-post* punishments on severe violations of laws (Liu and Shi, 2006). In 2013, the first nation-wide Blacklist was stipulated by China's Supreme People's Court (SPC) to record and expose those who refuse compliance to civil court judgments (SPC, 2013).

JSPs were mainly introduced since 2014 to strengthen the state enforcement of court judgements and legal regulations (Dai, 2018; Mac Síthigh and Siems, 2019). The most prominent JSP is the one for the SPC Defaulters' Enforcement List. It aims at enforcing judgements and preventing debt defaulters from concealing their assets. It achieves this goal by limiting high-end spending of those blacklisted, which means the person or legal representative of the blacklisted corporation cannot, for example, travel by airplane or first-class high-speed train, or even take the civil service exam (NDRC and SPC et al., 2016; Zhao, 2019).

3.2 Scaling, layering and complementarities

It is also due to such enforcement power that many have criticised Blacklists and JSPs as a threat to China's path towards rule-of-law. It was claimed that their ambiguous procedures and their nature as administrative punishments provided rooms for rent-seeking and abuse of power (Chen et al., 2018; Shen, 2019).

Indeed, more institutional and procedural safeguards are required for Blacklists and JSPs to function properly. In fact, it can be argued that a greater threat lies in the negative lock-ins if they are layered on repressive laws and social norms. Recent improvements have been made to prevent such potential abuse, for example by the SPC amendment (2017).

However, when properly designed and implemented, Blacklists and JSPs can be crucial anchors in the SCS that strengthen the rule-of-law state instead of threatening it. Some evidence has demonstrated initial beneficial complementarities, for instance, in the case of migrant labour protections. By enacting a Blacklist (MOHRSS, 2017) and subsequent JSP (with NDRC, 2017), China's Ministry of Human Resources and Social Security (MOHRSS) allegedly helped 1.3 million migrant workers claim unpaid salaries totalling RMB 12.98 billion (around 1.4 billion pounds) (Credit China, 2018b).

This effect came from the state-enforced nature of these interventions: Blacklists and JSPs are integrated as part of the socio-legal institutions that already underpinned governance by numbers and code. They have the potential to enhance the social norms and rule-of-law state in order to achieve beneficial complementarity by working with other branches of the SCS as hybridised algorithmic governance.

VI. Conclusion and Outlook

This paper has developed an institutionalist theory of algorithmic governance and applied it to the understanding of China's Social Credit System. It has explored the SCS's potential for creating a new model of governance using emerging technologies including machine learning and deep learning.

The paper's first contribution is to develop an institutionalist understanding of algorithmic governance, in which laws and social norms are seen as foundational systems underpinning numbers and code. This approach argues that governance by algorithm is a hybrid model. Distinct modes of governance are layered as a result of their successive stages in their evolution: from social norms to laws, from laws to numbers, and from numbers to code. In this process, governance became, over time, increasingly algorithmic and computational: the 'algorithmic turn' in governance.

The second contribution of this paper is to identify and explore two essential qualities of algorithmic governance: scaling and layering. The more computational governance becomes, the more potential it has to govern large-scale and complex social interactions: 'scaling'. However, this scaling effect is limited by 'layering', meaning that the more computational modes of governance are cognitively layered and thus path-dependent on their predecessors. Moreover, layering can lead to negative complementarities, that lock in flaws in existing institutions and 'freeze' the future. Emerging technologies using ML/DL code are in essence still based on statistical measurement, which is itself defined by reference to non-computational laws and social norms. Code and numbers, therefore, must coordinate with laws and norms to achieve positive complementarity and avoid potential freezing. This view of governance can be distinguished from approaches to the SCS that rely on the more static and rigid assumptions of mainstream law and economics.

The paper's third contribution is to begin applying the theory of algorithmic governance to an analysis of China's SCS. A preliminary analysis shows that despite some positive scaling effects, initial evidence in various branches of the SCS reveals that due to layering, code and numbers were not necessarily better for governance than laws and social norms. Over-reliance on these code and numbers meant that expected benefits of the SCS were not realised; there is evidence of negative freezing and lock-in effects. By contrast, positive complementarities in scaling and efficiency have been demonstrated to date in the cases where code and numbers were coordinated with the laws and norms they layered on.

An exploration of the SCS using an institutionalist approach can influence not only China's population of 1.3 billion and vast numbers of corporations, but also be referenced by law makers concerning a range of issues for algorithmic governance in Europe, Africa, and North America. Future research will address in more detail how this new model of governance by algorithm is playing out in the context of China's SCS, and which working mechanisms can usefully be referenced for other countries. Case studies involving fieldwork will be conducted along with documentary and archival analysis to explore more deeply how China's SCS operates. This will require close focus on the uses of ML/DL code along with statistical rankings and ratings and more conventional socio-legal institutions like Blacklists and JSPs. Analysis of this kind will allow for an assessment of how far these different governance modes can be made to work together to achieve complementarity in governance.

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