Technology and Regulation

Machine-learning algorithms in regulatory practice

Nine organisational challenges for regulatory agencies

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Institutional work, Organisational practice, Algorithms, Machine-Learning, AI, Regulation, Regulatory Agency

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A growing body of literature discusses the impact of machine-learning algorithms on regulatory processes. This paper contributes to the predominantly legal and technological literature by using a sociological-institutional perspective to identify nine organisational challenges for using algorithms in regulatory practice. Firstly, this paper identifies three forms of algorithms and regulation: regulation of algorithms, regulation through algorithms, and regulation of algorithms through algorithms. Secondly, we identify nine organisational challenges for regulation of and through algorithms based on literature analysis and empirical examples from Dutch regulatory agencies. Finally, we indicate what kind of institutional work regulatory agencies need to carry out to overcome the challenges and to develop an algorithmic regulatory practice, which calls for future empirical research.

1. Introduction

The rise of machine-learning algorithms in regulatory practice has resulted in a body of literature on *algorithmic regulation*.[1] Algorithmic regulation refers to the use of algorithmically generated knowledge to automate or inform decision making in regulatory processes.[2] Algorithmic regulation differs from the traditional regulatory practice in which human actors execute the function of regulation.

Machine-learning algorithms considerably expand the range of regulatory instruments.[3] Regulatory agencies started using basic algorithms as instruments a long time ago, though they started using *machine-learning* algorithms as instruments only a few years ago. Scholars have picked up on this development and have identified legal and technical challenges inherent to algorithmic regulation.[4] However, scholars have so far paid only limited attention to the question how regulatory agencies embed machine-learning algorithms in their organisational processes and structures. Therefore, we have investigated what organisational challenges arise for regulatory agencies that introduce these algorithms into their regulatory practice. Identifying organisational challenges will help to point out the conditions under which algorithmic regulation succeeds and fails when it is implemented in regulatory agencies.

We understand *regulation* not only as legal frameworks but also as social and organizational practices that include enforcing rules and monitoring compliance.[5] Drawing on Julia Black's definition and following Karen Yeung and other scholars in the field of algorithmic regulation, regulation is a 'sustained and focused attempt to alter the behaviour of others according to defined standards or purposes with the intention of producing a broadly identified outcome.'[6] Regulatory practices increasingly employ technologies, such as algorithms. In this paper, we understand the interaction between regulatory practice and algorithms from a sociological-institutional perspective.[7]

1 Karen Yeung and Martin Lodge, 'Algorithmic Regulation', *Algorithmic Regulation* (2019); Karen Yeung, 'Algorithmic Regulation: A Critical Interrogation' (2018) 12 *Regulation and Governance* 505 https://doi.org/10.1111/rego.12158; Mireille Hildebrandt, 'Algorithmic Regulation and the Rule of Law' (2018) *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences* 376 https://doi.org/10.1098/rsta.2017.0355; Christian Katzenbach and Lena Ulbricht, 'Algorithmic Governance' (2019) 8(4) *Internet Policy Review*; Lena Ulbricht and Karen Yeung, 'Algorithmic Regulation: A Maturing Concept for Investigating Regulation of and through Algorithms' (2021) *Regulation and Governance* https://doi.org/10.1111/rego.12437.

2 Yeung (n 1); Yeung and Lodge (n 1).

3 Martin Lodge and Andrea Mennicken, 'The Importance of Regulation of and by Algorithm' (2017) 85 *LSE Discussion Paper* 2; Martin Lodge and Andrea Mennicken, 'Reflecting on Public Service Regulation by Algorithm' in Karen Yeung and Martin Lodge (eds), *Algorithmic Regulation* (Oxford University Press 2019).

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Received 27 Sep 2021, Accepted 4 Feb 2022, Published: 7 Feb 2022.

4 Yeung and Lodge (n 1).

5 Julia Black, 'Critical Reflections on Regulation' (2002) 27 *Australian Journal of Legal Philosophy*; Julia Black, 'Learning from Regulatory Disasters' 10(3) *Policy Quarterly* 3.

6 Black (n5) 26; Yeung (n1); Florian Eyert, Florian Irgmaier and Lena Ulbricht, 'Extending the Framework of Algorithmic Regulation. The Uber Case' (2020) *Regulation and Governance*.

7 John W Meyer and Brian Rowan, 'Institutionalized Organisations: Formal Structure as Myth and Ceremony' (1977) 83 *American Journal of Sociology* 340; Paul J DiMaggio and Walter W Powell, 'The Iron Cage Revisited: Institutional Isomorphism and Collective Rationality in Organisational Fields' (1983) 48 *American Sociological Review* 147; Pamela S Tolbert and Lynne G Zucker, 'Institutional Sources of Change in the Formal Structure

This perspective entails that both organisations and technology are *constituted through action* on the one hand and *constitute action* on the other hand.[8] This process is called structuration and involves the interplay of three basic concepts: meanings, norms, and power relations.[9] These three concepts are highly interdependent in the reproduction of a social order. For example, divergent interpretations of meanings and norms are expressed in reproducing a set of power relations. Social practices can be understood by investigating the meanings, norms and power relations that emerge from the practice and that constitute the practice. For regulation, this entails that regulatory practices are seen as actively constructed and constituted by meanings, norms and power relations, while at the same time they constitute these meanings, norms and power relations. Misalignments between meanings, norms, and power relations between organisation and technology may result in technological failure or undesirable organisational effects. Thus, mediating between organisations and technology creates challenges for regulatory agencies.

Our sociological-institutional point of view complements existing legal and technological perspectives. Mapping organisational challenges for regulatory agencies from this perspective does not emphasize algorithms as technologies but rather algorithmization as a process of social change. Thus, our analysis does not focus on the content or substance of the rules but on professionals' efforts to mediate between the algorithmic technology and the regulatory organisation.[10]

To map the organisational challenges that emerge from using algorithms, we took three steps. First, we drew on a commonly used distinction in techno-regulation literature. Van den Berg, for example, distinguishes between regulation through technologies and regulation of technologies.[11] We adapted this distinction and added a third form: regulation *through* algorithms, regulation *of* algorithms, and regulation *of* algorithms *through* algorithms. Academic and societal debates rarely distinguish regulation *through* algorithms from regulation *of* algorithms. This generates confusion and misunderstanding. Second, we mapped organisational challenges that emerge from using machine-learning algorithms. To map these challenges, we used existing scientific literature and examples that illustrate how algorithms are introduced into regulatory practice. To ensure that we mapped the challenges systematically, we used the forms of regulation and algorithms that we identified in the first step. Third, for each challenge, we explored what role the sociological-institutional concepts of meanings, norms, and power relations play in regulatory practice. We contribute to the current literature on algorithmic regulation by improving the understanding of how algorithmization plays out in regulatory agencies.

Our paper combines a literature review with illustrative cases. We reviewed the literature by browsing relevant journals in the fields of regulation, governance, and regulatory governance, screening references of pertinent publications, and using automated notifications from search engines. We have closely read 28 articles and chapters to identify references to the role of meanings, norms, and power relations as well as challenges that were mentioned explicitly and implicitly. In the first half of 2020, we collected examples for the use of algorithms from three national regulators and inspectorates in the Netherlands. From a broader set of regulatory agencies, we selected three agencies that are at the forefront of algorithmization and that provided examples with high illustrative values. We conducted interviews with senior staff members who are closely involved in the implementation of algorithms in the regulatory practice and collected documents at (1) the Human Environment and Transport Inspectorate (ILT), (2) the Inspectorate for Social Affairs and Employment (ISZW), and (3) the Dutch Authority for the Financial Markets (AFM). Based on these materials, we concretized the findings from the literature by presenting three examples of the roles that algorithms play in Dutch regulatory practice and the organisational challenges that emerge.

In the next section, we develop a theoretical perspective and clarify the core concepts. In section 3, we present the forms of regulation and algorithms. In the following three sections, we present results from the literature and examples from real-life cases for the previously identified forms of regulation and algorithms. In section 4, we discuss regulation through algorithms. In section 5, we discuss regulation of algorithms. And in section 6, we discuss regulation of algorithms through algorithms. In section 7, we present our conclusions about organisational challenges, connecting them to institutional work, and setting out an agenda for future research.

2. A sociological-institutional perspective

Algorithms are, in their most basic understanding, encoded procedures for performing a task.[12] Their conditional structure with known and explicitly stated 'if..., then...'-decision rules entails that algorithms are *a form of regulation* as well as *commonly used in regulation*.[13] In contrast to these rule-based and manually programmed algorithms, machine-learning algorithms 'are programmed to learn' from data-

of Organisations: The Diffusion of Civil Service Reform, 1880-1935' (1983) 28 *Administrative Science Quarterly* 22; Christopher R Hinings and Pamela S Tolbert, 'Organisational Institutionalism and Sociology: A Reflection', in Royston Greenwood, Christine Oliver, Roy Suddaby, and Kerstin Sahlin (eds), *The SAGE Handbook of Organizational Institutionalism* (London: SAGE Publications 2008).

8 Anthony Giddens, *New Rules of Sociological Method: A Positive Critique of Interpretative Sociologies* (2nd edition, Polity Press 1993); Wanda J Orlikowski, 'The Duality of Technology: Rethinking the Concept of Technology in Organizations' (1992) 3 *Organization Science* 398 https://www.jstor.org/stable/2635280.

9 Wanda J Orlikowski and Susan V Scott, 'The Entanglement of Technology and Work in Organisations' (2008) 44 *Working Paper Series* http://eprints.lse.ac.uk/id/eprint/33898; Wanda J Orlikowski and Stephen R Barley, 'Technology and Institutions: What Can Research on Information Technology and Research on Organisations Learn from Each Other?' (2001) 25 *MIS Quarterly: Management Information Systems* 145 https://doi.org/10.2307/3250927; Wanda J Orlikowski, 'Sociomaterial Practices: Exploring Technology at Work' (2007) 28 *Organisation Studies* 1435 https://doi.org/10.1177%2F0170840607081138; Stephen R Barley and Pamela S Tolbert, 'Institutionalization and Structuration: Studying the Links between Action and Institution' (1997) 18 *Organisation Studies* 93; Gerardine DeSanctis and Marshall Scott Poole, 'Capturing the Complexity in Advanced Technology Use: Adaptive Structuration Theory' (1994) 5 *Organisation Science* 121; Jodi R Sandfort, 'Exploring the Structuration of Technology within Human Service Organisations' (2003) 34 *Administration and Society* 605 https://doi.org/10.1177%2F0095399702239167.

10 Robert Baldwin, Martin Cave and Martin Lodge, *Understanding Regulation* (Oxford University Press 2012); Christel Koop and Martin Lodge, 'What Is Regulation? An Interdisciplinary Concept Analysis' (2015) 11 *Regulation and Governance* 95 https://doi.org/10.1111/rego.12094.

11 Bibi van den Berg, 'Robots as Tools for Techno-Regulation' (2011) 3 *Law, Innovation and Technology* 319 https://doi.org/10.5235/175799611798204905; Roger Brownsword and Karen Yeung, 'Regulating Technologies : Tools, Targets and Thematics' in Roger Brownsword and Karen Yeung (eds), *Regulating Technologies : Legal Futures, Regulatory Frames and Technological Fixes* (Hart Publishing 2008).

12 Thomas H Cormen, Algorithms Unlocked (MIT Press 2013); Tarleton Gillespie, 'The Relevance of Algorithms' in Tarleton Gillespie, Pablo Boczkowski, and Kirsten Foot (eds.) *Media Technologies* (Cambridge, MA: MIT Press 2014).

13 Yeung (n 1).

sets.[14] These machine-learning algorithms generate knowledge computationally. They analyse data through a variety of statistical techniques to identify probable relationships instead of relying on static rules.[15] Machine-learning algorithms are more capable, complex, and opaque than algorithms that have been used in regulation before.[16]

The use of these new types of algorithms initiates a social and organisational change process, known as algorithmization.[17] Algorithmization goes hand in hand with datafication and results in a fundamental transformation of organisations and societies.[18] This means that algorithmization stretches far beyond the use of technology but affects expertise, information relations, organisational structure and policy, as well as monitoring and evaluation.[19]

The algorithmization perspective entails that studying technology in regulation and governance should encompass more than the technological artefacts themselves. Studying technology should include organisational structures and policies, information streams and relations, as well as knowledge and expertise; all in relation to ICT.[20] This perspective is reflected in Orlikowski's notion of the duality of technology, which conceptualizes technology as 'the product of human action, while it also assumes structural properties.[21] On the one hand, this means that actors who are embedded in existing social contexts *construct* technology physically and socially. Thus, technology is a product with meanings and ideas about how it will be used. On the other hand, once technology is developed and used, it appears as an object that *structures*, thus enables and constrains, action. Only if human actors continuously use the technology, it is created and maintained as structure.[22]

Consequently, technologies, just as organisations, constitute and are constituted by human action.[23] Both can be regarded as institutions in the sociological sense: 'more-or-less taken-for-granted repetitive social behaviour that is underpinned by normative systems and cognitive understandings that give meaning to social exchange and thus enable self-reproducing social order'.[24] In both institutional contexts, technology and organisation, human action produces and perpetuates three basic elements: meanings, norms, and power relations.[25] These elements can serve as analytical categories for investigating human action and institutionalised structures. Meanings are constituted in human interaction as 'interpretive schemes or stocks of knowledge'.[26] These interpretive schemes are organisational rules that structure human interaction. However, they are themselves maintained or changed through the interaction depending on whether the human actors follow the rules or not. Power relations come into play as organisations provide human actors with different capacities to exercise authority over other human actors and to allocate material resources. These capacities are not allocated equally among actors, but they are characterized by asymmetries. Some human actors have more power than others. Norms guide human interaction as they prescribe what is considered to be legitimate or appropriate. This moral order is manifested in 'rituals, socialization practices, and tradition'.[27]

The three elements, meanings, norms, and power relations can be found back in both regulatory agencies and algorithms that should support regulatory professionals. Both regulatory agencies and algorithms contain specific sets of rules because they ought to serve a specific purpose, for example, facilitating a good regulatory practice. The rules guide regulatory professionals in selecting objects for inspection. The organisational rules prescribe, for example, under what conditions (eg visible defects) it is *legitimate* to inspect an object. These rules are reproduced, if the inspectors actually act in accordance with them. The algorithmic rules prescribe, for example, under what conditions (eg a history of violations) it is *effective* to inspect an object. If inspectors use that algorithm, they will reproduce its rules, which will result in a regulatory practice that might be effective, but that contradicts the organisational rules aimed to foster legitimacy. As this contradiction was created through human action, this contradiction can also be resolved through human action. However, this requires the actors to change institutions, which comes with organizational challenges. The following section outlines these challenges by distinguishing various relations between regulation and algorithms.

3. Mapping the relations between algorithms and regulation

Mapping the different relations between algorithmization and regulation will help us to take stock of the organisational challenges systematically. We describe four forms of regulation and distinguish between using machine-learning algorithms as instruments and as objects of regulation, as is illustrated in Figure 1.

Figure 1 Forms of regulation through and of machine-learning algorithms

		Objects of regulation	
		Behaviour & processes	*(Machine-learning) Algorithms*
Instruments of regulation	*Behaviour & processes*	Regulation	Regulation of algorithms
	(Machine-learning) Algorithms	Regulation through algorithms	Regulation of algorithms through algorithms

Traditional regulation, found in the upper left box of the figure, does not use machine-learning algorithms at all, neither as regulatory

14 Andrew Tutt, 'An FDA for Algorithms' (2017) 69 *Administrative Law Review* 85 https://www.jstor.org/stable/44648608.
15 Gillespie (n 12); Rob Kitchin, *The Data Revolution: Big Data, Open Data, Data Infrastructures & Their Consequences* (2014); Lodge and Mennicken 2019 (n 3).
16 Lodge and Mennicken 2017 (n 3); Lodge and Mennicken 2019 (n 3).
17 Resa Mohabbat Kar and Peter Parycek, 'Berechnen, Ermöglichen, Verhindern: Algorithmen Als Ordnungs- Und Steuerungsinstrumente in Der Digitalen Gesellschaft' in Resa Mohabbat Kar, Basanta Thapa, and Peter Parycek (eds) *(Un)Berechenbar? Algorithmen und Automatisierung in Staat und Gesellschaft* (Kompetenzzentrum Öffentliche IT 2018); Albert Meijer and Stephan Grimmelikhuijsen, 'Responsible and Accountable Algorithmization: How to Generate Citizen Trust in Governmental Usage of Algorithms' in Marc Schuilenburg and Rick Peeters (eds), *The Algorithmic Society* (Routledge 2021).
18 Mirko Schäfer and Karin van Es, *The Datafied Society* (Amsterdam University Press 2017).
19 Meijer and Grimmelikhuijsen (n 17).
20 A Zuurmond, 'From Bureaucracy to Infocracy: A Tale of Two Cities' (1994) 3 *Informatization and the Public Sector* 189.
21 Orlikowski (n 8) 406.
22 Orlikowski (n 8); Orlikowski and Barley (n 9).
23 Giddens (n 8).
24 Royston Greenwood, Christine Oliver, Kerstin Sahlin, and Roy Suddaby, 'Introduction' in Royston Greenwood, Christine Oliver, Kerstin Sahlin, and Roy Suddaby (eds.) *The SAGE Handbook of Organisational Institutionalism* (London: SAGE Publications 2008).
25 Anthony Giddens, *Central Problems in Social Theory* (Macmillan Education UK 1979); Orlikowski (n 8).
26 Orlikowski (n 8) 404.
27 Orlikowski (n 8) 405.

instruments nor as objects. Traditional regulation uses instruments, such as experts' judgment, market analyses, on-site inspections, and non-learning devices, to regulate non-algorithmic objects: regulated products, behaviour, or processes.[28] Thus, in this default form of regulation, algorithmization does not impact regulatory agencies.

Regulation through algorithms, found in the lower left box of the figure, uses machine-learning algorithms as regulatory *instruments*. It uses algorithmic instruments to regulate non-algorithmic objects: regulated products, behaviour, or processes.[29] This form of regulation has several types of instruments.[30] To clarify the nature of these instruments, we can use a taxonomy, such as the one developed by Karen Yeung[31]. She distinguishes between algorithmic systems based on their way of standard setting, their information processing, and their role in decision-making processes. For example, some algorithms aim to increase the quantity or efficiency of regulatory decisions, whereas others aim to improve the quality of decisions.[32] To illustrate the challenges of regulation *through* algorithms, we use the example of the Dutch Human Environment and Transport Inspectorate:

> The Human Environment and Transport Inspectorate (ILT) oversees domains ranging from (toxic) waste management and handling of dangerous goods to transport safety on the road, on the rail, on the water, and in the air. Because the ILT has such diverse tasks and a limited budget, they must prioritise their supervision activities and ensure their effectiveness. These priorities must reflect the risks on strategic, tactical, and operational levels in the overseen domains. To improve the way of prioritising supervision activities and to ensure their effectiveness, the ILT has committed to selecting cases based on data. The data-driven work is advanced by the ILT's innovation and data lab (IDlab). The IDlab develops data applications that use methods, such as (advanced) modelling, data visualization, and machine-learning. These data applications ought to provide more and better information on risks in the regulated domains. Thus, the ILT uses machine-learning algorithms to strengthen regulation.

Regulation of algorithms, found in the upper right box of the figure, uses machine-learning algorithms as regulatory *objects*.[33] It uses non-algorithmic instruments to regulate algorithmic objects, such as prioritization models. Regulatees use algorithms which makes algorithms *objects* of regulation. Machine-learning algorithms can entail risks, such as discrimination and the infringement of data privacy. In this form of regulation, traditional, non-algorithmic means of inspection and auditing manage the use of algorithms to minimize the risks. The regulation of algorithms entails challenges for regulatory agencies. To illustrate them, we use an example from the Inspectorate for Social Affairs and Employment:

> The Inspectorate for Social Affairs and Employment (ISZW) oversees domains such as socio-economic security and safety, health, and fairness in the workplace. Besides enforcing compliance with laws and regulations, the ISZW investigates regulatees. The investigations aim to identify harmful developments and potential risks early on. One potential risk they have identified is using machine-learning algorithms in job selection and recruitment. Algorithms are used by employers, for example, to automatically match CVs and vacancies for determining whether applicants are suitable for a job. The ISZW cannot inspect these algorithms in detail because legislation is missing. However, they anticipate that this legislation will be adopted soon and are enhancing their organisational ability to enforce compliance effectively. The ISZW needs to enhance its abilities because using algorithms has rendered the existing regulatory practice insufficient. In particular, it is difficult to detect discrimination in job recruitment and selection processes that use algorithms. The ISZW struggles to detect discrimination because transparency decreases, and new forms of discriminations increase when recruitment and selection are automated. Thus, the ISZW must change their regulatory practice so that they can regulate algorithms.

Regulation of algorithms through algorithms, found in the lower right box of the figure, uses machine-learning algorithms as both regulatory *instruments* and *objects*. It uses algorithmic instruments to regulate algorithmic objects, such as prioritization models. In this fourth form of regulation, challenges for regulatory agencies emerge from the algorithmization of both regulators and regulatees. As such this form is a combination of the other two forms of regulation with and of algorithms. Therefore, an example of regulation of algorithms through algorithms might uncover challenges that can also be relevant for the other two forms. Regulation of algorithms through algorithms has resulted from our map and has not yet been explored in the literature. To illustrate this new form, we use an example from the Dutch Authority for the Financial Markets:

> The Dutch Authority for the Financial Markets (AFM) oversees domains, such as investment, insurance, loans, pensions, and capital market. The capital market is probably one of the most advanced fields when it comes to using machine-learning algorithms. On the Dutch capital market, algorithms carry out an estimated 60-70% of all transactions. Using algorithms has increased the frequency of trading on the capital market and thereby changed how it functions radically. The more frequent trading has made the capital market more complex and led to new risks. Detecting and managing these risks is the task of the AFM. To fulfil this task, the AFM must adjust its notion of what constitutes unlawful behaviour and how to detect it on the capital market. Therefore, the AFM explores more advanced ways of analysing data: simulations that model how specific algorithms and their interactions impact the market, stress tests that check how rigorous algorithms are, and machine-learning algorithms that enhance the AFM's capabil-

28 Baldwin, Cave and Lodge (n 10).
29 Yeung (n 1); Karen Yeung and Martin Lodge, 'Algorithmic Regulation: An Introduction' in Karen Yeung and Martin Lodge (eds), *Algorithmic Regulation* (Oxford University Press 2019); Alex Griffiths, 'The Practical Challenges of Implementing Algorithmic Regulation for Public Services' in Karen Yeung and Martin Lodge (eds), *Algorithmic Regulation* (Oxford University Press 2019).
30 Yeung and Lodge (n 1); Yeung (n 1); Hildebrandt (n 1); Katzenbach and Ulbricht (n 1).
31 Yeung (n 1).
32 Michael Veale and Irina Brass, 'Administration by Algorithm? Public Management meets Public Sector Machine Learning' in Karen Yeung and Martin Lodge (eds), *Algorithmic Regulation* (OUP 2019).
33 Tutt (n 14); Fotios Fitsilis, *Imposing Regulation on Advanced Algorithms* (Springer International Publishing 2019); Valerie Frissen, Marlies van Eck and Thijs Drouen, 'Research Report on Supervising Governmental Use of Algorithms' (2020) https://hooghiemstra-en-partners.nl/wp-content/uploads/2020/01/Hooghiemstra-Partners-rapport-Supervising-Governmental-Use-of-Algos.pdf accessed 11 September 2020; Wolfgang Hoffmann-Riem, 'Artificial Intelligence as a Challenge for Law and Regulation' in Thomas Wischmeyer and Timo Rademacher (eds) *Regulating Artificial Intelligence* (Springer Link 2020); Nikolaus Marsch, 'Artificial Intelligence and the Fundamental Right to Data Protection: Opening the Door for Technological Innovation and Innovative Protection' in Thomas Wischmeyer and Timo Rademacher (eds) *Regulating Artificial Intelligence* (Springer Link 2020); Araz Taeihagh, 'Governance of artificial intelligence' (2021) *Policy and Society* https://doi.org/10.1080/14494035.2021.1928377.

ity to analyse data. The machine-learning algorithms take more indicators and how they interact into account than conventional outlier-detection algorithms can. The machine-learning algorithms could help the AFM to prioritize cases for inspection more effectively. Thus, the AFM could use algorithms as an instrument that strengthens the regulation of algorithms.

By distinguishing between algorithms as instruments and objects of regulation, we identified three forms of regulation that involve machine-learning algorithms. Using these three forms will help us to explore systematically and more in depth the organisational challenges for regulatory agencies that emerge from using machine-learning algorithms. We will do this in the next sections.

4. Regulation *through* algorithms

The first form of regulation that uses algorithms is regulation through algorithms. The form uses algorithmic instruments to regulate non-algorithmic objects, such as regulated products, behaviour, or processes. This form is subject to an extensive body of literature. This section explores what this current literature teaches us about regulation through algorithms. In the literature review, we will pay special attention to the role of meanings, norms, and power relations in the algorithmization of regulators. We will present the findings from the literature as a number of challenges and illustrate them with examples from the three regulatory agencies included in this study.

Challenge 1: Safeguarding accountability for the way complex algorithms are used

For regulatory agencies, using machine-learning algorithms is often associated with expectations of enhancing their information processing capabilities, making their oversight more effective, and using their scarce resources more efficiently.[34] In addition, regulatory agencies that use algorithms might appear to be more innovative and appear to have neutral rationales for difficult decisions.[35] For example, regulatory agencies that assess risks by analysing data appear to prioritize cases for inspections objectively. Regulatory agencies that make decisions based not on human intuition but on algorithms appear to be more easily held accountable by external stakeholders.

However, it is difficult to exploit the potential for higher accountability and effectiveness. In fact, using algorithms has been associated with a lack of transparency and accountability. For regulatory agencies, the first challenge is to harness complex, dynamic, and networked algorithms while *safeguarding accountability*.

In scientific and public debate, machine-learning algorithms have often been described as black boxes.[36] A black box symbolizes a lack of transparency. Regulatory agencies, however, need to be transparent. Regulatory agencies, as bureaucratic organisations, are transparent because well-known formal rules guide human action.[37] Machine-learning algorithms are not transparent because unknown rules guide human action. These rules are not formal, but they represent the probability of events and stem from automatically analysing data.

Machine-learning algorithms analyse data in complex and changing ways, which makes it difficult for users to tell how a particular output of the algorithm came about. For some algorithms, outputs are not explainable at all.[38] Because users lack this information, they cannot easily retrace how the algorithm makes decisions and they are unable to evaluate the output of the algorithm in terms of their *norms*.

In regulatory agencies that use algorithms, professionals rely on two sets of rules that guide their actions. One set of rules contains known organisational rules, which stem from legal and professional frameworks. Another set of rules contains unknown algorithmic rules, which stem from the analysis of data. The unknown algorithmic rules provide professionals with information often opaquely and incomprehensibly. Because the professionals do not know the algorithmic rules, they also do not know what *norms* these rules contain. Professionals who rely on algorithmic rules create a regulatory practice that is based on unknown meanings and norms. Depending on the specific configuration of norms, a regulatory practice can emerge that is less legitimate and accountable.[39]

These insights show that regulatory agencies need to develop ways to make algorithms transparent and to retain control over how algorithms make decisions. Regulatory agencies have to deal with these challenges for already existing algorithms as pointed out by the literature. However, challenges arise even earlier as pointed out by the respondents at the Human Environment and Transport Inspectorate. Regulatory agencies that develop machine-learning algorithms have to deal very early on with a much more basic challenge: How can an organisation acquire relevant data as input for the algorithm?[40]

To use data for prioritizing tasks, the ILT's IDlab develops machine-learning algorithms. Machine-learning algorithms need sufficient data of good quality to be effective. For example, for the inland shipping sector, an algorithmic model ought to assess the risk that individual ships will violate safety standards. This risk assessment ought to help inspectors prioritize high-risk ships for inspections. Assessing risks effectively requires training the algorithm with relevant data, eg information on ship owners, types of ships, and their inspection histories including earlier detected violations. The ILT does not gather all of this information directly but has to request it from its ministry and other agencies. Data sharing is subject to regulations, such as the GDPR, that restrict the use of data to the purpose for which the data have been collected. This restriction means that the developers of machine-learning algorithms cannot just focus on the technical process of developing algorithms, but they also have to navigate different sets of norms that govern how data is shared and used in governmental organisations. The developers of machine-learning algorithms, however, lack experience with aligning these different sets of norms.

To increase machine-learning algorithms' transparency, regulatory agencies need to develop new procedures. These procedures ought to help make sense of algorithms' quality and ensure compliance with *normative* standards. Steps towards setting such standards have been taken, for example, by the EU's high-level expert group on artificial intelligence. The IDlab has put the expert group's recommendations into practice by using them to review their machine-learning models. The review consists of a number of sessions with different thematic focuses. In each session, reviewers raise questions and discuss those

34 Tutt (n 14); Lodge and Mennicken 2019 (n 3); Griffiths (n 29).
35 Griffiths (n 29).
36 Frank Pasquale, *The Black Box Society. The Secret Algorithms That Control Money and Information.* (Harvard University Press 2015); Tutt (n 14).
37 James Q Wilson, *Bureaucracy: What Government Agencies Do and Why They Do It* (Basic Books, 1989).
38 Tutt (n 14).
39 Jason D Lohr, Winston J Maxwell, and Peter Watts, 'Legal Practitioners' Approach to Regulating AI Risks' in Karen Yeung and Martin Lodge (eds), *Algorithmic Regulation* (Oxford University Press 2019).
40 Information based on one interview (June 26th, 2020) with a staff member of the ILT's Innovation and Data Lab and two documents (a strategic development plan and algorithm-guidelines)

with the developers of the model. The IDlab pursues two main goals with this procedure. First, the review ought to test whether norms have been considered in the development of the model that ensure a transparent and explainable use. Second, the review ought to direct attention to unintended consequences that could emerge from using the algorithm. Unintended consequences include making biased decisions and infringing human rights and autonomy.

Challenge 2: Preserving discretion for human decision-makers

Using algorithms as regulatory instruments standardizes regulatory work increasingly. The algorithms reduce the discretionary space of their users.[41] This space is, however, often needed in regulatory contexts, which include ambiguous situations that do not allow for applying rules straightforwardly. Therefore, more discretionary space is usually available to street-level bureaucrats in regulatory agencies than to street-level bureaucrats in decision-factory agencies such as those tasked with providing welfare services. Regulatory agencies need to protect the discretion of their bureaucrats against the impact of using algorithms.[42] The challenge is to create a synergy between the algorithm that processes huge amounts of information and the professionals who use domain knowledge and experience.

At the Authority for the Financial Markets (AFM), data scientists have developed models that ought to help detect manipulation on the capital market. These models calculate scores that reflect suspicious behaviour of participants on the capital market. For example, market participants who change prices each time that they make a transaction might create artificial price movements. While the models could create hundreds of alerts a day based on calculated scores, the usefulness of these alerts is determined by human capacity as all the alerts have to be checked by experts. Thus, instead of standardizing the experts' work by the use of algorithms, e.g. by automatically indicating the suspected offense, which then would only need to be confirmed or rejected by the expert, the models' use is limited to prioritizing those cases for expert inspection that are expected to have the highest risk.

The example of the AFM shows that preserving the discretion of human decision-makers is determined by the *norms* of the practice. If the efficient information processing of the algorithm is valued more highly than the expert's judgement, expertise might perceive the output of the algorithm rather as a rule, which they need to strictly follow, than as a source of information, which they need to evaluate critically.

How difficult it can be to preserve experts' discretion when algorithms are used in decision-making is emphasised by Yeung's concept of hypernudging.[43] Hypernudging builds on the idea, known as nudging, that positive reinforcements and indirect suggestions can influence human behaviour and claims that nudging can be made even more effective by using machine-learning algorithms.[44] With hypernudging Yeung demonstrates that even in organisations that provide professionals with considerable discretion machine-learning algorithms can shape users' choice architecture and provide them with a default option.[45]

To protect professionals' discretionary space, regulatory agencies will have to develop a hybrid regulatory practice. This hybrid regulatory practice must allow and enable professionals to both use algorithms and add their expert knowledge based on which they make quality judgments. If the algorithm is seen as the only reliable or legitimate source of information, then regulatory professionals are greatly restricted in making decisions based on their expertise.

Challenge 3: Overcoming the automation bias in algorithms

The challenge presented above has shown that the discretion of human decision-makers needs to be preserved when implementing machine-learning algorithms. However, even if the discretion is successfully preserved, the question remains whether and how this discretion is used. Even though developers and users have discretion, they might let the algorithms overpower all other information and blindly accept the algorithmically produced information. Sometimes algorithms even 'dominate conversations within regulatory organisations.'[46] This dominant position can be especially harmful if it undermines the users' judgment about how to act upon the information that the algorithm produces.[47] Regulatory agencies face the challenge of using the algorithm while overcoming the automation bias.

In addition to the bias towards blindly *accepting* algorithmically produced information, implementing opaque algorithms can also lead to forms of *rejecting* algorithmically produced information. Some forms of rejecting algorithms have been described in the literature as so-called buffering strategies that ought to separate technology and practice.[48] Professionals who use buffering strategies aim to dismiss algorithmically produced information as unhelpful or inconclusive. By dismissing the algorithm, professionals aim to avoid that algorithms affect their acting. If the buffering strategy is successful, professionals carry out their activities independently from the algorithm and the information it provides. In institutional terms, buffering strategies can also be understood as a decoupling of formal technological structures from actual organisational practice.[49]

We have identified two extremes of using algorithms: First, users let algorithmically produced information *overpower* all other information. Second, users *dismiss* algorithmically produced information and rely exclusive on other information. In both extremes, *meanings* are missing that could bring these sources of information together. Meanings are interpretative schemes that form the basis for a regulatory practice that uses machine-learning algorithms.[50] To create the needed meanings, regulatory agencies must enable experts from different fields or disciplines to collaborate and share their expertise.

At the ILT, algorithms require the organisation to find new ways of working. Professionals with different expertise from various organisational departments need to collaborate to develop, implement, and use machine-learning algorithms. Inspectors identify the issues at hand for a specific regulatory field, whereas data scientists specify the requirements for data and model development. Still others work on supplying data or providing the IT environment in which the model ought to be embedded. This diversity of tasks shows that not only

41 Veale and Brass (n 32).
42 Albert Meijer, Lukas Lorenz and Martijn Wessels, 'Algorithmization of Bureaucratic Organizations: Using a Practice Lens to Study How Context Shapes Predictive Policing Systems' (2021) 81 *Public Administration Review* 837 https://doi.org/10.1111/puar.13391.
43 Karen Yeung, '"Hypernudge": Big Data as a Mode of Regulation by Design' (2017) 20 *Information Communication and Society* 118 https://doi.org/10.1080/1369118X.2016.1186713.
44 Richard H Thaler and Cass R Sunstein, *Nudge: Improving Decisions about Health, Wealth, and Happiness* (Penguin Books 2009).
45 Yeung (n 43).
46 Lodge and Mennicken 2019 (n 3) 191.
47 Lohr, Maxwell, and Watts (n 39).
48 Angèle Christin, 'Algorithms in Practice: Comparing Web Journalism and Criminal Justice' (2017) 4(2) *Big Data and Society* 1 https://doi.org/10.1177%2F2053951717718855.
49 Meyer and Rowan (n 7); DiMaggio and Powell (n 7); Christin (n 48).
50 Orlikowski 2007 (n 9).

do the data scientists have to make sense of the machine-learning algorithms, but that also the inspectors, information technology and data staff, and lawyers who work with the algorithms need to ascribe a *meaning* to them. To facilitate the collaboration between the various professionals, they have to come to shared understandings of how to develop, implement, and use a machine-learning algorithm.

Challenge 4: Enabling the cross-organisational collaboration needed for effective algorithms

Using algorithms as regulatory instruments requires technological experts such as ICT specialists and data scientists to collaborate with regulatory professionals such as inspectors and lawyers. These professionals are often from very different parts of regulatory organisations. The need for increased coordination and collaboration caused by using algorithms may challenge existing role understandings and *power relations*.[51]

The ILT example has already shown the need for organisational settings that facilitate the coordination between departments and across expertise. Data scientists are needed for developing algorithms. The data scientists form new teams or departments which differ greatly from others in regulatory agencies in terms of aims, tasks, and expertise.[52] These differences can severely hinder interacting and cooperating with other departments, which seems to be crucial for developing a functioning regulatory practice that uses algorithms. If the organisational setting hinders coordination, the ambition of using algorithms in regulatory practice can easily become isolated in the organisation.[53]

Coordinating and collaborating between organisational departments and professionals with different expertise is a challenge in itself as it contradicts the existing regulatory practice. Usually, the existing regulatory practice relies on single organisational departments, which are tasked with overseeing a specific regulatory field. Inspectors from these departments could perceive using algorithms as infringing on their professional autonomy and discretion. The same applies to professionals who are needed to implement algorithms technically and oversee that the algorithms function continuously.

For example, the IT department needs to adapt to its new responsibilities of supplying the IT environment for algorithms. Reassigning responsibilities among departments addresses their respective positions of *power*.

Challenge 5: Stimulating the use of algorithms while paying attention to the risks

The example of the ILT highlights how using machine-learning algorithms can make regulatory agencies more complex. Becoming aware of such risks depends, inter alia, on how capable regulatory agencies are of shaping the discourse on algorithms. Being capable of shaping the discourse 'is essential to the deliberative process of problem-sensing, problem-definition, and problem-solving'.[54] If a regulatory agency lacks this discursive capacity, risks might not be identified as such and remain uncontrolled. For machine-learning algorithms, having discursive capacity seems to be especially important not only because these algorithms are comparably new but also because their often powerful, internationally operating proponents try to embed machine-learning algorithms in a positive discourse.

Only little by little, the risks of machine-learning algorithms have become apparent through cases that entered the public debate and scientific research. Researchers have identified nine categories of risk linked to the use of machine-learning algorithms.[55] Regulatory agencies that use machine-learning algorithms need to understand their *meaning* for their regulatory practice. Once regulatory agencies understood this meaning, they can start changing it.

Challenge 6: Finding good data to train algorithms while acknowledging limitations

In general, data is seen as an increasingly available and comprehensible resource. While this is an undisputed development, Johns and Compton make an attempt in their article to come from this general perspective to more precise accounts of using data and algorithms.[56] By giving more precise accounts of how data is used in specific practices, the authors show that data availability, comprehensiveness, and meaningfulness is unequally distributed across social contexts. In regulatory contexts, data can capture the ambiguity and inconsistencies that are inherent to regulatory practice. Inconsistencies occur, for example, when different inspectors are likely to come to different conclusions about the same case. Collecting and using such data on past inspection results to train algorithms introduces the inconsistencies into the model, which will then reproduce these inconsistencies in the decision-making.[57]

The example from the Dutch Authority for the Financial Markets (AFM) illustrates this challenge for regulation through algorithms. [58] Algorithms need data to be trained effectively. However, laws and provisions that protect the privacy of regulatees may restrict the data availability for developing and using machine-learning algorithms. The example of the AFM highlights that regulatory agencies have to find a way that safeguards the data protection *norms* but that also allows them to use data that are sufficient in quality and quantity for machine-learning. An additional issue is the low number of known cases of market manipulation, which makes it more difficult to develop a meaningful algorithm that can reliably detect these cases from the data. This shows how difficult it can be to find good data with which models can be trained while legal limitations are respected.

This challenge is a bit puzzling since enormous amounts of data are available. Following European standards, all transactions on the capital market are recorded. The data availability is therefore much higher than in many other regulatory domains. Using these data, the AFM conducts algorithmic data analysis to detect potential violations of transaction rules as well as extreme buying or selling behaviour that could indicate market manipulation. However, whereas outlier-behaviour can be easily detected by algorithms, determining whether this behaviour violates rules and can be considered market manipulation is much more complicated. Therefore, the AFM currently applies a three-step process: First, from all transactions that are carried out on

51 Lodge and Mennicken 2019 (n 3).
52 Lodge and Mennicken 2019 (n 3).
53 Lodge and Mennicken 2019 (n 3).
54 Leighton Andrews, 'Algorithms, Regulation, and Governance Readiness' in Karen Yeung and Martin Lodge (eds), *Algorithmic Regulation* (Oxford University Press 2019) 209.
55 Florian Saurwein, Natascha Just, and Michael Latzer, 'Governance of Algorithms: Options and Limitations' (2015) 17(6) *Info* 35 https://doi.org/10.1108/info-05-2015-0025; Florian Saurwein, Natascha Just, and Michael Latzer, Algorithmische Selektion im Internet: Risiken und Governance automatisierter Auswahlprozesse (2017) 18(3) *Kommunikation @ Gesellschaft* 1 http://nbn-resolving.de/urn:nbn:de:0168-ssoar-51466-4.
56 Fleur Johns and Caroline Compton, 'Data Jurisdictions and Rival Regimes of Algorithmic Regulation' (2019) *Regulation and Governance* https://doi.org/10.1111/rego.12296.
57 Griffiths (n 29).
58 Information based on one interview (June 12th, 2020) with an AFM-employee tasked with capital market oversight and on three documents (strategic development plans and reports)

a daily basis, extreme behaviour is automatically flagged as potential cases of market manipulation. Second, market analysts review all flagged cases and select based on their expertise those cases that they deem as most likely being cases of market manipulation. Third, their selection is then forwarded to investigators who review the cases in detail. This regulatory practice requires market analysts and investigators to closely collaborate as identifying and prioritizing potential cases of market manipulations play an important role in overseeing the capital market at the AFM. The first step is supported by the algorithm. The second and third steps use still entirely the expertise of the professionals. The number of regulatory professionals, therefore, limits the capacity of the regulatory practice.

5. Organizing regulation *of* algorithms

The second form of regulation that uses algorithms is regulation of algorithms. The form uses non-algorithmic instruments to regulate algorithmic objects of regulation, such as ranking models. Surprisingly, this form has been studied much less than the previous form, but some interesting patterns were identified from the literature. Also for this form, we have analysed the literature to identify challenges which we have illustrated with the example of the Dutch Inspectorate for Social Affairs and Employment (ISZW).[59]

Challenge 7: Enhancing regulatory agencies' new expertise while still respecting old expertise

The regulation of algorithms challenges the expertise of regulatory agencies. Regulatory agencies need to develop a regulatory practice that can effectively deal with regulatees that use machine-learning algorithms. To develop this practice, regulatory agencies have to invest in their expertise (*meanings*). Expertise can come from inside the organisation, for example by educating domain experts in data science or technical experts in the functioning of governmental organisations, though often additional expertise from outside the organisation is required.[60] Whether from inside or outside the organisation, the newly built expertise needs to be combined with existing regulatory expertise of lawyers, inspectors, and others.[61]

Our interviews at the ISZW highlighted that most inspectors are legal experts who are specialized in a particular regulatory domain. The inspectorate lacks technological expertise on algorithms and how they are used in the field. The inspectorate aims at filling this gap by hiring 'digital inspectors', who bring data and programming skills into the regulatory process. Building on their stocks of knowledge and combining them with those of other ISZW-inspectors, a new regulatory practice that deals with the risks of algorithms more effectively could be developed.

Besides enhancing expertise within the regulatory agency, scholars have also pointed to the need for access to external expertise.[62] Compared to the regulatory practice, other governmental practices, such as the legislative process, are more open to external expertise. Such 'an open practice by the regulatory agency is likewise desirable, receiving feedback from society and academia alike'.[63]

If regulatory agencies take new internal as well as external expertise into account, it could transform the regulatory practice. This transformation might entail similar challenges as discussed for the regulation through algorithms in Section 4 above. Especially challenging is the question of how to position the new expertise and experts (eg data scientists) vis-á-vis more established expertise and experts (eg inspectors) in the regulatory practice. All in all, these challenges evolve, first and foremost, around *norms* that determine what is seen as legitimate expertise for regulatory practice.

Challenge 8: Enabling closer collaboration among regulatory agencies focusing on the same algorithm

To deal with the risks that emerge from using machine-learning algorithms, regulatory agencies need to develop new ways of collaborating. The collaboration between regulatory agencies can take various forms. One form, some scholars have called for, puts a single regulatory agency for algorithms centre stage.[64] This regulatory agency would oversee the use of algorithms in its entirety and could facilitate collaboration with other regulatory agencies. The algorithm regulator could be tasked with approving algorithms before they are given access to the market – or at least those algorithms that are considered having high risks and impacts.[65]

However, how the regulatory agency could (dis)approve algorithms in detail and how this organisation would have to be equipped beyond its authority to perform this task has been left largely unanswered by scholars. Other scholars have actively advised against a central regulatory agency for algorithms, for example in a report to the Dutch government.[66] A central regulatory agency for algorithms could create legal uncertainty. By adding a regulatory agency, overseeing a domain in which algorithms are used could become more complex as the oversight needs to be carried out by two independent regulatory agencies.

To deal with this uncertainty that results from different agencies overseeing a single domain, new forms of collaborating would be required. Despite the absence of a central algorithm regulator, regulatory agencies in EU countries need to collaborate closely already today.[67] Regulatory agencies tasked with protecting data privacy have a new prominent position in the regulatory ecosystem because data and machine-learning algorithms have become so omnipresent to which the EU reacted by enacting the GDPR. This position of the data protection authority requires all regulatory agencies to collaborate with it. For example, if data from a job application tool would become publicly available in the Netherlands, the domain regulator (ISZW) and the data protection agency (AP) would need to collaborate to investigate this data breach.

Besides the need for changing *norms*, such as openness and trust, that govern the regulatory practice, this collaboration could be impeded because the AP is also responsible for overseeing the data protection practices of all other regulatory agencies in the Netherlands. Considering the proceeding dissemination of data and machine-learning algorithms inside and outside of regulatory agencies, a regulatory agency tasked with overseeing data or algorithms could become a powerful super-regulator which could further

59 Information based on two interviews (April 24th and 29th 2020) with two employees of the ISZW responsible for oversight of job application and selection processes as well as for analysis and research; on one interview (June 12th, 2020) with TNO-researchers and above-mentioned ISZW staff; and on five documents (3 working papers and 2 reports)
60 Andrews (n 54); Frissen, van Eck, and Drouen (n 33).
61 Lodge and Mennicken 2017 (n 3); Lodge and Mennicken 2019 (n 3).
62 Patricia Almeida, Carlos Santos and Josivania Silva Farias, 'Artificial Intelligence Regulation: A Meta-Framework for Formulation and Governance', *Proceedings of the 53rd Hawaii International Conference on System Sciences* (2020) http://hdl.handle.net/10125/64389.
63 Almeida, Santos and Farias (n 62) 5263.
64 Tutt (n 14).
65 Tutt (n 14).
66 Frissen, van Eck and Drouen (n 33).
67 Tutt (n 14).

complicate a collaborative regulatory practice.

Challenge 9: Developing transparent oversight instruments for opaque algorithms of regulatees

Algorithmic transparency is a widely discussed issue and it is often perceived as one of the key conditions for realizing accountability.[68] A lack of transparency is seen as particular important in the public sector as it might impact government responsibilities, procedures, and practices, which unavoidably affect citizens' lives.[69] Therefore, scholars have demanded that all algorithms used for public decision-making, such as oversight instruments, should be both accessible and explainable. The conditions of accessibility and explainability are met, if clear information is provided both about the decision-making process as well as about the substantive reason for a decision.[70]

That reliable information on algorithms is difficult to obtain because how specific algorithms function and are used is often not made transparent was mentioned specifically by respondents at ISZW. The ISZW lacks the manpower, expertise, and legal basis for examining the actual algorithms that their regulatees use in job selection and recruitment. Therefore, the inspectorate counts on technology to obtain information about algorithms and to assess the risk of discrimination. The ISZW developed a technological solution, a so-called reference system. The reference system matches applicants and vacancies just as real systems used by regulatees. However, the reference system matches applicants and vacancies in a transparent and explainable way. The ISZW uses applicants' CVs, which the inspectorate requests from their regulatees, as input for the reference system. By using the same input data, the ISZW can compare which candidates have been selected by the reference and the real system which is called an input-output-output analysis. If the systems show major discrepancies between selected candidates, for example on the distribution of gender, the selection process of the real system may be biased, and it is flagged for further (human) inspection.

Thus, the ISZW has complemented its regulatory practice with a data-informed step to react to the lack of transparency caused by regulatees who use machine-learning algorithms. The new regulatory practice draws on a different set of expertise and needs to be put into practice by the inspectors. To make the regulatory practice effective, the inspectors are asked to use the information, which the reference system provides them with, in a way that helps them to identify actual high-risk cases. For these cases, the inspectors need to collect evidence of the regulatees' violations, based on which the ISZW can enforce compliance and sanction rule violations.

Hiring digital inspectors and finding new ways of obtaining information despite the algorithms' lack of transparency might send an important message to the ISZW's regulatees. It could restore the power relations between ISZW and the regulatees and establish the reputation of a capable regulatory agency that is able to detect *violators and to hold* them accountable.[71]

6. Regulation of algorithms through algorithms

The third form of regulation that uses algorithms is regulation of algorithms through algorithms. The form uses algorithmic instruments to regulate algorithmic objects of regulation. Algorithmic objects can, for example, be prioritization models such as those used in job recruitment and selection.

To be able to regulate domains in which algorithms are frequently used, regulators also resort to using algorithms. As data and algorithmic technology become increasingly available it becomes more and more likely that the regulatory practice will undergo lasting changes linked to the algorithmization of both parties. In the scientific literature, the idea of regulation by code has emerged.[72] Leenes and Lucivero, for example, distinguish between four categories of regulation that involve robots.[73] One category concerns the regulation of robot behaviour through code, which entails regulating robots by inscribing rules and norms into their code. While this approach seems to be transferable to regulating algorithms, it would entail that regulatees regulate their own algorithms by coding them in accordance with certain rules and norms. In contrast, regulation of algorithms through algorithms would rather entail the regulation of regulatees' algorithms through regulators' algorithms.

Moreover, the more general notion that 'the outputs from one system will increasingly generate inputs into another' has been developed in the scientific literature.[74] Some scholars have recognized that this will lead to new forms of information and decision chains in public organisations.[75] The impact of this development on the regulatory practice is still emerging and so far absent from the scientific literature. At the same time, this form may gain relevance soon as the example of the AFM, which is exploring how algorithms can be used to regulate the use of algorithms in the Dutch capital market, illustrates. Therefore, this relation between algorithmization and regulation deserves separate attention from academic scholars.

In many ways, the challenges for this regulatory practice can be regarded as the sum of regulation through algorithms and regulation of algorithms. All the challenges of regulation through algorithms and regulation of algorithms which we identified in the previous sections also emerge for the regulation of algorithms through algorithms. However, for this form additional challenges might emerge because two or more challenges attributed to the other forms could interact to multiply this form's complexity and challenges. For example, challenge 2 (preserving discretion for human decision-makers) could interact with challenge 7 (enhancing regulatory agencies' new expertise while still respecting old expertise). Both challenges emerge because algorithmization affects the role of professionals and their specific expertise in regulatory agencies. If both challenges emerge jointly because both the regulatory instruments and objects become algorithmic, regulatory agencies could face a challenge that is even more complex. It will be necessary to adjust regulatory professionals'

68 Meijer and Grimmelikhuijsen (n 17).
69 Bruno Lepri, Nuria Oliver, Emmanuel Letouzé, Alex Pentland, and Patrick Vinck, 'Fair, Transparent, and Accountable Algorithmic Decision-Making Processes' (2018) 31 *Philosophy & Technology* 611 https://doi.org/10.1007/s13347-017-0279-x; Nicholas Diakopoulos, 'Accountability in Algorithmic Decision Making' (2016) 59 *Communications of the ACM* 56.
70 Joshua A. Kroll, Joanna Huey, Solon Barocas, Edward W. Felten, Joel R. Reidenberg, David G. Robinson, and Harlan Yu, 'Accountable Algorithms' (2017) 165 *U. Pa. Law Review* 633 https://scholarship.law.upenn.edu/penn_law_review/vol165/iss3/3.
71 Lauren Fahy, Scott Douglas, and Judith van Erp, 'Keeping up with Cryptocurrencies' (2021) *Technology and Regulation* https://techreg.org/index.php/techreg/article/view/65.
72 Lawrence Lessig, *Code and Other Laws of Cyberspace.* (Basic Books 1999).
73 Ronald Leenes and Federica Lucivero, 'Laws on Robots, Laws by Robots, Laws in Robots: Regulating Robot Behaviour by Design' (2014) 6 *Law, Innovation and Technology* 193 https://doi.org/10.5235/17579961.6.2.193.
74 Lohr, Maxwell, and Watts (n 39) 229.
75 Marlies van Eck, *Geautomatiseerde Ketenbesluiten & Rechtsbescherming: Een Onderzoek Naar de Praktijk van Geautomatiseerde Ketenbesluiten over Een Financieel Belang in Relatie Tot Rechtsbescherming.* (Elsevier BV 2018); Lohr, Maxwell, and Watts (n 39); Stavros Zouridis, Marlies van Eck and Mark Bovens, 'Automated Discretion' in Tony Evans and Peter Hupe (eds) *Discretion and the Quest for Controlled Freedom* (Palgrave Macmillan 2020).

role and expertise vis-à-vis external as well as internal processes of algorithmization. For regulatory agencies, it might become more difficult to develop a practice, in which professionals can add their substantive domain expertise in a meaningful way and to compete with others, such as data scientists and analysts, whose expertise becomes increasingly important in these processes. In fact, regulatory agencies might run the risk of ending up with a regulatory practice that is a technical, high-speed, and fully automated process, from which regulatory professionals' discretionary space and expertise have vanished.

This discussion of the regulation of algorithms through algorithms highlights that complex new challenges are expected to appear in the near future. The complexities of the interactions between the various challenges can be identified theoretically, but they need to be investigated empirically. By identifying regulation of algorithms through algorithms as a separate type, we draw attention to this phenomenon, the gap in the literature, and the necessity to explore it further by conducting empirical research.

7. Conclusion

In this paper, we aimed to show how using algorithms challenges regulatory practice. To meet this objective, we developed a sociological-institutional perspective and mapped three forms of regulation that use algorithms: regulation through algorithms, regulation of algorithms, and regulation of algorithms through algorithms. For each form, we identified challenges for regulatory agencies, based on a literature review on regulation and algorithms. Based on the literature, we present nine challenges for regulatory agencies. We illustrate the challenges with examples retrieved from interviews with three Dutch regulatory agencies. The challenges are presented in Table 1. These nine challenges show how using algorithms can be understood from a sociological-institutional perspective, though regulatory agencies might face additional challenges that have not yet been identified. This requires future empirical research.

This list highlights three types of challenges. Firstly, well-known organizational tasks, such as safeguarding accountability, enhancing expertise, developing oversight instruments and enabling both cross-organisational collaboration and intra-agency collaboration, are connected to specific features of the use of algorithms. Secondly, the challenges emphasize that technological tasks, such as stimulating the use of algorithms, overcoming the automation bias and finding good data to train algorithms, require organizational interventions. Finally, tackling both the organizational and technological tasks means connecting human and non-human actors (algorithms): creating a synergy between professionals and algorithms in a new regulatory practice.

Table 1 Challenges connected to using algorithms based on literature and examples

Regulation through algorithms	Safeguarding accountability for the way complex algorithms are used	Norms
	Preserving discretion for human decision-makers	Norms
	Overcoming the automation bias in algorithms	Meanings
	Enabling the cross-organisational collaboration needed for effective algorithms	Power relations
	Stimulating the use of algorithms while paying attention to the risks	Meanings
	Finding good data to train algorithms while acknowledging limitations	Norms
Regulation of algorithms	Enhancing regulatory agencies' new expertise while still respecting old expertise	Meanings
	Enabling closer collaboration among regulatory agencies focusing on the same algorithm	Norms
	Developing transparent oversight instruments for opaque algorithms of regulatees	Power relations

By systematically discussing the challenges and analysing them from a sociological-institutional perspective, this paper contributes to the literature on algorithms and regulation. Adding to legal and technical perspectives, our analysis has shown that good legal frameworks and sound technology may not suffice: regulation through and of algorithms also comes with organisational challenges. Algorithms affect meanings, norms, and power relations within organisations and thus change human actions that constitute regulatory practice. If an algorithm instead of the organization structures human action, its technological rules replace the existing bureaucratic rules. While regulatory agencies intend to change their regulatory practice by introducing machine-learning algorithms to a certain extent, the discussed challenges demonstrate the risk that the new rules that are being introduced by algorithms change regulatory practice in unintended ways. For example, challenge 3 – overcoming the automation bias in algorithms – means that algorithms can lead to disfigurations of existing practices with potentially dangerous implications for society when regulators developed biased practices.

The introduction of algorithms thus requires that regulatory agencies develop a practice that aligns organization and algorithm. This alignment effort is understood here as institutional work, which are actions intended to create, maintain, and disrupt institutions.[76] Institutional work is as much about changing institutions as it is about working to maintain what is valuable in changing environments. How can the regulator ensure, for example, that it will not develop biased practices? This problem cannot be solved only by developing unbiased algorithms but also requires re-organizing the work of professionals through training, work manuals, monitoring and clear

76 Thomas B Lawrence, Roy Suddaby and Bernard Leca, 'Introduction: Theorizing and Studying Institutional Work' in Thomas B Lawrence, Roy Suddaby and Bernard Leca (eds) *Institutional Work: Actors and Agency in Institutional Studies of Organisations* (Cambridge: Cambridge University Press 2009); Charlotte Cloutier, Jean-Louis Denis, Ann Langley, Lise Lamothe, 'Agency at the Managerial Interface: Public Sector Reform as Institutional Work' (2016) 26(2) *Journal of Public Administration Research and Theory* 259 https://doi.org/10.1093/jopart/muv009.

guidance of their work.

Actors who perform institutional work – whether it is to change or maintain an institution – will likely face resistance from other actors who either question whether the new practice is necessary and legitimate or who ignore the new practice altogether. The fact that many actors share agency and no single actor has complete control makes developing a hybrid regulatory practice a difficult task and it draws attention to the need for collaboration across organizational and professional groups.[77]

In conclusion, this paper has shown how a sociological-institutional perspective for analysing the relation between algorithms and regulatory practice can help to strengthen our understanding of the organisational challenges for regulatory agencies. Future research should empirically investigate how these challenges manifest themselves in different domains and different legal contexts. In addition, research is needed to analyse to what extent these challenges form a barrier to regulatory practice and to the use of algorithms by regulatory agencies. Furthermore, research is needed to investigate how regulatory agencies deal with these challenges and how their institutional work transforms these agencies. This broad research agenda is needed to complement current legal and technical knowledge with organisational knowledge about algorithms in regulatory practice.

77 Thomas B Lawrence and Roy Suddaby, 'Institutions and Institutional Work', in Stewart R Clegg, Cynthia Hardy, Tom Lawrence, and Walter R Nord *The SAGE Handbook of Organisation Studies* (SAGE Publications 2nd edn 2006); Lawrence, Suddaby and Leca (n 76); Thomas Lawrence, Roy Suddaby and Bernard Leca, 'Institutional Work: Refocusing Institutional Studies of Organisation' (2011) 20 *Journal of Management Inquiry* 52; Cloutier, Denis, Langley, and Lamothe (n 76); Christian E Hampel, Thomas B Lawrence and Paul Tracey, 'Institutional Work: Taking Stock and Making It Matter' in Royston Greenwood, Christine Oliver, Thomas B Lawrence, and Renate E Meyer (eds.), *The SAGE Handbook of Organisational Institutionalism* (SAGE Publications 2017).