Information regimes in government bureaucracies and 'digital decompression'

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Abstract:

In all bureaucracies how information is acquired, stored, re-accessed and analysed creates an 'information regime' of crucial importance for the rational or efficient conduct of business. Government departments and agencies use a wide range of information practices that can seem simply heterogenous, highly specific or hard to characterize. Yet an essential move in all pre-digital forms of organization has been data compression, using administrative routines to reduce complex realities to data and information in formats and quantities that can be classified, indexed, filed and re-found when needed. Three conventional information regimes can be distinguished by their level and mode of compression. *'Lossy' data compression* via drastic data selection and radical simplification, especially using open or gated-access forms, predominated in machine bureaucracies with hierarchic morphologies. By contrast, professional bureaucracies developed *'lossless text/narrative/verbatim' compression* for mission-critical tasks, relying on professional language, socialization, and knowledge development to summarize cases or events in more fully recoverable forms. With the advent of new public management and late twentieth century computerization/automation, hybrid forms of machine/professional bureaucracy developed, focusing on *metrics-based compression* (using pre-fixed statistics, key performance indicators and similar data) in a central governance role.

In the current digital era governance wave technologies facilitating big data, artificial intelligence and data science approaches have made feasible a new information regime of '*lossless' uncompressed data* and expanded data science, opening a potential for bureaucratic operations to alter in fundamental ways. Full digital data gathering or recording of interactions at the initial stage plus complete storing, organic indexing and new analytic capabilities can obviate much of the earlier need for data compression, and foster forms of post hoc knowledge development, e.g., via machine learning and algorithmic governance. This development will change most government bureaucracies somewhat, but how far still remains unclear.

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Historically ‘a bureaucracy is an organizational form reliant upon, and designed to exert control over, information, knowledge, and communication’ (Muellerleile and Robertson, 2018, p.193). What constitutes the core of a bureaucracy famously ‘cannot be pinned’ (Lea, 2021, p. 4.1), but this aspect is a constant. As ‘cybernetics’ models (vaguely) stressed in the 1950s, bureaucratic organization can in large part be seen as a set of connected social structures that carry out information-acquiring, processing and retrieval functions, and then ally them with a decision and executive power system. In this sense the state is constituted through writing… one of the main activities of bureaucrats’ (Gupta, 2012, p. 143). And:

> ‘Files are what shape the state. Something to which the innumerable treatises on the state never allude and which, from the lofty perspective of the pure concept, is considered unworthy of mention, is nevertheless thereby fully possessed of formative force’ (Vismann, 2011b, pp. 309-10).

However:

> ‘Collecting, storing, and analysing data were often hard, time consuming, and costly. The difficulties in handling data prompted humans to use as little data as possible. The very methods and techniques, the structures, and institutions of discovery were designed so that the most insights could be squeezed out of the least amount of data’ (Mayer-Schönberger, 2016, p. 996).

In the dominant type of organizations in national government, those structured on (neo-) Weberian or ‘machine’ bureaucracy lines (Peter, 2021), the information regime was premised on the drastic selection of knowledge and compression of data, a relatively crude form of ‘lossy’ (high information loss) compression (covered in section 1 of this paper).

This pattern contrasted acutely with a radically different information regime that prevailed in the other major form of modern government agency, namely professional bureaucracies. In mission-critical roles these organizations place a premium on recording fully recoverable or replicable information. Professional expertise and cultures provided a key to them being able to create, maintain and decode economically much more re-expandable records and files – using a ‘lossless’ information regime (see section 2). Of course, these agencies must also rely extensively on ‘lossy’ forms of data-reduction for their routine operations and handling internal administration.

Modern machine and professional bureaucracies in advanced countries have increasingly converged on hybrid organizational forms, especially under new public management since the 1990s. They rely on a metrics-based information regime that focuses on collecting pre-set statistics and monitoring organization performance against multiple

output targets and metrics (section 3). It lies at a tangent to both earlier regimes, but also partly integrates with both.

Finally, digitally changed bureaucracies are strongly emergent in the current era as an important development and extension of an evolving 'digital era governance' (DEG) approach (Torfing et al, 2020, Ch.6; Margetts and Dunleavy, 2013; Fishenden and Thompson, 2013; Dunleavy et al, 2006a, 2006b). Central to modern digital change within firms and agencies alike is an information regime centred on lossless uncompressed data acquisition and data science (section 4). Lossless acquisition technologies create big data that is not pre-set, and allows artificial intelligence, machine learning and data science analysis to be creatively deployed, often in real-time. All three other earlier forms (lossy compression, lossless text compression, and a hybrid/metrics approach) of course are also still present within digitally changed bureaucracies, albeit in reduced roles. The extent to which the new regime permits or requires public bureaucracies to operate differently from predecessor forms of organization remains open to debate and research.

1: 'Lossy' compression of data in machine bureaucracies

At the macro-organizational level of a government department or agency its 'information regime' operate in ways that are analogous to 'data compression' within information theory and most modern digital technologies. Data compression is 'the art or science of representing information in a compact form' (Sayood, 2006, p. 1). In technological settings it entails using algorithms to condense an initially voluminous quantity of information from a source text into a more parsimonious representation (signal) that none the less captures what are judged to be the salient features of the source data. Some modes of doing so are 'lossy', and here there is a direct and acute trade-off: more selection and compression of data means a worsened quality of reproduction. At the other end of the spectrum, however, are 'lossless' approaches, those that allow radical selection and compression of the source data while still capturing most (or all) of its salient features.

A core organizational form in national civil services have been 'machine bureaucracies', a modernized and internally differentiated form of Weber's (2013) pyramidal /hierarchical form (Mintzberg (1983, 1979); Silberman, 1989; Peters, 2021; Torfing et al, 2021, Ch. xx). They have always depended pervasively on the drastic pre-selection of data and information for recording, and then intensively compressing it for storage, with strictly limited retrieval systems using pre-defined index variables (see the left-hand chart in Figure 1

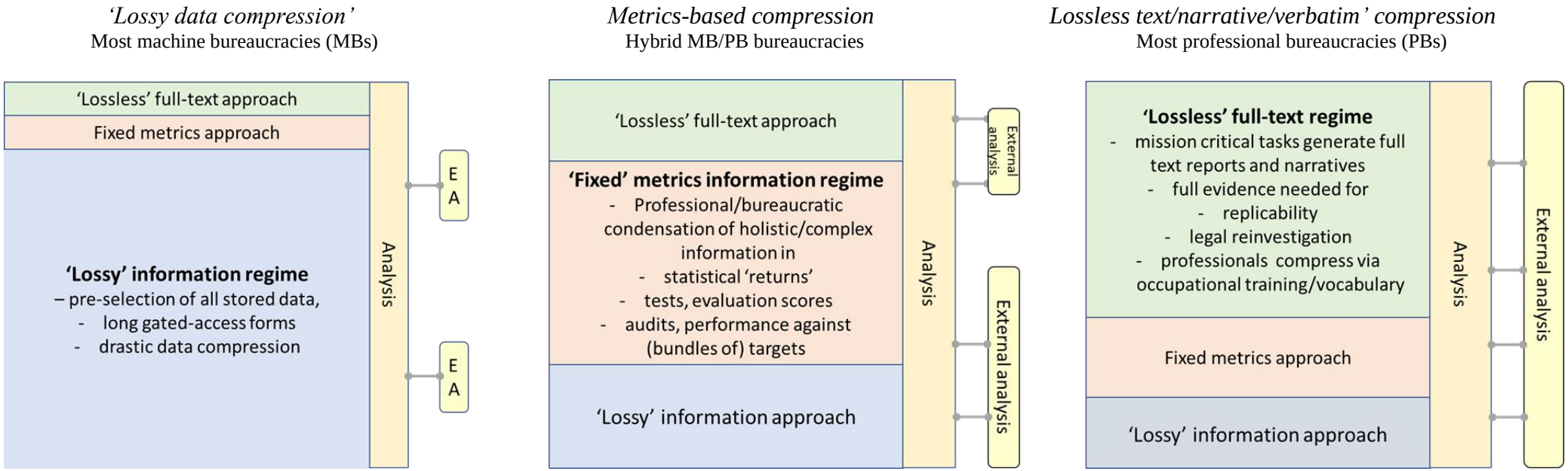
below). Across many decades this 'lossy' information regime allowed the 'classic' Weberian/neo-Weberian/machine bureaucracy to focus on paper-based files which strongly standardized strictly limited information about its caseload, the environment and the appropriate responses to be made (Kafka, 2012).

Over time government machine bureaucracies doing transactional functions and 'old-style' labour-intensive regulatory tasks perhaps came to stand at the limit of all organizations in terms of the radical extent and drastic nature of their information selection and compression practices. Right up to the 2000s they relied extensively on first paper and then online forms to solicit information from 'clients' or 'customers' and to create the information basis for activating a narrow range of pre-defined 'treatments':

> In contrast to most companies, processes in governments are driven by forms... At the beginning of government processes, governments receive application forms when a citizen requests a service. At the end, governments issue certificates that are forms to indicate the decision on the application… Forms are central artifacts of government processes (Höhenberger and Scholta, 2017, p. 737).

Myriads of smaller, internal forms also governed the in-house regulation of personnel, procurement, evaluation of policies, lesson-learning, setting budgets and undertaking expenditure.

Figure 1: Data compression and storage practice in government and public service bureaucracies under three conventional information regimes



Note: The relative sizes of the box shapes shown indicates (very approximately) their relative importance within the activity mix of government departments and public service agencies. EA = 'external analysis'.

Forms filled in by external clients always had two main roles and by the late 1980s had acquired a third (Jansen and Steehouder, 2017):

(i) *Legally and in audit terms* signed forms were foundation documents for applications, regulatory declarations and establishing liabilities. In the case of complaints or allegations of errors or maladministration, forms, declarations and associated documentation (e.g., records of phone calls to contact centres) were the evidence on which an agency defence would stand, as containing everything legally or formally salient from an interaction with citizens or firms. Intra-agency forms similarly were the cornerstone of documentation and control records.

(ii) *Transferring information* from interviews with external clients to departments and agencies was the key second role that forms played. 'From the welfare worker's perspective, a good client is one who has lived his [or her] life in such a way as to provide easy documentation' (Wheeler, 1969b, p.13) Form designs were always algorithms on paper, with routing instructions and jump-steps built into them.

(iii) Forms were also *key vehicles for outward agency communications*. They were how citizens appreciated the 'bottom line' information that agencies wanted, although this role long went unrecognized by departments and agencies, and was only incorporated into external communications strategies after long lags:

> Many forms are used by a large number of citizens and they are often read more carefully than whatever other document from the organization. The number of accurately and timely returned forms is increasing not only as they are easier to fill out, but also as they encourage more citizens to do so (Jansen and Steehouder, 2017, p. 14).

Most transactional machine bureaucracies used a drastically 'lossy' approach to data compression, discarding almost immediately (as administratively irrelevant) most of the transitory information they gathered from all their interactions. For example, a person might present at a job centre or unemployment office or call centre seeking to register and receive benefits, always with a complex story to tell of the misfortune and personal circumstances behind their joblessness. From this full narrative, written out on a form or given orally to a local office or contact centre worker, only the barest skeleton of points was recorded on paper or computer, sufficient to classify and establish the person's legal eligibility for assistance (or not). Computerization, automation and digitization further sought to reduce grass-roots administrative workers' limited discretion (Bovens and Zouridis, 2002), especially the introduction of computer-scripting in centralized contact centres. By the 2000s a few

'discretionary' words of description from the case worker, or some justification by the deciding official, might still be included on a full paper or PDF record. But they mostly would not make it onto the formal or legacy system master record (except perhaps as a publicly-unacknowledged 'grading' code, indicating the official's impression of a client's trustworthiness or merit, or their absence). Similarly, a complex regulatory case might get summarized in terms just of a few key data points or recorded situations that demonstrated compliance with or specific infractions of a required standard.

Some U.S. observers reported in shocked terms that 2.2 million Medicare forms per year were computer-decided, and that only a 'paper hearing' was accorded to any difficult cases (Shuy, 1998, Ch.1). But given their case-load, the administrators involved successfully convinced US courts that no other way of proceeding was remotely feasible. The multiplication of hundreds of external and internal gated-access forms (GAFs) as core means of control and activation of decisions applied within all large machine bureaucracies, extended through all of government advice-giving and safety warnings (Shuy, 1998, Chs. 2-3). It is also a familiar feature of in-house administration in all public agencies.

In a neo-Weberian form this hierarchical model still predominates within national government systems across some countries in Europe most resistant to 'new public management' (NPM) changes (Torfing et al, 2020, Ch.5; Byrkjeflot et al, 2017). The East Asian bureaucracy variant marries machine bureaucracy operations to strong Confucian themes of unquestioning hierarchy, tradition, deference to power, and complete consensus (as in China, Taiwan and Hong Kong). A development state ethos was sustained for decades by these features, plus a national cultural emphasis upon hierarchy, including strong respect for and deference to high ranked civil servants, especially in Korea and Japan (Berman, 2017; Kim, 2017).

The levels of data selection and compression in transactional and regulatory machine bureaucracies peaked in the UK under the rather despairing 'zombie-NPM' wave influential in the austerity years after the 2008 global financial crisis (de Vries, 2010; OECD, 2010; Dunleavy, 2010a, 2010b). NPM's emphasis on stronger corporate management, and achieving efficiency via staffing reductions and service simplifications or terminations, lead to an even greater focus on forms and contact centre interactions as the dominant form of external communication. Monitoring data-trends in management information systems became the crux of internal control in flatter hierarchies. The design of forms and contact conversations slowly moved from being an amateur craft skill into the domain of 'designers', especially in increasingly critical online contexts. Officials under pressure to cut running

costs gradually focused much more on whether forms were needed in the first place, enhancing their useability and clarifying the supplementary information that explained forms and processes to citizens and enterprises (Dunleavy et al, 2009).

Earlier machine bureaucracies had relatively little internal analysis capability. And they made only episodic or 'spotty' use of external analysis, principally management consultants and auditors from giant firms. In addition to 'lossy' compression, late-period machine bureaucracies also strongly developed 'fixed metrics' and KPI approaches (see section 3 below). More use began to be made of external consultants and even academic studies from the 1990s onwards. And both computerization and automation in neo-Weberian and NPM bureaucracies created a greater capacity for collecting data-bits and meta data from forms, tests, audit and performance statistics. These partial digital transitions perhaps created a 'Says Law' effect, where the greater supply of data available lead to both top management and ministers/government executives expanding their demands for in-house analysis, often in fragmented ways. External sources like the legislature also piled in in the same vein. But typically the pre-set character of 'lossy' data recording meant that only what had been anticipated as salient at data collection, perhaps years before, could now be recovered.

2: 'Lossless' compression in professional bureaucracies

'State patronage' of professions and occupational groups allowed them to operate in a licensed-discretionary way within an apparatus of government (Johnson, 1977), as in most welfare state areas and state-science/technical development of development of new technologies. Across this growing area professional bureaucracies (PBs) had emerged as dominant organizational forms, almost before Weber had finished defining his machine bureaucracy paradigm, especially in welfare state and the regulation of 'corporate patronage' professionals (Silberman, 1989). Knowledge intensive professional bureaucracies may have less hierarchical structures, because they focus on achieving consistent outcomes chiefly via developing professional and scientific skills (Mintzberg, 1983, 1979).

In their defining or mission-critical tasks government PBs normally generate and retain a lot more information per case than do machine bureaucracies. Their hallmark approach to generating and storing information is to strive for full and often 'comprehensive' documentation. Reports and files seek to secure a full record of the unique features of every case, and the organization then aims to achieve 'lossless compression' in storing the data, as

Figure 1 shows. Of course, some information is necessarily still lost, but PBs capture far more salient information by recording far more phenomena initially, documenting everything, using narrative form and qualitative analysis text forms, and coding salient phenomena directly into professional language that can be 'unpacked' later within the occupational group's professional knowledge, socialization and ethics.

Full recording of information and 'lossless' text forms of compression did come to apply to some of the most distinctive processes in the initially most uber-machine bureaucracies, like police forces and the armed forces (Little, 1969). Despite their super-strong hierarchies and cultures (e.g., expressed in rank uniforms and insignia, and deferential forms of address to superiors) even in the early twentieth century these large agencies did not solely rely on drastic data selection and 'lossy' compression. For selected mission-critical tasks (like battle-analysis and lesson-drawing in the military, and evidence-collection and crime scene documentation in police forces) a contrasting tradition developed, matching the lossless model most associated with professional bureaucracies. From the 1960s onwards this also went along with both the military (Tillberg, 2020) and police (Holdaway, 2017) substantially professionalizing (or 're-professionalizing') at 'staff/policy' levels and in terms of using new technologies. In welfare state and criminal justice areas the extension of civil rights enlarged the scope of date recording and retention to areas previously handled at street level – not least because life chances could be affected by even the creation of a record, as with arrests, police handling of juveniles (Meehan, 1986) or juvenile courts (Lemert, 1969).

In addition to their core written or orally recorded text/narrative descriptions, PB's exhaustive case histories often came to incorporate other pre-fixed evidence materials, including full context or situational notes (like crime scene recordings and data points);

- complete audio/video recordings of interviews, or transcripts or other comprehensive records of interactions with clients (e.g., patients, police suspects or crime victims);
- briefer records of interactions with other relevant actors in a case (like the family members of patients, or witnesses in criminal investigations);
- long case histories of clients or people who are the focus of professional efforts, especially in 'total institutions like mental hospitals (Erikson and Gilbertson, 1969) and security contexts (Orlansky, 1969; Harrits, 2019)); and so on.

If an incident, complaint or problem arises then evidence records also form part of the long-term case documentation. As clerical or secretarial staff were cut or shrunk by

computerization and now digitization changes, full-text documents in most welfare state areas increasingly came to be produced directly by 'street-level' professional or semi-profession staffs, 'building an audit trail', especially in NPM agencies (Hoybye-Mortensen, 2019; Hupe, 2019).

The rationale and ethos of 'lossless' text compression and full information storage in legal contexts can be traced back to the Roman law maxim, 'Quod non est in actis non est in mundo' (whatever is not in the files is not in the world) (Vismann, 2011a, p.56). Always a critical component of legal systems since then (Goldstein, 1969), in the modern era this stance has broadened into a wider approach to documentation across multiple professions. In social work the equivalent maxim is now, 'If it's not written down it didn't happen' (Lillis et al, 2017). Verbatim, word for word, records are often (naively) construed as

> 'a text that faithfully captures and represents a discursive event that took place in time and space, which would otherwise be ephemeral and unrepeatable. In modern societies, verbatim stands in for durable indexicality and materializes the social epistemology of evidence, accountability, and authenticity' (Inoue, 2018, p.217).

Perhaps the administrative apotheosis of the lossless text/narrative form have been top-level inquiry reports - like the relatively terse *9/11 Commission Report* (2004) in the USA; the grotesquely enlarged Chillcot report (2016) on the UK's entry into and conduct of the 2003 Iraq war and its aftermath; or the Queensland IT disaster inquiry (Chesterman (2013), dissected in detail by Chisnall (2018).

Full (or fully unpackable) documentation has become a critically important touchstone of modern professional good practice. The acid test is reproduceability - if another individual member or team from the same occupational group subsequently audits the critical data from Case x then they should be able to reconstruct the original information gathered in detail, and (almost) in full – for instance, if case files on patients move between organizations (Räsänen and Günther, 2018), or if a legal or liability question arises. Professional evaluation or a re-audit may reach different conclusions, for instance, if they find some previously overlooked evidence or detail that could have significant implications for the interpretation of the case, and the 'treatment' that was or should have been given to it, or if analysis technologies have progressed since the case. In law and order contexts (legal, policing, prisons), appeals often occur, and cases may be reopened in the light of new evidence emerging. Comprehensive documentation needs explain why 'the majority of a detective's time is spent documenting cases, and locating and interviewing victims' (Westera et al, 2016, p. 3), and why social work has become ever more 'a writing-intensive profession' (Lillis et al, 2017). Many lossless

records, artefacts and evidence must be stored for years or decades. In other situations, the retention of data and materials may have a future end-date, with longer retention depending on complaints arising or issues being raised about potential mis-diagnosis, malpractice or maladministration.

Because professional bureaucracies are founded upon in-depth expertise, professional socialization and long years of training, forms of communication within the occupational group can still accomplish compression, and may even create highly compact records, but in a quite different way from the lossy model. Professional occupational groups master an esoteric, specialized language and vocabulary that then forms an integral part of their occupational identities, and is used in almost every interaction in order to pick out and drastically summarize the data to be retained. This 'packed' potential information can be inspected, understood and 'unpacked' again in something like its full form by other professionals. For example, a doctor presented with a new patient can consult earlier case notes (frequently voluminous, but still very compressed), and so re-create much (but not all) of the knowledge available to earlier doctors who treated that person. Professional language, and lossless text (even verbatim records) can also be used to mask 'uncomfortable knowledge' (Rayner, 2017) and as a 'political technology' (Inoue, 2018). They form important ways in which institutions 'do the remembering' and 'forgetting' of knowledge (Douglas, 1986).

Of course, as a raft of work in social construction emphasizes, there is invariably an interplay of implicit and explicit knowledge in professional contexts. Studies of the replication problem in science bureaucracies (labs and university departments) have repeatedly demonstrated how much implicit knowledge and information is lost in re-examinations and the replication of experiments (Collins 2010; Collins and Evans, 2009). Even professionals with specific 'craft' training protocols (like medicine and law) may face losses of core information in re-looking at records. Alternatively, they may be able to do better than scientists in handling reasonably similar cases and curtailing losses of implicit knowledge through stronger socialization, greater familiarization or repetition of cases, and hence more accumulated experience. In the modern era, these occupations have been remarkably resistant to adopting lossless digital recording, partly because of the 'replay' times involved in any later familiarization with cases.

Only activities falling within their central mission are fully documented in professional bureaucracies. In other respects, throughout their development, and especially in their internal management, these agencies have also remained addicted to using forms to govern the myriad

support processes underpinning their core mission. Figure 1 above thus shows that gated-access forms and 'lossy' information approaches were extensively used in professional bureaucracies for lower salience internal administrative purposes, while a small (but later growing) amount of internal KPI (key performance indicator) metrics were produced. This is particularly the case in more hierarchic national cultures, and countries with Silberman (1993)'s strong organizational version of civil service. A prevalent legalism in neo-Weberian countries also often means that compliance with approval and reporting forms is widely accepted by professional staffs in the wider public services as an inevitable concomitant of their role. Yet there always remained a clear contrast between PBs and MBs in the relative significance of the same three information modes, as Figure 1 demonstrates. In professional agencies the 'lossy' and 'metric' modes of operation both remained culturally less important, and subordinate to the predominant 'lossless' or full text modes.

Public service professional staffs in PPA and later NPM countries have also made frequent countervailing efforts to reduce their 'paperwork' from internal forms and 'audit' tasks. A 'de-regulation' cover has often been a 'flag of convenience' here, to try to convince right-wing governments to reign-back from obsessively strengthening the surveillance of public service staffs. Professionals' organizational cultures always code the constant need to cope with internal forms as detracting from their time on 'core' mission tasks. Form-reduction initiatives sometimes lead to budget decentralization, the raising of overly low delegation or viring limits, and occasionally the scrapping of dated forms. But they generally failed to turn back the tide of gated-access and reporting forms, especially under NPM governments which multiplied controls.

In recent years, department and agency managers have often used shifting to first computerized and later digital/online inhouse forms as a pretext for under-estimating the compliance costs and time involved for professional occupational groups. For instance, a survey of American hospital doctors found that purely administrative tasks (not including patient-related record keeping etc) absorbed 15-20% of their time budgets, with government hospitals at the top of this range (Woolhandler and Himmelstein, 2014, Table 1). Using electronic health records only increased this load somewhat compared with paper forms. The external budgetary or accountability relations of professional bureaucracies generated multiple additional pressures for KPI (key performance indicator) metrics, especially under NPM's fragmented structures (Burton and van den Broekfield, 2009).[1] Even within regulatory agencies different legislative requirements often meant that NPM managers operated with different criteria on when to notify different levels of risk to different external

agencies. the relatively random and 'lossy' approach of different funders (especially those that were machine bureaucracies) could come to shape large parts of the information regime that prevailed in professional bureaucracies beyond their core missions.

Compared to machine bureaucracies, PBs also made somewhat more use of external evidence (especially from academia as well as consultants). Professional staffs showed far more openness to outside analysts/consultants' insights within a shared professional language.

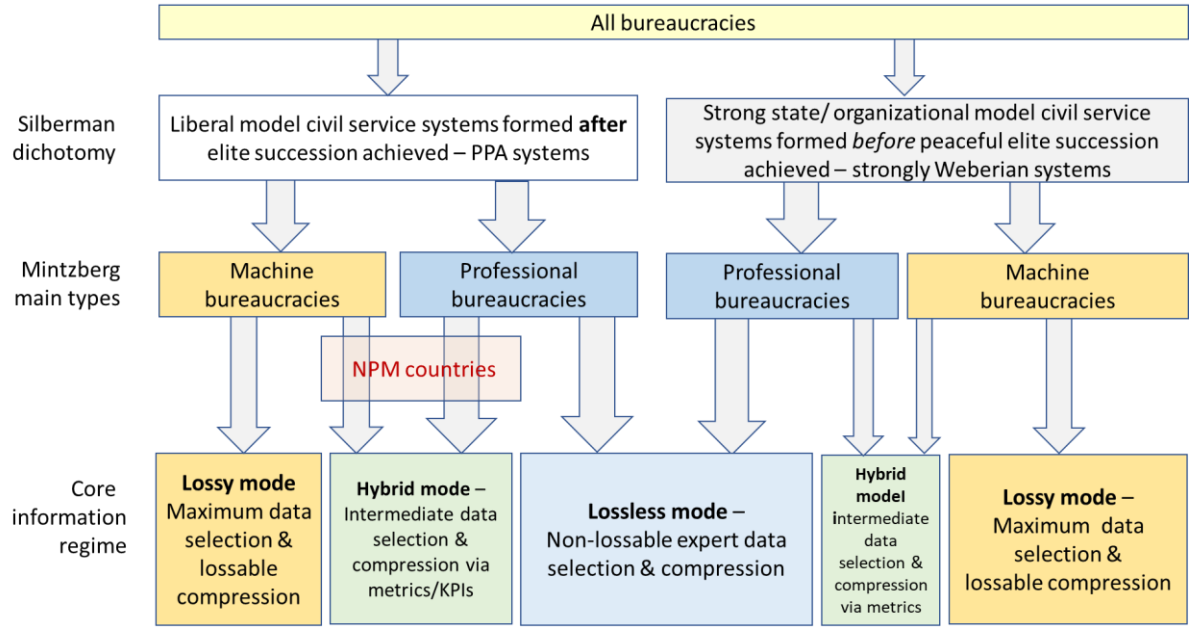
Quite different from both machine bureaucracies' central reliance on 'lossy' data compression, and professional bureaucracies 'lossless' verbatim compression was the metrics/statistics approach characteristic of hybrid machine/professional bureaucracy forms, to which I turn next.

3. Metrics-based compression in hybrid machine/professional bureaucracies

Long run 'neo-liberal' pressures, boosted by the advent of new public management contributed to the strong growth of hybrid organizational forms, sharing features of both machine and professional bureaucracies, This was especially the case in countries with Silberman (1993)'s 'weak' civil service pattern nationally. Figure 2 below shows in summary form the two sets of processes that lead to the emergence of a distinct metrics/statistics information regime in the two different civil service systems. If national state bureaucracies developed *before* political elites worked out how to achieve peaceful leadership succession between them (as in France and Japan), then 'strong' organizational civil systems became permanently needed to hold the state together (Silberman,1993). In other new democracies with still authoritarian elements a 'strong' Weberian or hierarchic model of organizational socialization model for national civil services and associated very intensive file systems also developed, as in Prussia/Germany (Brecht and Glaser, 1940; Chatfield, 1941), Bonapartist Europe and East Asia. By contrast, where politicians mastered the art of peaceful political succession early on before national bureaucracies really developed, as in the USA and UK countries, more 'liberal' and politically-subordinated national civil services emerged (Silberman, 1993). This pattern was sustained in the USA by the continuous efforts of conservatives to restrict 'deference' to administrative elites (Postell, 2017). These divergent strong and weak patterns in central state operations created early on at national level have persisted in various forms as 'traditions' to the present day (Peters, 2021). They also

progressively transmuted also into different yet 'family resemblance' variants of civil service models at regional and local government levels in the same countries.

Figure 2: The key factors shaping bureaucracies' information modes



Notes: PPA = Progressive public administration as defined by Hood (2007).

Two routes by which hybrid bureaucracies emerged are shown by the flows into the smaller right hand green box in Figure 2. First, some technobureaucratic occupations and agencies in intensively Weberian countries pursued a 'professionalization' agenda in order to enhance their work autonomy and salaries. Second, in the wider public service systems dominated by Weberian and hierarchical models, in Europe and modern 'East Asian' systems, some strongly hierarchist welfare state professional administrations emerged. Agencies like hospitals, universities and schools systems here acquired more of a hybrid character because their stronger internal hierarchies were more like those of machine bureaucracies.

In Anglo-American countries with the 'weak' civil service model, developments towards hybrid MB/PB organizations were greatly fuelled by shifting to new public management (shown by the two flows into left-hand green box in Figure 2). First, some generic management occupations in machine bureaucracies inside government were able to use agencification (Pollitt et al, 2004), an emphasis on 'leaderism' (O'Reilly and Reed,

2011)) and strong, corporate management to raise top pay in the guise of 'professionalizing' delivery and operational roles. Some salary escalation for elites ensued, but later stalled in 'austerity' countries like the UK (Dunleavy, 2018).

Second, under NPM a far bigger impetus to the creation of 'hybrid' MB/PB organizations came from sustained efforts to 'de-privilege' public sector professional staffs, (the second from left stream in Figure 2). A metrics-based impetus was key here, focusing on creating 'clients' and service users as 'informational persons', defined (even in professional settings) by their data (Koopman, 2019). This drive especially affected the information regimes of less well-established or prestigious 'semi-professions', like social workers, teachers and nurses. Here 'proletarianization' changes weakened public sector professions and trade unions, flattened organizational hierarchies, and widened spans of central government control. Most NPM countries over-developed the network and control potential in ICT modernization, while systematically neglecting its equally salient decentralizing and holistic potential (Bloom et al, 2014).

Whatever the route by which hybrid MB/PB bureaucracies came about, these agencies always adhered to a third information region, shown by the middle panel of Figure 1, one focused on compressing data via pre-fixed metrics, statistics, and targets – a change often associated with an 'audit explosion' (Power, 1994, and 1997; Graeber, 2015). Performance evaluation in complex public services like school education and social work came to be conceived in ever more pared down and metricized terms. In many US states politicians early on promoted constant testing regimes for school systems (Goslin and Bordier, 1969, p.33), and the pervasive use of test scores in performance-related pay systems for teachers. Professional diversity was later severely eroded as teachers were increasingly allowed only to 'teach with the test' (Berliner, 2011) and uniform curricula were imposed on ethnic minorities (Cunningham, 2017). In most US states (Chubb, and Moe, 1990), and in England and Australia, some or all schools were converted into micro-local agencies, recruiting 'customers' via their performance as measured in 'league table' rankings (e.g., see Leckie and Goldstein, 2017). In the UK providing comparable information to parents lead to the creation of a 'national curriculum' and multiple top-down stage tests supposed to track students' progress.

A similar 'audit explosion' in social work and social care resulted from NPM managers' often unavailing efforts to stem services quality shrinkages and service delivery disasters stemming from systematic under-resourcing (Munro, 2004; 2011). In multi-agency settings like social work, whole-person approaches (and full-text reporting based on them)

gave way to agencies 'covering their back' by creating an 'audit trail' of fragmented documentation and 'returns', exonerating them from culpability in the case of a serious failures (Hood, 2020). Similarly, data-creation to meet multiple NPM funding agencies 'needs' and KPIs often eroded social workers time with clients or on interventions (Burton and van den Broekfield, 2009, pp.1337)

Universities early on used abbreviated metrics to create enduring records of routine student achievement (Clark, 1969), but retained lossless reporting for academic staff. Information regimes became increasingly metricized, focusing on pre-defined report templates and numeric targets. Metrics-based reporting and testing process later even extended into core profession areas like evaluating research outputs (HEFCE, 2015), and patient care in NHS acute hospitals. UK hospitals were supposedly 'freed' to compete with each other as local public corporations, a change claimed as beneficial in some studies (Bloom et al, 2010). Yet other researchers found incentives to 'quality shade', so as to cut costs (Moscelli et al, 2021).

As professional bureaucracies in NPM countries became nominally disaggregated competitors, and also faced demanding austerity pressures in the UK and USA, so information regimes dominated by metrics and test data squeezed down the zone of full professional reporting. Many critics on the left saw in such trends not just an NPM corporate management drive, but also a wider 'neo-liberal' drive to de-skill public service professional work by substituting for it semi-automated monitoring of pre-fixed indices, driving up work rates and driving down pay levels xxxx, source. In some organizations these developments severely reduced the scope of non-lossable data compression previously achieved by professional expertise.

As professional self-policing and full text reporting were curtailed by recording more 'externalized' control data hybrid agencies had to invest heavily in staff to process, aggregate and condense the original myriads of data points drastically down into terse metrics and statistics. This data-based compression may make hybrid agencies seems closer to the machine bureaucracy's reliance on storing only highly compressed data. Like them hybrid organizations also developed a strongly managerialist orientation towards data.

However, NPM hybrid forms of bureaucracy depended more heavily than either old-style machine or professional bureaucracies on ICT and analysis/statistical professionals, who were often in short supply in central governments. and even more so in sub-national governments (Dunleavy, 2021). Under PPA arrangements a critical mass of ICT staff to support decentralized agencies' operations could normally be gathered together in

state/regional administration offices or in a large city administration. When NPM changes fragmented ICT across hundreds of different micro-agencies, most IT for professional bureaucracies was contracted out, with only low-level maintenance staff retained in-house or on-site. For instance, in England after NHS reforms in 1988 regional ICT centres were largely cutback because 'strategic' authorities were abolished. The change contributed strongly to the perpetuation of minimal and laggard digital tech development in English health trusts into the 2000s, when the NHS was around 15 years behind the private sector in its (non-) use of ICT. The problem was meant to be counteracted by creating the national level NPfIT programme in 2003-4, but this soon ran into difficulties as costs soared (Sauer and Wilkinson, 2007). It was scrapped in 2010-11, so that something like regional support centres had to be reinvented (Department of Health, 2010).

Shifting towards a metrics/KPI/statistics orientation often means that hybrid agencies must make more use of external research from universities or advice from consultants. Work by applied social scientists is especially influential in fostering more sophisticated metrics, or critiquing in-house statistics or metrics work (Bastow et al, 2014, Ch.6). In regulatory settings, agencies are often dependent for useful data and analyses on the regulated industry themselves, who extensively employ consultants to try to shape the 'hands off' policies of NPM-'modernized' regulators. With the rise of new big data stores and data science capabilities hybrid agencies may also apply conventional optimization and algorithmic analysis more to both compressed transactional data they hold, and to their full text 'lossless' documentation, seeking to extract greater value-added from them. But the scope for additional learning from such pre-fixed data is inherently quite limited, even when new data amalgams are mashed together.

In hybrid MB/PB bureaucracies Figure 1 above shows that the metrics approach mostly must coexist with substantial amounts of 'lossy' data compression in MB mode, and with a good deal of full text reports still in more of a 'lossless' mode on the PB pattern. The distinctive metrics component is rarely dominant and the precise mix of information approaches in any hybrid agency is likely to be conditioned by whether it started out in an MB or PB pattern. Where hybrid agencies started out as machine bureaucracies, their information regimes seem to have shifted away less from reliance on drastic data selection and compression. They may report more complex artefacts than simple codes and numbers derived from them, such as market condition indicators, scientific test results, summary statistics or ratios of objective data. These can increasingly be gathered automatically and

objectively without using inspectorates – e.g., water flow and quality measurements across a river system, or remotely monitoring emissions from traffic flows.

Hybrid regulatory agencies that started out as professional bureaucracies may still use a lot of labour-intensive inspections, producing full text reports. A veneer of top-down command and control administrative methods is often retained here (with strong legally monitored sanctions). But in fact, a measure of professional-like discretion can be created by 'corporatist' negotiations about compliance and improvements with (most) regulatees (Nielsen, 2015). A raft of unacknowledged, informal or 'corporatist' negotiations may not often be fully recorded, unless cases are referred to prosecutors or go to court, when legal norms of 'lossless' information compression again prevail. Changing to focus on metrics capabilities has had the most profound effects on 'new' regulatory agencies, where high level statistical and macro-level reports become the dominant basis for regulatory action, enforced by small, central expert-analysis agencies, focusing on formulaic tests and KPIs (xxx, 20xx).

4. The 'lossless' uncompressed data regime in digitally changed bureaucracies

In the current phase of public sector development, a new information regime appropriate for digitally-changed bureaucracies (DCBs) is emergent, but still under construction. So, delineating it in any detail remains in part a conjectural/predictive exercise. None the less we know enough already about current trends to outline in Figure 3 a *lossless uncompressed full text* information regime, where:

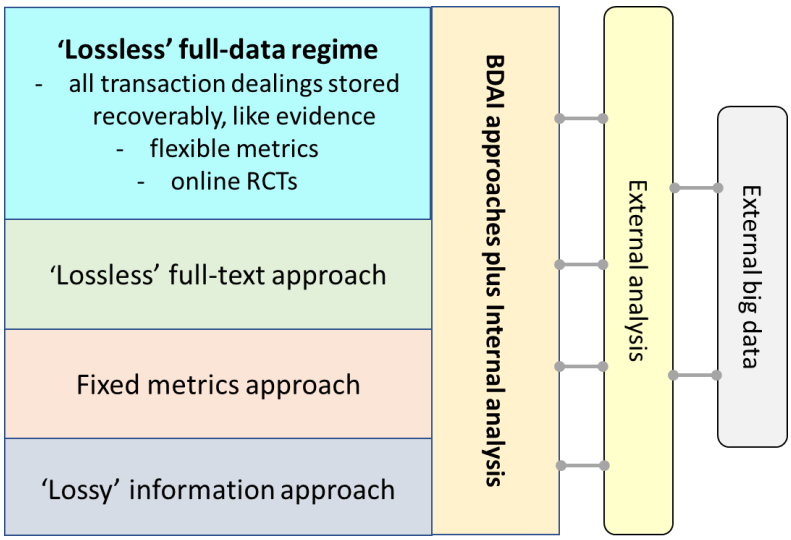
(i) initial full-content digital recording of interactions and events is achieved, stored using 'big data' (BD) capabilities, and married with artificial intelligence (AI) and data science modes of analysis in near-real time; and

(ii) other administrative data is combined with agency-owned data, and (potentially) with the private sector 'digital footprint' data of civil society actors, and mined for new insights.

This model is already well-developed in intelligence/national security and homeland security agencies, with some extensions also into the policing of organized crime, and the retrospective investigation of serious crimes. Extensive video/photo/audio full text acquisition operating via surveillance, data seizure and intensive interrogation has been legitimated for certain purposes in liberal democracies. Massive data storage and very fast,

high-capacity real-time analysis are then used to filter out the 'paydirt' connections and patterns involved.

Figure 3: The relative weights of components in the 'lossless uncompressed full text' information regime of digitally changed bureaucracies



Note: BDAI = big data/artificial intelligence

Early indications of how features (i) and (ii) above will develop suggest a radical extension of the professional bureaucracy 'lossless' compression model to now cover things like:

- Comprehensive real time audio or video recordings of bureaucracy members in action in critical contexts (e.g., police interviewing people, or a forensic doctor doing an autopsy).
- Omni-surveillance using audio and video recording (with files retained for a short period) of all *activities* carried by agency officials or personnel, on their own premises or outside in society, using CCTV, bodycams or vehicle cams. Partly police and prison service usage has grown up as a check that staff are respecting citizens civil rights . But it is also a response to increasingly pervasive citizen surveillance via smartphone cameras (Houwing and van Eck, 2020), whose immediacy can trigger strong public responses, as the 'Black Lives Matter' protest wave in the USA and globally demonstrated (xxx). (A social media storm was triggered by a smartphone recording by a teenage girl of a U.S policeman kneeling on the neck of an arrestee for 8.5 minutes, until he died). At a more mundane level, social workers' behaviours have

altered to project more responsibility for decisions onto clients themselves, who can now record interviews (xxx,20xx).

- Agencies creating massive behavioural data (that is state-owned) about civil society actors using biometric data, facial recognition, CCTV, automatic number plate recognition, and other technologies, analysable with AI in real-time.
- States gaining access to massive privately-held behavioural data, not just in a few legally regulated contexts (like law and order, homeland security and intelligence work(Brill, 2016)) , but also in emergency management – as in the tracking of millions of the constantly changing locations of people's smartphones by many national governments' Covid 19 tracking apps in 2020-21, again using AI to analyse and activate exposure warnings in real time (xx).
- The development of 'robot' apps to accomplish repetitive tasks or create new modes of interaction. E.g., public consultation exercises could use online avatars and 'conversation' bots to surface huge volumes of citizen reactions to detailed policy issues, options and choices, to create massive text files – which AI programmes then filter through for salient issues, unforeseen angles complications, and the balance and intensity of opinions (with and without 'filtering' for formulaic interest group or media lobby-speak).

In most of civil government, however, similar digital developments to dark state agencies are constrained by privacy and civil rights legislation. In liberal democracies there are many, deeply felt 'big brother' fears around state actors pooling illegitimate amounts or sources of behavioural/observational data in a privacy-destroying manner. Consequently, apart from areas where national security or criminal activities justify it, state agencies normally cannot directly hoover up or gain unrestricted access to most externally held private sector transactional data or 'digital footprint' data. Here the new information regime has generally been applied only to already-state-owned data.

Fear of government linking up its internal big data/AI information with civil society data generally means that combining such data has generally had to be implemented by arms-length researchers in academia or consultancies. Consequently, Figure 3 shows that digitally changed agencies use external analysis more extensively than any of the previous regimes in Figure 2. Governments can do policy learning from consumer interactions with private firms and platform companies, and using social media, online retail and other web/cloud-based

activities. However, this chiefly happens using outside professionals, in a different manner from intra-governmental analysis of transactional or regulatory behaviours data.

A full-data 'lossless' regime differs from the previous 'lossless' full text/narrative approach of professional bureaucracy, because the agency captures and stores all the 'big data' needed to re-create when needed a complete, recoverable set of transaction dealings or behavioural observations. Relevant metrics are found analytically, not prefixed and hard-wired in the data from the outset as in the other information regimes (Figure 1). (The difference is akin to having a full dataset of cases-by-variables, rather than having only a PDF table printout out of the data). What is known is no longer pre-fixed at the dataset-creation stage, because metrics are developed flexibly and post hoc, via exploring within the dataset, discovering new possible connections and linkages, and learning about causalities and associations. So digitally changed agencies can in principle respond more flexibly to major changes in the systems or external environments being tracked, and adapt to policy makers' changing concerns, priorities and needs.

A lossless uncompressed full text information regime also fosters the use of control-orientated, short-cut methodologies to uncover more effective methods of working, instead of chasing elusive causal understanding in very complex and ever-changing settings (Dunleavy, 2016). Big data (BD) in government is distinctive not just because of the sheer volume of transactional or behavioural data, but also because of its scalability, comprehensiveness (all-actors, census-like quality), high velocity or frequency (at a limit, renewed in real time), high granularity, amenability to indexation in multiple ways, relational qualities, low cost creation and other features (Kitchin, 2014a; 2014b). New sources of BD information feed into the expansion of in-house analysis made possible by machine learning (Anastasopoulos and Whitford, 2018; Cobbe, 2019; Wirtz et al, 2019)) and wider AI and 'algorithmic governance' capacities (National Security Commission on Artificial Intelligence, 2021; Gualdi and Cordella, 2021; OECD Observatory of Public Sector Innovation, 2019; Powell, 2021).

Combining big data and data science advances (AI and machine learning, but also conventional optimization tech) may largely avoid the previous age-old problem of policy analysis, where decision-makers were advised to wait ages to build up a complete causal understanding of citizens' or enterprises' response dynamics (even supposing this were feasible). Older information tools (like most fixed official statistics or repeated annual reactive surveys) typically meant that policy interventions always badly lagged changes in the environment, often becoming out-of-date before any analytic clarity was achieved. By contrast, running massive scale online randomized control trials allows real time comparison

of the effects of different policy 'treatments' or communication strategies (Varian, 20xx). Similarly real-time uploading of full data in local units to 'intelligent centre' monitoring expert systems has a potential to revolutionize national internal state regulation processes, just as it has in the very dissimilar global platform companies (Google, Apple, Facebook etc), and the much more similar firms in the modern logistics industry (such as, Amazon, Walmart or Occado). The use of contract-tracing apps in the Covid 19 pandemic is a large-scale example.

As with the other three information regimes in Figure 1, the lossless uncompressed data regime is not an all-or-nothing phenomenon. Digitally changed bureaucracies must still do extensive data filtering in large areas of their operations using lossless data compression, full-text recording, or reliance on multiple pre-fixed metrics (Figure 3). So how far the information regime of digital changed bureaucracies differs from earlier versions will be a matter of degree, requiring careful measurement and estimate to determine. What seems clear is that if we are to recognize a distinct information regime then lossless data acquisition and analysis must in time come to be the largest component in an agency's activity mix, or to pre-dominate in its core 'mission' roles, or both. Much of the rapidly growing literature on AI, 'algorithmic governance' and so on demonstrates that this some early techniques rapidly emerged as organizationally salient from the mid 2010s onward (Vogel et al, 2018; Engstrom et al, 2020). Yet in the current state of knowledge how important or widespread this information regime is cannot yet be easily determined.

Conclusions

Digital change essentially *de-compresses* data, with sweeping consequences across the private and public sector organizations. Technology advances have substantially alleviated previous constraints and costs that enforced the drastic selection and compression of information in line with a fixed, pre-defined task-architecture. Digitization radically increases the amounts of data that is being captured or created, and can be stored and later flexibly interrogated or re-interrogated. What follows is not fully determined, because no bureaucracy is ever 'just' like a conventional computer in its operations (as earlier 'cybernetics' texts misleadingly asserted). But every government organization is somewhat similar and must successfully tackle the information problems associated with its mission. Conventional public administration apparatuses followed one of the information regimes outlined in the top three rows of Table 1. All focused on data compression, achieved either

via ‘lossy’ data sacrificing, ‘lossless’ full text/narrative retention, or metrics-based compression. By contrast, digital changes have opened a potential for a radically different model, shown Table 1’s last row.

See Table 1 overleaf

Data held in a comprehensively-captured form from the outset creates multiple possibilities for cognitive agents (both human and artificial) to *discover* (from big data stores and using data science methods) information that was not initially foreseen as relevant. And with faster communication and analysis of more data, new control capabilities are created for real-time automation in the physical realm, as already with autonomous vehicles, drones in military uses (Chamayou, 2015) and (still mundane) robots in social care (Nielsen et al, 2016). Compared with organizations relying on earlier lossy, lossless/text, and metrics-based information regimes, there are grounds for believing that digitally changed bureaucracies will be radically different in their operations.

However, projecting from current trends must come with a prominent health warning. Digital changes will keep on working through for two decades more at least, and are likely to take many unanticipated turns in the process, as they have done in the past (Isaacson, 2014, 2015). Yet if anything, IT visionaries’ radical expectations of the organizational, political and societal effects of tech changes (Brate, 2002) have been over-fulfilled in the last three decades. Digital change could make bureaucratic organizations increasingly more flexible and diverse as information-handling mechanisms. And the weight of information processing will shift in fundamental ways, from the human/social organizational systems towards IT/robotic and wider tech-based methods. In the ‘third wave’ of digital era governance now in train, these effects may have fundamental consequences for how we understand the essential character of bureaucracies. Alternatively, they may lead only to substantial but still more incremental alterations of the three conventional information regimes. Whichever outcomes follow, using the information regime perspective to re-focus public administration ‘from institutions to technologies’ (Koopman, 2021, p.6; Pollit, 2011; Andrews 2018) and towards media formats (Beverungen et al, 2019) can be valuable in exploring the large research agenda now opened up.

Table 1: A summary table of four main information regimes in government and public service bureaucracies

Data selection, compression and reduction is achieved by	**Key logic forms used**	**Most characteristic and important artefacts**	**Information is recorded/stored/ re-accessed by**	**Most used in government services for:**	**Most associated organization forms** ***and bureau-shaping types***
'Lossy' regime. Radical pre-selection of relevant information (via legal/statute, regulation and executive actions)	Questions designed in a mini-algorithm guiding users. Answers determine service eligibility, tax liability, or regulatory relevance	- Long gated-access forms (LGAFs) for financial benefits/ transfers or services - Compulsory information forms (CIFs) for taxation and regulatory permissions	- Codes in IT systems (normal use) - Paper files (or images) in registries (back-up)	- Transactional services for/with individual units (people, households, firms,); - less often groups (e.g., NGOs, localities)	- **Machine bureaucracy (MB)**, strong Weberian form *- Transfer, taxing, some regulatory agencies*
'Lossless' full text/ narrative regime. Expert data selection, compression (and decoding again), achieved via primary occupational group expertise and culture/socialization	Comprehensive professional report that is checkable, re-interpretable and replicable by other expert professionals. Inclusiveness is important for professional quality, legal re-access or liability/insurance reasons.	- Investigation/diagnoses - Treatment records - Case histories and reports - Narrative accounts - Either verbatim or expressed in condensed specialist vocabulary - May report quantitative data on multiple standardized indices - Often linked to stored primary evidence sources	- Full text files and reports, and evidence. Often include numerical sub-data. - Frequently broad coverage, with just-in-case information on persons, context, situation, environment, alternative views/ explanations	Personal or variable services for heterogenous clients/cases and with quality-sensitive delivery	- **Professional bureaucracy (PB)**, and other non-Weberian forms, such as adhocracies *- Delivery agencies at regional/local level*

/Table continues

Table.1 continued

Data selection, compression and reduction is achieved by	**Key logic forms used**	**Most characteristic and important artefacts**	**Information is recorded/stored/ re-accessed by**	**Most used in government services for:**	**Most associated organization forms *and bureau-shaping types***
Fixed metrics regime. Complex data gathering against pre-defined template, then aggregated or made comparable for evaluations via test processes/personnel. *- Metricized versions of PB information used for national policymaking*	Pre-defined information metrics, key performance indicators, statistics, or testing/ evaluation schemas, pre-defined and set by profession	- Statistical returns (variant of CIFs) - Compulsory (or near-required) performance/ test evaluations - Exams/ test outcome scores - Inspection reports and grades - League tables - Sometimes: Metrics reports supplemented by summary text exposition.	- Certified individual grades or evaluations. permanently stored as bare numbers. - Grades sometimes backed by short text reports, stored short-term only. - Aggregated statistics and back-up data	- Statutory statistics collection. - Services delivered by 'semi-professions' with a lot of political/ legislative oversight/rule-making	- **Hybrid MB/PB bureaucracies**, especially those run by 'semi-professions' *- Control agencies, some regulatory agencies, national delivery agencies*
'Lossless ' uncompressed data regime. Omni-data capture from interactions analysed post hoc via AI as need/interest arises. Comprehensive BD acquisition and AI learning/training capabilities avoid (any) pre-fixed data limitations.	Conventional optimization methods, algorithmic analysis, machine learning, iteration, learning by doing, analysis of segments and clusters, prediction and modelling	- Big data sets - of non-reactive, behavioural data, - flexibly analysable in brief time, or near-real time	- Real, time full recording of all administrative interactions - Stored in lossless formats - Re-accessed via full-text AI search and analysed via machine learning etc.	- At present professional bureaucracies with the greatest prior stress on lossless compression, e.g., national security/ intelligence/homeland security, law and order. Widely applicable in PBs.	**- Digitally changed bureaucracies (DCBs)** - with more pluralized information regimes, dominated by BD/AI modes - making more use of analysis and of external analysis than conventional bureaucracies

Notes

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1. An anecdotal illustration of how far technology issues are still marginalized in the discipline comes from a prize-winning recent book on 'reinventing public administration for a dangerous century' (Roberts, 2019), where the words 'digital' and 'online' occur nowhere in the main text, and 'computers' or 'IT' only once or twice, in basic uses.

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