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Thinking of data protection law's subject matter as a complex adaptive system: A heuristic display

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ABSTRACT

According to both whistle blowers and public reports, some commercial and governmental practices concerning personal data do not even appear to notice the law as a regulatory force. We are not satisfied by what mainstream legal scholarship has on offer in this context. Positivists consider the issue outside their domain. Realists (including their critical branch) focus on the behavior of legal institutions, ignoring many of the diverse institutions that have regulatory force. We need an additional, complementary perspective to help us, legal scholars, earn and hold serious positions in the diverse disciplinary teams that we need to participate in, in order to adequately investigate (and inform on) persistent problems concerning personal-data protection as faced by legislators.

In this article we investigate whether the subject matter of data protection law, identified as Personal Data Community (hereinafter PDC), can be treated as a complex adaptive system (hereinafter CAS). This proposition is premised on the argument that the PDC exhibits key traits of CAS, including systemic, dynamic and complex characteristics. And we further show how complexity theory can help legal scholarship (without losing its identity) to join and add value to diverse disciplinary research and advisory teams. In this article, we aim for a stepping-stone (establishing that data protection law addresses a complex adaptive system with all of its corollaries), rather than for final solutions.

1. Introduction

On May 20th 2013, a former Central Intelligence Agency employee and former National Security Agency Contractor, Edward Joseph Snowden revealed insider information on Internet surveillance programs such as PRISM, Xkeystone and Tempora, as well as on the interception of US and European telephone meta-data.[1] Snowden's disclosure caused a great stir, and a moral panic[2] ensued. American feelings on privacy

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[1] The Snowden Wikipedia page provides a record of some important debates in America on data protection and the NSA. More information about the event is provided at http://en.wikipedia.org/wiki/Edward_Snowden#cite_note-Hill.2FPoll-333. Moreover, The Guardian, one of the first media that got access to the news, made available a timeline that describes the unfolding of the Snowden Story (see Gidda (2013)).

[2] As defined and described in Cohen (1972).

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and data protection were battered in this storm.[3] The after-effects of the event, directed against American legal practices over both data-protection and public-security issues, followed each other in quick succession. On October 29, 2013, a complete proposal for new legislation was submitted to the House Judiciary Committee. The legislative proposal aimed to end the bulk collection of American communication records and to better balance security and privacy.[4] Moreover; cases were filed to courts, with varying outcomes. In one case, US Federal Judge Richard J. Leon ruled that bulk collection of American telephone metadata likely violates the Constitution of the United States.[5] Yet in another, comparable case, Judge William Pauley ruled differently.[6] Dealing with personal data has become complex and adjudication of these dealings is no longer what we crave for in our legal systems: straightforward and simple.

Media and modern communication facilities encouraged the panic to grow and be transmitted across borders. NSA's practices caused significant discussion in Europe.[7] The reputations of European data protection institutions suffered plenty.[8] The heat produced by Snowden's revelations threatened to blemish the European legal system over data protection, which until then had freely flaunted its banners of strict and comprehensive protection.[9] Its flaw was found in practice since its institutions accomplished nothing, apart from adopting the role of witness to what has been described as "a systematic breach of people's fundamental rights."[10] As a result some future tightening of provisions in the Data protection regulation may occur, perhaps even with some impact on how the U.S.–EU differences concerning legal data protection will be handled.[11] From Asia, since Snowden's first hideout was in Hong Kong, China was inevitably dragged in. China has in the mean time warned that revelations of electronic surveillance on a huge scale by American intelligence agencies will "test developing Sino-US ties" and exacerbate their already "soured relation-ship" on cyber security.[12]

When we wrote this paper, the dust of the storm appeared to have settled a bit. Yet, data protection law was still having a hard time. Concerns on privacy had attracted people to reconsider current legal institutions.[13] Several proposals to fix the data protection laws have been inspired by the panic mentioned. These proposals, together with current data protection laws are striking illustrations of how policy makers attempt and have attempted, through laws, to tame "situations." What is to be tamed are not personal data, but people's individual and collective behaviors related to personal data. Through the lens of legal scholarship the subject matter evokes the need for several perspectives.

In this article we argue that traditional perspectives are insufficient to address these questions in (or in order to help prevent) turbulent times. We show that the complexity perspective may provide at least part of the additional insights required. We first explain why we address the possibilities of complexity theory (Section 2) and subsequently sketch the networked character of the community that is addressed by personal-data protection laws (Section 3) and name it the PDC. In order to be able to decide on the applicability of complexity theory, we first list a set of essentials that define its subject matter, complex adaptive systems (CASs, Section 4). Then we analyze the PDC, and identify it as a CAS (Section 5), our most important result. In Section 6 and Section 7 we provide some considerations for further research into the exploration of combining complexity theory and legal scholarship.

Before entering into the analysis, it is useful to clarify three issues.

First: we do not consider any individual law, treaty or institution to be our main subject matter. Instead, we look at the global cluster of personal-data users, as a whole. We consider it to be at the core of legal scientific ethos to strive for improved understanding of what legal rules and institutions will accomplish when goal-directed laws have to be designed (by the legislator) and upheld (by government agencies and the general public) while facing the possibilities of unforeseen contingencies and incomplete or false information.

[3] For instance, according to Rieder (2013) Snowden's disclosure sparked debates over finding the right balance between national security and civil liberties, while complaints were directed at Obama and his enthusiasms for security and his indifferent attitudes towards privacy and data protection. According to AFP (2013), American spy chief James Clapper stated that "some of the debate ... probably needed to happen," referring to the debate about the best way to balance spy empowerment and privacy protection. He was candid enough to suggest that security agencies had lost the citizens' trust and confidence on privacy protection issues and related care for confidentiality. And according to Neff (2014), USA TODAY and the Pew Research Center conducted a poll surveying American attitudes towards NSA's data collection practices. 1504 adults joined the poll. In July 2013, half of them supported the NSA programs. By January 2014, the percentages had dropped to 40.

[4] See Risen (2013).

[5] Klayman V Obama, Civil Action No. 13-0851 (RJL) United States District Court District of Columbia, DEC 6, 2013.

[6] American Civil Liberties et al. V James R. Clapper, et al Civil Action No. 13-3994 (WHP). United States District Court Southern District of New York. DEC 27, 2013.

[7] In Germany, the data protection commissioner expects the Federal Government to do its best to provide protection against access to citizens' data by third parties and asks the Government to aim for tougher European privacy rules that will prevent the occurrence of similar incidents Scuppert (2013). In France, the International Federation of Human Rights Leagues (Fédération Internationale des Ligues des Droits de l'Homme) and the French League for the Defence of Human Rights (Ligue Française pour la Défense des droits de l'Homme et du Citoyen), filed a motion to open a criminal investigation regarding the incidents disclosed by Snowden dDe Souza (2013).

[8] The Snowden disclosure attracted Brussels' flash points. On October 17, the EU Parliament's Committee on Civil Liberties, Justice and Home Affairs ("LIBE"), released a draft Regulation to replace the original draft prepared by the EU Commission in January 2012. The currently adopted draft aims to establish "high data protection standards" that will be enforced consistently across the EU. It is easy to establish that the new draft was influenced by the Snowden disclosure incident, since it includes a prohibition against telecommunications and Internet companies transferring data to other countries' governmental authorities unless otherwise permitted by EU law Firmer (Firmer, 2013).

[9] See Jentzsch (2003): 2 & 12.

[10] See Rettman (2013).

[11] See Hakim (2013).

[12] See Murray (2013).

[13] Previous footnotes showed that the NSA scandal does change the future of the data protection domain.

Second, for better understanding the legislators' difficulties in regulating the behaviors in the global, multi-level and multi-niche cluster of networked personal-data devouring and producing individuals and institutions, we need a systemic perspective that relates responsible individuals with the communities they co-evolve with. An important concept therefore is 'system' in general (as complex adaptive systems form a species). Of course there are many definitions. We opt for a combination of the insights of Meadows[14] who considers a system to be

> *[…] a set of things – people, cells, molecules, or whatever – interconnected in such a way that they produce their own pattern of behavior over time. The system may be buffeted, constricted, triggered, or driven by outside forces. But the system's response to these forces is characteristic of itself […]*

and Holland,[15] who additionally requires of systems that they have boundaries that concurrently identify the system and are selectively permeable to signals (or signaling substances). We will use the term 'community' to refer to a system, whose units are formed by responsible individuals that share a common goal or interest. Of course, systems may interact and or overlap, which complicates things.

Third, because complexity theory is itself rather new, incomplete and spanning a diversity of disciplines, our efforts to understand its uses for legal scholarship and informed legislation are by necessity explorative and incomplete.

2. Why complexity theory?

We have worked together on a project for several years, investigating what scholarly legal arguments can inform the Chinese legislator about the pros cons of importing EU data protection law. In the Ph.D. research,[16] we found that and there are some constraints on the efficacy of data protection laws imposed by the "thing" it tries to govern, by its internal and external networked structures and by the environment the "thing" operates in. At the root of the constraints are the interconnectedness and the reciprocal dependencies of the "thing's" constituting elements. And the network of Chinese data protection law subjects is interconnected with the European subjects (They are in fact globally connected and form the PDC). Some may see this as a mess. Yet, it prompts us to start our line of argument by justifying our attempt to tally complexity thinking with the traditional legal approaches. Complexity thinking is especially useful when considering regulation by law. It appears to be welcome in Goldberg's inclusive pragmatism, which (we tend to think) embraces both positivist and realist reasoning, and keeps an open mind to recognize complexity:

> *Of course, the brass-tacks pragmatist will be inclined to equate antireductionism with soft mindedness. But this judgment is itself a manifestation of the narrowness of brass-tacks pragmatism. What reason is there to equate the recognition of complexity with the rejection of critical thinking?*[17]

Encountering such submissions as cited above ignited our ambition to continue on the path Zhang's Ph.D. had laid bare, and to reiterate and improve our analysis – hence our methodology is heuristic as mentioned in the title.

2.1. When mainstream perspectives fall short

As our contribution does not focus on legal theory *per se*, we establish a context to our story by introducing our position and basic reasoning in broad and well-known strokes. We mention two mainstream perspectives, legal positivism and legal realism.

2.1.1. The positivist perspective

From one perspective, looking through the pure legal positivist lens, the subject matter of law is completely shaped by validly promulgated law. As Marmor postulates:

> *Positivists… have argued that what is law is determined only by the institutional facts internal to a legal system, facts that may or may not meet moral standards […] According to positivism, law is a matter of what has been posited (ordered, decided, practiced, tolerated, etc.)*[18]

Consequently, the positivist perspective tends to support the notion that positive law represents an intrinsic value. As a result, the main techniques and methods of the legal positivist are concerned with interpretation, with finding objective ways to establish what a law means in a specific situation. We need the positivist perspective to establish what an individual case means under valid material law. Thus, positivism is related to an engineering attitude. It is about understanding available canonical knowledge in a specific, individual setting.

Positivism has nothing to say about the quality of established law, or, rather, it has only to say something about the quality of established laws when such content has managed to get accepted in the law in the books. It then often employs rather elusive concepts. Western highlights of this kind are the requirements of 'the separation of powers,' the 'Rule of Law,' 'Rechtstaat,' the 'equality of arms' and 'human dignity.'

A fine example of legal research that analyses the positivist perspective can be found in Bobbitt (1982). We do not doubt that the positivist perspective provides excellent and useful results. Still, its domain is not complete. Not all (future) situations can be interpreted in terms of (previously promulgated) existing laws. There may emerge white spaces on the positivist's legal map. Then, the law is incomplete and the positivist perspective becomes stale.

2.1.2. The realist perspective

At the other extreme, forces from outside the law are seen as decisive influences in shaping the law's subject matter, resulting in the pure legal realist position. As Marmor postulates:

[14] Meadows (2008): 2.
[15] Holland (2012).
[16] Zhang (2014).
[17] Goldberg (2012): 1651.
[18] Marmor (2011).

> *The school of legal realism [...] took up the idea that social forces outside the law are central in determining what the law is. Realists opposed traditional 'formalist' accounts of adjudication, where judges are understood to rely on uniquely and distinctively legal materials in rendering their judgments.*[19]

The realist perspective is descriptive and apt to employ the methods of the empirical social sciences. Its main purpose is to support predictability of legal consequences, to support decision making in the face of expectations about how legal institutions will operate. Its focus on legal institutions makes the realist perspective incomplete, for legal institutions are not alone – there are more regulatory forces. And it is important to understand how the combination of heterogenous regulatory forces works out (This perspective will be served by additionally adopting the complexity perspective in legal scholarship.)

2.1.3. *Positivism and realism for order and predictability*

Both positivism and realism have long been strongly advocated, they still are, often in an exclusive manner, by competing schools of legal thought. Combining the two perspectives (as we will do in what follows) may thus be considered unorthodox. We find, however, that the perspectives provide complementary insights. We submit that the positivist perspective is of dominant importance for legal professionals (e.g., when representing clients and adjudicating in court cases), while the realist perspective is of dominant importance to law subjects (e.g., when estimating the legal risks of behavioral choices). The positivist perspective yields – crudely stated – a description of what a legal professional ought to do and the realist perspective provides a description of what a 'bad man'[20] will or will not accept to be sufficient reason to be deterred from a behavioral option. Both perspectives are concurrently useful to describe and understand legal arrangements and their efficacies to a large extent.[21] They allow for both deontological (or categorical) and consequential (or utilitarian) argument.

Thus both extreme and seemingly contradictory perspectives share a common fundamental assumption. They contribute to that "a certain level of predictability and order exists in the world."[22] However, dynamic circumstances embedding data protection law's subject matter are not simple and may make rational behavioral choices difficult to achieve. The circumstances may follow from, particularly, the dynamics in technologies, in infrastructures, in business models for the use of personal data – in other words: from the accelerating series of technological innovations that support widely divergent and highly versatile networked business models (like of social media users and -providers, of Google Inc., of the NSA, etc.).[23]

2.2. *Intuitive links with complexity and its theory*

Nevertheless, we wanted to follow up this problem and decided to investigate whether non-legal approaches could make a breakthrough, offering greater fidelity to the relationships between data protection law and its subject matter. So, we widened our scope and read several works on institutional economics,[24] on CASs,[25] on models and modeling[26] and so on. This literature prompted us to investigate what looking through a CAS lens would yield.

Our primary justification for the inclusion of the CAS perspective is that reliance on the traditional legal analysis approaches has led to a truncated understanding of data protection law's subject matter. Considering the fact that the law is mostly drafted or amended *post factum*, i.e. after a certain event has taken place or problem has become observable, we expect that this has become a "persistent problem" (and thus: a fact that is open to be addressed) as the response time of traditional democratic decision-making is steadily outpaced by the social dynamics following technical innovations in the areas of both social media and proactive policing.

As far as we know, few jurisdictions[27] are able to accommodate their data protection law to the dynamics that its subject matter exhibits, other than by binding itself in the half-blind, to preconceived stories about the unpredictable. And as far as we know, few data protection laws avoid to get stuck in the ambition that the law must be general, certain and predictable, even when its subject matter is special, dynamic and unpredictable. We consider the unpredictable dynamics of massive personal-data use in the commercially oriented web of interconnected and continually innovating internet-based services (both commercial and for public security[28]) to be a possible "pathology" to any legal regulatory endeavor that relies on the two mainstream perspectives mentioned above. In other words, the limits of mainstream scholarly data protection responses to the dynamic characteristics of its subject matter are being felt, and stridently so, when adaptations to innovations in society are required and we concurrently do not yet know how these innovations will turn out socially.[29] These are at least some of the reasons why they continuously remain failures to find stable legal formulae for the control of legitimate personal-data use.

Of course, the legal provisions on the more technical aspects on data protection could be tuned. However, the future will present new puzzles. For instance when a trend emerges – as we are sure that has emerged by now – wherein the intelligence and policing services (with their distinct legal competencies) start making agreements with each other (even across jurisdictions) on personal data sharing and both

[19] Marmor (2011).
[20] Wendell Holmes (1897).
[21] Both of these seem necessary to a well-informed legislator, yet – so we claim – they are not sufficient to inform the legislator adequately.
[22] See Snowden and Boone (2007): 68.
[23] In another paper by Kunbei Zhang, "Incomplete Data Protection Law", which has been published in the October issue of the German Law Journal (2014), the dynamics of technology and its influences on the effectiveness of the law are analyzed in further details.
[24] E.g., Hirshleifer (1980).
[25] E.g., Mitchell (2009).
[26] E.g., Miller and Page (2007) and Page (2010).
[27] Or none at all.
[28] Of course, the circumstance that terrorist risks increase in probability and in frequency does make the intelligence departments seek access to commercially generated collections of "big data". This does not simplify matters.
[29] These would mark the areas that Lawrence Lessig called areas of inherent ambiguity Lessig (2006).

services mentioned adopt completely new scenarios for cooperating on the same subject with big private players like Google, Baidu, Facebook and RenRen.

We gained the impression that the CAS framework could help bridge the gaps between data protection law and its subject matter – the gaps that were left wide open by positivist and realist considerations. In order to explore an approach to this "mess", we widened our scope to other multidisciplinary academic networks that also try to "domesticate" a dynamic, interconnected and co-evolving system.[30] Contrary to what seems intuitive, improved understanding of the workings and dynamics of such complex configurations is not impossible. This has become focal to a few multidisciplinary academic networks. The scientific perspective that emerged in these institutions is often referred to as complexity theory, or simply 'complexity', and participants often work on problems that, for a solution, not only seem to require a diverse bunch of science (often to be derived from personal data), but also seem to require well founded and coordinated guidance by the law (like economic "bubbles," pandemics, global warming, urbanization, excessive wealth/income inequality or waging wars).

It was (and still is) our intuition, that these Big International Problems are persistent and capricious because they are complex adaptive systems.

2.3. *Weather forecasting as an example*

When we consider the weather as a problem, much of our hope is in improving our understanding of it and in improving what we can do to prepare for making the best of both the good times and the storms.

For forty years now, every decade has yielded a lengthening of reliable forecasts with one day. We will never be able to solve the problems inherent in weather forecasting, yet we have lengthened the time to prepare for most weather excesses by almost a week. This strange phenomenon of knowing that there is no definitive solution, but that we can successfully aim for understanding that will support partial prediction has co-evolved with complexity theory.

In 1960, Edward Lorenz studied the solutions to equations describing and predicting the weather. The American physicist realized that a weather system exhibits behavioral patterns that are radically different from what had up to then been studied as systems. He found that the weather couldn't be predicted accurately even if everything in the system is causally connected in a deterministic way (Chan (2001): 4). Lorenz's exploration was triggered by computing limitations, leading to the discovery of particular prediction models (coarsely speaking: where the current state of a system influences tomorrow's state) that is extremely dependent on initial conditions – even when everything else is deterministically known. Lorenz's discoveries (and his famous question: "Does the flap of a butterfly's wings in Brazil set off a tornado in Texas?") sparked of a wide interest in Chaos theory, which is mainly mathematical. The application of chaos theory, its empirical sibling as it were, has, together with many other notions and models (we mention some in the next Section) become complexity science.

Along with computer science's development, weather forecasting as a practice has evolved, employing the findings of complexity theory while adding to its corpus. Even though long-term prediction is not possible in our weather system, computer simulation, which is an important analysis tool of CAS theory, is applied to perform probabilistic forecasting. Through combining thousands of forecasts based on slightly varied initial states, possibilities, simulation could present the most probable scenario and risk associated with it.

We are impressed by what has been gained in weather forecasting since the current state of data protection law's subject matter may be unpredictable too: tiny disturbances can produce exponentially divergent behavior, in the weather (Chan (2001)), but perhaps also in data protection.[31] The similarities are striking and need not be coincidental. Because unreliable weather forecast and unpredictable data protection situations could be different branches of the same network family tree, where initial states are difficult to know precisely and where the dynamics of the systems involved are heavily dependent on these. We have witnessed that understanding weather dynamics has gained lessons with the aid of CAS theory. We expect that CAS theory can help us to better understand the dynamics of the PDC and that it can eventually help us to better design and enforce personal-data protection regulation.

It is in that spirit that we submit that complexity theory matters and that we recommend policymakers and legislators to take complexity theory serious.

2.4. *CAS and its theory: a crude look at the whole*

What are CAS and its theory?[32] As the term suggests, CAS-theory is the collection of conceptual models built for understanding CASs and their dynamics. According to Mitchell, a CAS is a system in which large networks of diverse components with simple rules of operation operate, a system without central control, a system that gives rise to complex collective behavior, a system that is capable of sophisticated information processing, a system that is capable of adaptation via learning or evolution.[33]

[30] As for instance initiated at the Santa Fe Institute (SFI), the Edge Foundation, and the Michigan University Institute for Complex Sciences, The Institute for New Economic Thinking (INET) and the Nanying University Institute for Complexity. To us it appears a missed opportunity that legal scholars do not (or hardly) seem to belong and/or take part.

[31] Viz., the Snowden panic mentioned earlier.

[32] We are not attempting to give a deep review of complexity science or CAS-theory. Neither do we attempt to make a systematic analysis of the feasibility of applying CAS-theory to the data protection field. Research sources are gathered from the literature, which need not be related to the law, as current legal scholarship has not made many efforts to investigate CAS-theory potential for understanding hard questions in their domain. To a large part the books and articles on CAS-theory that do related to law are included, but we also use some of the others that write about the general characteristics of CASs.

[33] Mitchell (2009): 13.

CASs clearly is a subset of what Meadows and Holland define to be a system.[34] Any system, which is identified as a CAS, is (according to John H. Holland).

... a dynamic network of many units (which may represent cells, species, individuals, firms, nations) acting in parallel, constantly acting and reacting to what the other units are doing. The control of a CAS tends to be highly dispersed and decentralized. If there is to be any coherent behavior in the system, it has to arise from competition and cooperation among the units themselves. The overall behavior of the system is the result of a huge number of decisions made every moment by many individual units.[35]

These definitions feed our intuition that CAS theory will arguably do a better job of describing and clarifying the gaps between the dynamics of laws and of its subject matter than traditional legal theory will. First, any observed agent or institution is dynamic in the CAS perspective. This echoes what we have witnessed in the data protection field. And the dynamic nature, as we clarified in Section 2.1, is also a key challenge that the traditional legal theories fail to handle well.

Second, CASs appears to be and to form interconnected networks. A network node's change can have an effect that ripples through the whole network. We have witnessed in the Snowden event that the proverbial flap of a butterfly's wing in America (Snowden's revelation) generated a global hurricane around privacy and data protection. We might feel baffled, why a local event can cause such global hurricanes and why such a large amount of countries, companies, departments and people (which can be collectively named as "agents") get involved. CAS theory suggests that data protection law's subject matter is interlinked in a network, composed by (and behaving through) communication interconnections between the agents involved. And this suggested to us that CAS-theory might provide the concepts and the models needed for improved comprehension of the Snowden panic and of the related efficacies of personal data protection laws and its institutions.

We also witnessed in the Snowden event that the resulting damage was wide and deep, but that the immediate cause, with hindsight, proved to be rather accidental. An intuitive and apparently plausible reason is in the thought that if Snowden had not tipped off the NSA scandal, that then data protection law would have not been dealt such a crushing blow. However, from a CAS perspective, the Snowden event can be considered the signal that we have become close to a "tipping point" heralding a "critical transition" of the system, that is then considered to approach "the edge of chaos." Although these concepts can them easily transform into hypes, they remain central to the more serious forms of complexity theory.[36]

An interesting characteristic of complexity theory is that it does provide us with a stochastic foundation for expecting when small incidents have huge effects in a network: the size of resulting occurrences form a power-law distribution (instead of a normal distributions as is often intuitively considered to be universally applicable).[37] Physicist Per Bak discusses a classic example to illustrate how tipping points relate to power laws:

We are to picture a table. Above, rather like the hand of God outstretched toward Adam's on the ceiling of the Sistine Chapel, a hand is poised, holding sand. Sand slips persistently from the hand onto the table, piling higher and higher until the heap of sand slides in avalanches from the top of the table onto a distant floor.

Piling higher, then reaching its rest angle, the sand pile achieves a rough stationary state. As the sand is trickled onto the pile, many small sand-slides avalanche down the sides, and a few large sand-slides [...] we have noted before, if one plots these avalanches, one finds our [...] power-law distribution.[38]

From the CAS perspective, Snowden's revelation may well have been "the straw that broke the camel's back" rather than the chief culprit. The global hurricane occurred as the result of an accumulation of stimuli, both big and small, on data protection law, just as the accumulated weight of many sand grains precipitates large avalanches, every now and then. Repeated waves of scandals about abusing the right to personal-data protection have followed one by one. For instance, the passengers name record debate in 2004, the SWIFT case in 2006, the more recent Facebook audit, Google- and iPhone cases. All came in rapid succession, and revealed that the legal system was losing control over personal data use. So the Snowden revelation in 2013 may well have been the final "sand grain" falling on the "pile of data protection" inducing a full-fledged avalanche. Data protection laws have long been under stress. And people's confidences in data protection laws had been badly shaken before and consistently so. Seeking for specific causes for the data protection crisis to be hidden in the Snowden case might well be an exercise in futility.

Considering these findings, CAS theory seems to be able to do a substantial job, filling in the gaps that remain. Thus, we decided to investigate the possible fertility of the only additional, radically non-traditional and radically multi-disciplinary perspective that we think may fit the bill: Complex Adaptive System theory, or CAS theory.[39]

[34] See our remarks on the issue in the Introduction.

[35] Holland, who is one of the founders of the field of genetic algorithms and who is one of the pioneers of the new science of complexity, provided this characterization. The quotation is from Greer (2009) at page 12. See also: Holland (1995).

[36] See, for instance, Scheffer (2009).

[37] This has huge consequences for the behavior of CASs that consist of nodes, connected in a so-called small-world network (see for instance Watts and Strogatz (1998) and Barabási and Albert (1999) for further details). For instance the forces with which earthquakes, scientific referencing and the unfolding of epidemics tend to occur do all fit in power-law distributions.

[38] Kauffman (1996): 129.

[39] The Santa Fe Institute has, since its founding in 1984, been working on CAS theory. On its website (http://www.santafe.edu/about/faq/) it explains what complex system research is about: "Complex systems research attempts to uncover and understand the deep commonalities that link artificial, human, and natural systems. By their very nature, these problems transcend any particular field; for example, if we understand the fundamental principles of organization, we will gain insight into the functioning of such systems as cells in biology, markets and firms in economics, and phase transitions in physics and human social systems. This research relies on theories and tools from across the sciences.

2.5. CAS theory and legal scholarship

We believe that CAS theory can open a few windows for legal scholarship, by offering an additional perspective that allows combining forces with the natural sciences, the social sciences and the humanities. Although CAS-theory gained more attention from the natural sciences, and from mathematics and computer science (see, e.g., Mitchell (2009), Newman (2011) and Holland (2012)), it has also become attractive to and has been applied in the social sciences (see, e.g., Anderson (1999), Beinhocker (2006) and Pagel (2012)).

In the legal world, there are several efforts of employing CAS theory for looking at the law/legal systems themselves and sometimes also at their subject matter.[40] Mostly, these efforts offer completely fresh information to legislators and researchers.

For example, Tussey has done a survey of the music industry from the perspective of complexity science, combined with organizational theory.[41] In her paper, Tussey issues a compelling invitation to look at (and understand) the music industry as a CAS, in which "legal, political, economic, sociocultural, and technological subsystems converge, interact, and coevolve." (Tussey (2005): 149)[42]

Ruhl, who introduced CAS-theory into the legal field, provides another example. He wrote several papers about the application of CAS theory to the legal system.[43] In "*Thinking of environmental law as a complex adaptive system: how to clean up the environment by making a mess of environmental law*," Ruhl adopted CAS-theory to analyze environmental law and all the issues around and inside it. Ruhl found that, not only environmental law, but also the subject matters of environmental law such as ecosystems, technology, economies and land use arrangements are all CASs and share CAS-characteristics. Based on these findings, Ruhl criticized environmental law's methods as reductionist, linear and predictivist, ignoring the underlying CAS characteristics. Ruhl thereby suggested that to manage the impact of human society in the inherently chaotic, adaptive environment, the environmental-law system itself must adopt and possess dynamic qualities.[44]

The works by Tussey and by Ruhl show us that the "marriage" between CAS-theory and legal research is possible and can bear fruit. Yet, the possibilities of what CAS theory can offer to legal scholarship are by no means exhausted yet. What CAS theory can offer to legal scholarship is immense, we submit, yet it is hardly on the discipline's agenda.

3. Data protection law's subject matter: the Personal Data Community

As a starting point, we are going to describe the data protection law's subject matter as a human-created system within which all sorts of data users either cooperate or compete with specific references to personal data.[45] For the connivance of our following analysis, we tag the system as "Personal Data Community" (PDC).

For obvious reasons we will focus on data protection law as the control system of the PDC, although we believe that there are other control systems, such as technology, culture, the economy and the environment. For the moment we conceptually separate the law (and the other control systems) from the PDC, and imagine them all as its environment. The reason is that we want to be able to "theorize" about the relationship between data protection law and its subject matter, which may easily become too complicated when the latter is regarded to be part of the former.[46]

We take it that the term community refers to any social network with shared common values.[47] Community in PDC

[40] As exemplified by, e.g., Jones (2008) (considering the implications of networks, complex systems, and nonlinear dynamics to the future of the law), Holz (2007) (applying CAS theory to judicial decision making), Katz et al. (2008) (identifying the conditions under which network effects are present in the development of the common law), Post and Eisen (2000) (on the fractal nature of law), Bloche (2008) (discussing USA health care law with its resulting implementation as an emerging CAS), Tribe (1989) (shedding light on the character and structure of constitutional analysis as a process), Axelrod (1986) (investigating the emergence and stability of behavioral norms in the context of a game played by people of limited rationality), Picker (1997) (uncovering the boundaries of legal rules and defining their proper limits have traditionally vexed students of the law).

[41] Tussey (2005).

[42] According to her analysis, digitization and global networking can be considered as disruptive perturbations of the music industry as a system, that thus shows a typical CAS characteristic. The main challenge that the music industry is confronted with is how to respond evolutionarily to the new environment. Tussey's prediction, based on CAS-theory, is not as pessimistic as many others. Instead, the music industry which is a polygonal, multilevel, evolving, dynamic system, is adapting successfully to the digital environment and there is hardly any need to worry about its survival, she observes. Tussey predicts that "new models of information creation and dissemination will naturally emerge over time from the millions of individual interactions among users and providers of content and digital technologies, for instance the emergence of the P2P file sharing is the outcome the interactions. The P2P technology has fed back into the music system and has produced emergent responses in the form of new online business models" Tussey (2005) at 149–150.

[43] For instance to the co-evolution of law and society and its practical meaning for democracy, administrative law, environmental law, European justice and so on See Ruhl (1996a); Ruhl (1996b); Ruhl (2008); Ruhl (1997); Ruhl and Ruhl (1997), Ruhl (2009); Ruhl (2005); Ruhl et al. (2007).

[44] See Ruhl (1997).

[45] Systems could occur, either by nature, such as ecosystem (Levin (1998)) or earth (Steffen et al. (2006)), or by human design, such as music system (Tussey (2005)), international environmental law systems (Kim and Mackey (2013); Ruhl (1997)).

[46] The current orthodoxy in the CAS in Law studies is that law exhibits some key characteristics akin to its subject matter. That is: both the legal system and its subject matter can be considered complex. We think this to be true, yet we also think that the relationships between the two may easily become confusing. In this article, we focus on better understanding complex subject matter and on how it relates to the law (that we imagine – for the analysis, applying the ceteris paribus mechanism – to be static).

[47] According to Wikipedia, Community includes two distinct meanings: Community can refer to a usually small, social unit of any size that shares common values. The term can also refer to the national community or inter-national community, and 2) in biology, a community is a group of interacting living organisms sharing a populated environment (Wikipedia (2010)) Community in this paper took the first one.

follows this definition. It provides an analogy that can serve as a tool for understanding data protection law's subject matter as a system: the PDC is the community that is constituted by all connected data users that share an interest in using personal data. The network is the system. Thus, by imagining the PDC as a system we pave the way for discussing it as a unit, as a single object.

Below, we draw a figure to help imagine what this object looks like. Herewith, we followed Lessig's lead[48] and represent the PDC/system as a dot. Fig. 1 shows what the PDC/dot looks like in isolation.

But the PDC is not as simple as it appears to be in Fig. 1. In the initial conceptualization, all data users, both individual and institutional ones, together constitute the PDC. These (sub) units are not visible in the dot. Nevertheless, these sub-units include individuals such as data subjects and individual data users, but also data using organizations such as banks, governments, social groups (e.g. hacker groups), big or small companies (e.g. Google, Facebook, twitter, RenRen) and other data-using stakeholders, as long as they are represented by an autonomous and responsible agent, as long as they are nodes in the network and as long as they share an interest in the use of personal data.

The PDC has many sub-systems, for example: European and Chinese (based on both cultural and territorial criteria). These sub-systems are PDCs themselves. There are PDCs in the banking industry, PDCs in the Social Networking Services industry, PDCs in Security/anti-terrorism systems and so on. Further, as the social networking PDC shows, autonomous, responsible agents can be personal-data users as well as personal-data subjects.[49] Moreover, units that may concurrently take part in several sub-systems constitute PDCs. We sketch an example in Fig. 2 to show the internal structure of the PDC.

Prior to discussing the PDC as a CAS, it is necessary to stress that the PDC, as discussed here, is a web of webs (a network of networks, a PDC of PDCs) with personal data users at its nodes, users that are responsible for the instruments employed for storing these data locally, and that are responsible for the local mechanisms that import, process and export such data over its edges or links.

When we assume as a working hypothesis that data protection laws constitute the main control system for the internal and the external behavior of the PDC and its sub-PDCs, we can already now postulate that it will be really important to try and understand how PDCs are formed from sub-PDCs (emergence) and how sub-PDCs are formed by other sub-PDCs (reproduction). And how PDCs influence their sub-PDCs and *vice-versa*.

And what the law has to do with it, and the other non-legal regulatory forces, as in our current story this has not yet been touched upon. Before doing that we discuss complex adaptive systems in general.

Fig. 1 – The PDC-"dot" to be regulated.

4. A framework of CAS essentials

Before explaining the PDC from a CAS perspective in greater detail, we turn to a brief overview about CAS essentials.

4.1. *CAS theory's emergence*

Philip Anderson published his extensively cited *More is Different* in 1972.[50] It is widely considered to have provided a cradle for CAS theory. Although CAS theory began to seriously surface in the 1980s, it took another decade for the activities in the Santa Fe Institute to begin and crystallize into a niche theory and research approach. The Santa Fe Institute, which is the dominant contributor to the field, was founded in 1984 by a group of physicists, economists, and others interested in studying complex systems in which the agents of those systems change.[51] In 1994, John Holland gave a famous presentation titled 'Hidden Order' and subsequently published a book under that name.[52] In the book, he offered a comprehensive picture of CAS theory as it was at the time. Thereafter, CAS theory began to stand out as a new and productive paradigm for multi-disciplinary work. Nevertheless, its main

[48] We follow Lessig's representation of an agent that is regulated in a regulatory field as a dot (Lessig (2006) at 122).

[49] For instance, in the social networking world: "Person A may comment about what person B did in school that day, while person C reads the post but says nothing. Person D may post a photo from dinner about person E that gets a thumb up from person F. On these facts, there are no distinct "users" or "data subjects" (Swire (2012): 1410).

[50] Anderson (1972).

[51] Brownlee et al. (2007).

[52] Holland (1995).

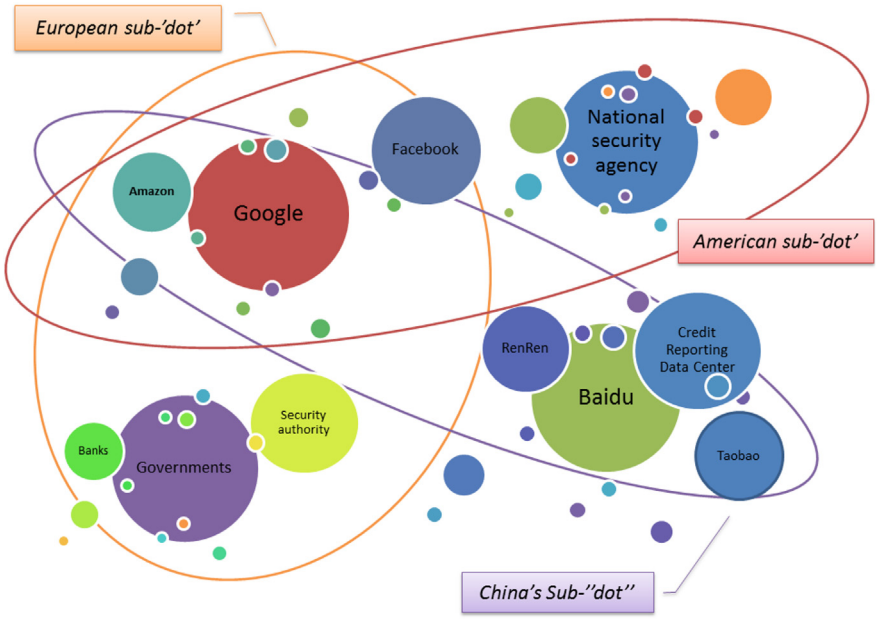

Fig. 2 – Dots (like the PDC) have internal structure.

contributions took many years to be digested and received by researchers in many fields. In the past decades, multiple subject matter domains have been re-observed through the lens of CAS theory. Its subject matters are across the whole spectrum of the universe, including systems of sub-atomic particles, protein systems, eukaryotic cells (and systems of such cells),

- Weather systems,[53]
- Immune systems,[54]
- Ant colonies[55] and
- Other social systems, such as the global macroeconomic networks within a country or group of countries,[56]
- Language,[57]

[53] Chan explained that weather is a complex system, which is fundamentally unpredictable. Very small changes in initial conditions in the weather system can lead to unpredictable consequences, even if everything in the system is causally connected in a deterministic way. The current state of the weather is no predictor of what it will be in a couple of day's time because tiny disturbances can produce exponentially divergent behavior, See Chan (2001).

[54] Grilo thought immune systems, ecological systems as well as many others, are difficult to control or describe using traditional computational methods. Two main difficulties are ensured when modeling such a system. The first problem arises from nonlinear interactions among system components. The second is issued when system's units can evolve, or change their specification over time. Systems with these properties are sometimes called Complex Adaptive Systems. See Grilo et al. (2002).

[55] Ant colony is a canonical example of a complex adaptive system. In this system, each individual ant has a decision role. Each one also interacts with the other ants. A lot of that is local interaction. What emerges from their behavior is an ant colony. See, Kay and Schneider (1995) Also see "An interview with Michael J. Mauboussin by Tim Sullivan," in Harvard Business Review, Embracing Complexity, through the following link: http://hbr.org/2011/09/embracing-complexity/.

[56] In "Unit-based computational economics: modeling economies as complex adaptive systems", the paper outlines the main objectives and defining characteristics of the unit-based computational economics methodology which is identified as evolving systems of autonomous interacting units (See Tesfatsion (2003)). In, "From simplistic to complex systems in economics," Foster applies CAS theory to economics and tries to evaluate and compare it with standard approaches, which are based on constrained optimization. Foster recommended that the prevailing simplistic theories, based in constrained optimization, can better be replaced by 'simple' theories, derived from net-work representations in which value is created through the establishment of new connections between elements (See Foster (2005)). In another paper, "Why is economics not a complex systems science?" Foster even discussed why a complex system perspective couldn't develop in the mainstream of economics (See Foster (2006)). In "Rethinking the financial network", Haldane adopted network theory and other evidence to explain the emergence of two characteristics of the financial network over the past decade complexity and homogeneity. And he provided his diagnose of the troubles of the financial network when under economic crisis at the time. Haldane's diagnose was based on CAS theory (See Haldane (2009)).

[57] In "Language as a complex adaptive system: co-evolution of language and of the language acquisition device", Briscoe suggested that the reciprocal evolution of language learning procedures and of language creates a co-evolutionary dynamic (See Briscoe (1998)). In "Language is a complex adaptive system: Position paper", authors re-shaped language to be a CAS. And they have every features, a CAS should have. Their approach reveals commonalities in many areas of language research, including first and second language acquisition, historical linguistics, psycholinguistics, language evolution and computational modeling (See Beckner et al. (2009)).

- Organizations[58] and
- Cyberspace.[59]

CAS theory has emerged, developed and grown up around the study of such different systems.

4.2. CAS characteristics

Contrary to the conventional way of thinking about systems (as having equilibrium searching mechanisms and dynamics), CASs show a few key features not always acceptable to conventional approaches. We have to choose, for even in the CAS-theory communities there does not exist real consensus on the comprehensive set of characteristics that define a CAS. We think that it is possible to harvest a useful framework with CAS characteristics from Maguire's literatures "Complexity Science and Organization Studies".[60]

We summarize the characteristics that we harvested in Table 1. The table concurrently summarizes the elements in the framework that we use to decide whether a system is a CAS (or not) and to indicate what CAS-theory may have to offer to whom and under what conditions.

The three main characteristics concern being systemic (being a whole, aggregating agents or parts that operate, and may be aggregates themselves etc.), dynamics (changing over time, by learning and/or evolution) and complexity (showing emergent, aggregate behavior that is without central control and resists to being modeled with linear math). In the next Section we discuss why the PDC has these characteristics.

5. Understanding the PDC as a CAS

In this Section we discuss how the PDC shows the characteristics of CASs and how this awareness may be useful to legal scholarship. Each of the characteristics mentioned in Table 1 is discussed in a Subsection below. There we first highlight the characteristic in the light of one or more of the example CASs mentioned earlier and subsequently argue why the PDC has the characteristic too and why this is useful for legal scholarship.[61]

5.1. CASs are systemic – so is the PDC

According to Merriam-Webster's Collegiate Dictionary, generally, a system is "a regularly interacting or interdependent group of items forming a unified whole: as a gravitational system, thermodynamic system, digestive system, river system, a computer system, capitalist system."[62] A CAS is also a system following this definition, but much more complicated.

This type of system description considers identity, invariants and stable interactions in equilibrium to be focal. This is a manner of looking at the world that clearly helps us understand. One might even stipulate that we need such descriptions to support our comprehension by temporarily fixing a moving world into a series of snapshots of which we analyze the elements. This approach is so successful, that we tend to reverse the argument and assume the world to be in a state of equilibrium (or to be working towards such a state). But this would be ill advised, as our discussion of the dynamic and complex characteristics of CASs shows.

When looking with the ambition to describe what CASs are, we identified the systemic requirements for being a CAS to include being a whole, networked aggregation of diverse agents, that signal, that operate simple rules, that may be CASs themselves.

5.1.1. Any CAS is a whole

To be able to consider something to be a CAS, it must have identity; it must be possible to consider the thing to have a boundary and some internal coherence. We think that immune systems, ant colonies, economies, languages, organizations and cyberspace do not need additional evidence for establishing their capacity to have boundaries.

Local weather systems are not self-evidently wholes with an identity. Yet, this may be accommodated in several ways. One of them would be to consider a weather system to equal an atmospheric domain that has an isobar (a line connecting points of equal pressure) as its boundary. Within such a

[58] In "Organizations as complex adaptive systems: Implications of complexity theory for leadership research", Schneider and colleagues presented leadership in a Complex Adaptive System (CAS) may affect the organization indirectly, through the mediating variables of organizational identity and social movements (See Schneider and Somers (2006)). In "Health care organizations as complex adaptive systems" by Begun, Brenda and Dooley, the authors identified a series of key differences between complexity science and established theoretical approaches to studying health organizations. They found that complexity theory can broaden and deepen the scope of inquiry into health care organizations, and that it can expand corresponding methods of research, and that it increases the ability of other theories to generate valid research on complex organizational forms (See: Begun et al. (2003)).

[59] Phister thinks cyberspace has exhibited the traits of a CAS, since networks and information systems that are being constructed today are complicated. Integrating these networks together into a global Internet yields an extremely complicated environment (See: Paul (2010)). Andrus pointed out that the rapidly changing circumstances in which intelligence communities operate take on lives of their own that are difficult or impossible to anticipate or predict. The only way to meet the continuously unpredictable challenges ahead of us is to match them with changes of our own. We must transform into a community that dynamically reinvents itself by continuously learning and adapting as the national security environments change (See Andrus (2005)).

[60] In this book, CAS is featured by 1) consisting of a large number of elements; 2) that elements interact dynamically; 3) that interactions are rich, any element in the system can influence or be influenced by any other; 4) that interactions are nonlinear; 5) that interactions are typically short-range; 6) that there are positive and negative feedback loops of interaction; 7) that they are open systems; 8) that they operate under conditions far from equilibrium; 9) that they have (and their behavior in influence by their) histories; 10) that individual elements are typically ignorant of the behavior of the whole system in which they are embedded (See Maguire et al. (2006) at page 166).

[61] We hesitate to use 'legal theory' or 'jurisprudence' here. We are not quite sure that these disciplinary niches will consider our work to be within their domain.

[62] Merriam-Webster Inc (2004).

Table 1 – CAS-characteristics summarized.

Systematic	A CAS is a Whole, has, aggregates agents that are:	Networked, diverse, signaling, metabolizing CAS (themselves) often
Dynamic	A CAS is adaptive by: yet it is sensitive to	(co)-evolution, learning, critical transitions
Complex	A CAS shows emergent behavior that is often	Without central control, path dependent, non-linear

system, several subsystems may exist and interact with each other.

5.1.2. *The PDC is a whole*

In the Second Section of this paper, we already discussed the internal structure of the personal-data community as a whole (a "dot") that has internal structure. The body of the PDC contains a large amount of data users (in fact: all connected personal data users, world wide). The whole is the network. Its boundaries are determined by any "no further links to responsible individuals interested in using personal data" situation.

Kaliya Hamlin[63] drew a personal data list in a mind map to show the diverse uses (and thus the diversity in values) of personal data.[64] According to Kaliya, the contents of the mind map are derived from a long list in the Rethinking Personal Data Pre-Read Document, published by the World Economic Forum in June 2010.[65]

The complicated mind map in Fig. 3 shows us how diverse the data users are in the PDC. It is beyond our abilities to estimate how many data users do form the PDC. But, these users do vary to a significant degree, in terms of their objectives,[66] data types,[67] legal nature[68] and so on. Among these data users, some are relatively widely scoped (e.g. Google Inc.) while others are more specialized, focusing on particular problems such as the Military and the Police.

We submit that the PDC is a system, having identity, but also having internal structure in the form of collections of interconnected institutions, service providers, individual users and so on, composing a multi-layered network with hubs and overlapping communities.

5.1.3. *Why considering that the PDC is a whole is useful*

It is useful for legal scholarship to consider that the PDC is a whole because legal scholars tend to think in jurisdictions. The concept of the PDC provides an image of subject matter for regulation that does not coincide with the classic conditions that accompany the notion of nation-state related jurisdiction. Recognizing the related anomalies as relevant may well be a necessary condition for facing their consequences.

5.2. *CASs are complex – so is the PDC*

Ottino (2003) stressed, since networks of interactions form systems, that the first that must be done when discussing complex system is to distinguish complex from complicated systems. Complexity emerges only when "the collective behavior of the parts together is more than the sum of their individual behaviors".[69] The relationships in the system are not simply the aggregates of the individual static entities, but like "a cat's cradle of interactions"[70] between dynamic units. Complex systems are not controlled centrally and resist their behavior to be modeled linearly.

5.2.1. *The PDC self organizes*

Any CAS operates at least partially without central control Complex adaptive systems have internal structure (may show multiple levels of aggregation) and a dynamic history – they emerge, live and survive, in a co-evolving environment.

5.2.1.1. *The PDC operates without central control.* Among the diverse data users that constitute the PDC, no pure or ideal agent represents the system as a whole. One can argue that Facebook is the flagship in the social network ecosystem. But Facebook is not the ideal agent in charge of the whole PDC, and neither is its structure representative for the structure of the other agents that make up the PDC. It is fair to say that giant services like Facebook and Google are keystone agents that have disproportionally large effects on the PDC they are a part of. For instance, China's Facebook RenRen is strongly and unidirectional influenced by Facebook.[71] Yet we prefer to say that these keystone agents strongly influence their sibling agents (at the same level) than that they control the whole "dot." In terms of network theory,[72] they are "hubs" in the small-world[73] networks that connect those agents in the PDC that represent the social networking ecology.

[63] Kaliya Hamlin, Personal Data Mind Map, published on 12/07/2011 http://www.identitywoman.net/personal-data-list-in-mind-map-form.

[64] See http://www.identitywoman.net/personal-data-list-in-mind-map-form.

[65] See also: World Economic Forum (2011).

[66] For instance, Google collects personal data in order "to develop new ones, and to protect Google and our users…(and) use this information to offer you tailored content – like giving you more relevant search results and ads." See, Facebook's Privacy Policy, access via https://www.google.nl/intl/en/policies/privacy/. World Health Organization collections personal data for normal web site usage and personal identifiable use. See, WHO's privacy policy, access via http://www.who.int/about/privacy/en/.

[67] For example, financial institutions pay more attentions to personal data related to economic information, while others, such as health institutions, may concern with health data.

[68] Some data users, like Google, Facebook and Tecent, work for the benefits of companies, while the others are non-profits organizations, such as governmental data users.

[69] Newman (2011): 800.

[70] We borrowed the term from Haldane, "Rethinking the financial network". Haldane thought financial network is CAS. "Complex because these networks were a cat's-cradle of interconnections, financial and non-financial." His paper is an inspiration to us. It provides a fresh insight for looking at financial systems and to treat financial crises. See Haldane (2009) at page 3.

[71] Zhang and Schmidt (2013).

[72] See, for instance, Barabási and Albert (1999).

[73] As discussed by Watts and Strogatz (1998) and Barabási and Frangos (2002).

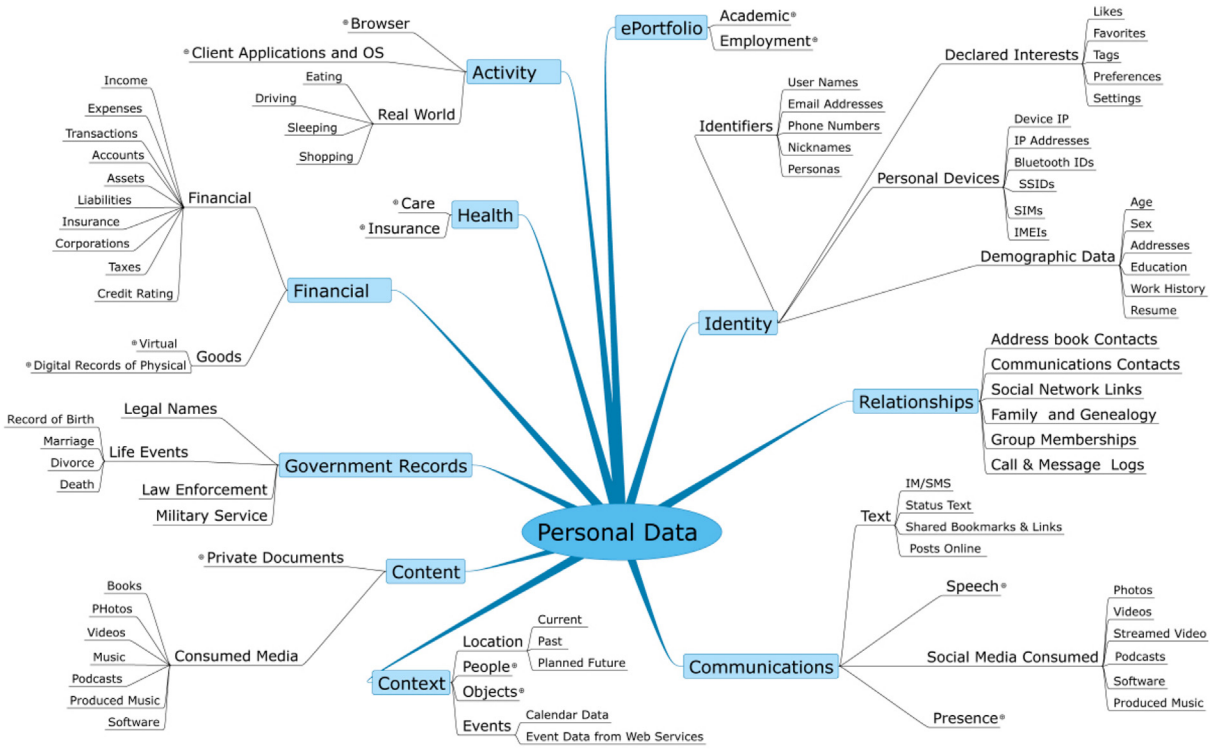

Fig. 3 – Diversity of personal data-use and -values.

The PDC exhibits the feature of self-organization very perceivably. Various units come to the system voluntarily and even without leaders from inside or outside the system. For instance, the development of the Facebook social networking technology by an undergraduate student, and then the rapid emergence of the Facebook community is a result of self- organization within the PDC. The appearance of the Facebook community was not designed or commanded. The local, individual actions and communications of technology providers, businessmen, service providers and individual users of social networking did produce the patterns that became the Facebook community. In fact, there are many PDC "sub-communities," such as around search engines, file sharing, online chat services and Wikipedia. These all emerged in the PDC in a manner similar to the one described for Facebook. Peltoniemi and Vuori (2004) said, as mentioned above, that emergent properties are the result of self-organization. Thus we assume that emerging phenomena are the result of self-organization. Consequently we accept that the PDC shows the third characteristic of what makes a CAS.

5.2.1.2. *Why considering that the PDC operates without central control is useful*. It is useful for legal scholarship to consider that the PDC emerges and operates without central control because this may become a systemic risk to legal systems. It is essential to legal practice that the CAS can identify human individuals as being responsible for behaviors in and by the CAS. It is our contention that the "responsibility drain" as implied here is currently in full swing for the law's grip on PDC behaviors. It is moreover useful to consider how network theory on strengths and vulnerabilities of hubs in small-world networks,[74] and as e.g. applied to epidemics, may prove useful by analogy to regulatory approaches.

5.2.2. *The PDC cannot be modeled as liner*

5.2.2.1. *No CAS can be modeled as linear*. The feedback loops in a complex system result in non-linear behaviors. Nonlinearity means that the behaviors based on relationships between system units we wish to measure are not mathematical proportional: outputs may be disproportional to inputs; small inputs can produce large outcomes; and large inputs can produce small outcomes (McDaniel et al. (2009): 193). The inputs of a CAS flow through a multitude of feedback loop that tend to produce nonlinearly related outputs (Ruhl (1997): 946). And as complexity theory allows for the analysis of all CAS behavior as being dynamic (or as having time related feedback loops), complexity theory allows for the study of phenomena that cannot be modeled with mathematics that yield solutions.

5.2.2.2. *The PDC cannot be modeled as linear*. The previous analysis has shown that the PDC can be described as a decentralized system, which comprises a web of interdependent data users. But is the PDC's behavior non-linear or is its behavior simply that of a system with a complicated internal structure? The characteristic that helps establish a system as a complex system is its having conditional feedback loops

[74] See Watts and Strogatz (1998) and Barabási and Albert (1999).

between its diverse units.[75] As we analyzed above, a complex system that has these non-linear characteristics often shows a capacity to self-organize into emerging aggregate agents.

The feature of emergence exhibits itself very clearly in the PDC. Different patterns of phenomena or behaviors emerge from the interactions among agents, rather than being designed into the system. In fact, even the PDC itself is an emergent community, produced by the individual activities of local agents without a clue about what their collective behaviors would look like or lead to. The PDC emerged from the local interactions of agents, particularly technology providers, service providers, institutional users, consumers, businessman and other stakeholders, pursuing their own interests. These interactions produced (led to the emergence of) vast and networked communities through which personal data (and much, much more) can be transmitted fast and easy. This PDC is neither invented nor designed by any individual agent. Rather, it emerged from interactions of a large amount of "constituent" agents that reacted to opportunity and need.

We thus conclude that the PDC has the characteristic of conditional, non-linear feedback loops (what is a hallmark of any complex adaptive system).

5.2.2.3. *Why considering that the PDC cannot be modeled as linear is useful.* It is useful for legal scholarship to consider that the PDC cannot be usefully captured in simple linear models because this may prevent legal scholarship from falling into the type of trap that has lured large communities in economic scholarship astray.[76] Legal scholars may well have hesitated to join forces (and scientific stories) with disciplines like economics and physics because considering the subject matter of legal scholars – autonomous decision making and relating that to individual responsibility – has long been considered resilient to scientific investigation. Only in the last three decennia there have become generally available methods[77] of and machinery[78] for simulations that allow for further investigation into behavioral models of diverse, dynamic and context dependent forms of autonomy and responsibility. Simulating the behavior of agents with distributed types of rule sets they follow has become a hallmark of complexity science. And knowing that such simulations can never be sufficiently deterministic to adequately predict in the short term/long run when and where some "situation" will arise, does not prevent that calibrated, stochastic agent based models can help to adequately model and research through simulation techniques the actual risks that "situations" will occur within a certain time span.[79]

We conclude that the PDC does show the characteristics of self-organization and of nonlinearity that make a complex system. We draw a map in Fig. 4 to illustrate what the PDC may look like if described as a complex system that is structured as a small-world network.

5.3. *CASs are dynamic – so is the PDC*

CASs change over time, by learning and/or evolution or co-evolution. It has been observed that the number of personal data users is increasing every year, every month and even every day. For instance, in February 2014, Facebook announced a new iPhone app called "paper." The app would be an artificial (or intermediate) personal data user, since it delivers the articles and videos that it expects you to like, based on the analysis of your personal data as collected by Facebook.[80] Thus, the PDC changed and its network increased in size.

5.3.1. *Any CAS does (co)evolve and/or learn*

What distinguishes CASs from other complex systems is their capacity to adapt. According to Tussey (2005) at page 155:

> *... adaptation most often results from coevolution, in which the system responds to changes in other systems with which it interacts, and those systems similarly respond to changes in the primary system ...*

According to Kim and Mackey (2013) at 8,

> *...CASs as complex systems with the ability to adapt to changes in the external environment as a result of experience via conditional action and anticipation.*

Adaptation of a CAS implies that a CAS has the capacity to co-evolve with its environment. No single CAS does exist independent from its environment. Each and every CAS is closely linked to its environment. And a CAS does not only exist within its environment, it becomes intimately related to it. Thus, most CASs have bidirectional relations with their environments: as the environment changes, the CAS needs to change along in order to ensure an adequate fit; and when the CAS changes, the environment is often changing along too. This is a continuing process: as its environment is changed, the CAS needs to change with it, and vice versa, and so it goes on and on.[81] Perhaps, co -evolution can be seen as a process wherein CAS and environment try to re-tune their reciprocally dependent fitness in the dynamics of unfolding time.

[75] Feedback loops exist in complex systems when information flows in the network follow paths that work circuitous, as in direct or indirect loops (Ruhl (1997): 948).

[76] Happily machining away from their models the mathematical difficulties that would ensue when accepting that diverse, dynamic and context dependent forms of autonomy and responsibility are at work in the decision making of the agents in the systems observed. Instead, these scholarly communities preferred to face the continuous falsification of their mathematical models by simplifying agents into being one-dimensional "rational economic men" and by concurrently making the models more and more mathematically complex. See Bowles (2006) for an extensive discussion.

[77] Agent Based Modeling – see Schelling (1969) for an early example.

[78] See http://ccl.northwestern.edu/netlogo/.

[79] For instance, the "Living Lab" at Leiden University provides promising initiatives and applications of agent-based models to test policy decision options. In their presentation, Yuan Yuan Zhao and Professor Katzy took the German Solar Panel Industry as an example and showed that computational policy simulations could be used to inform policy choices. See, e.g., www.centre4innovation.org.

[80] Goel and Somaiya (2014).

[81] See also Capra (1997) and Holland (1995).

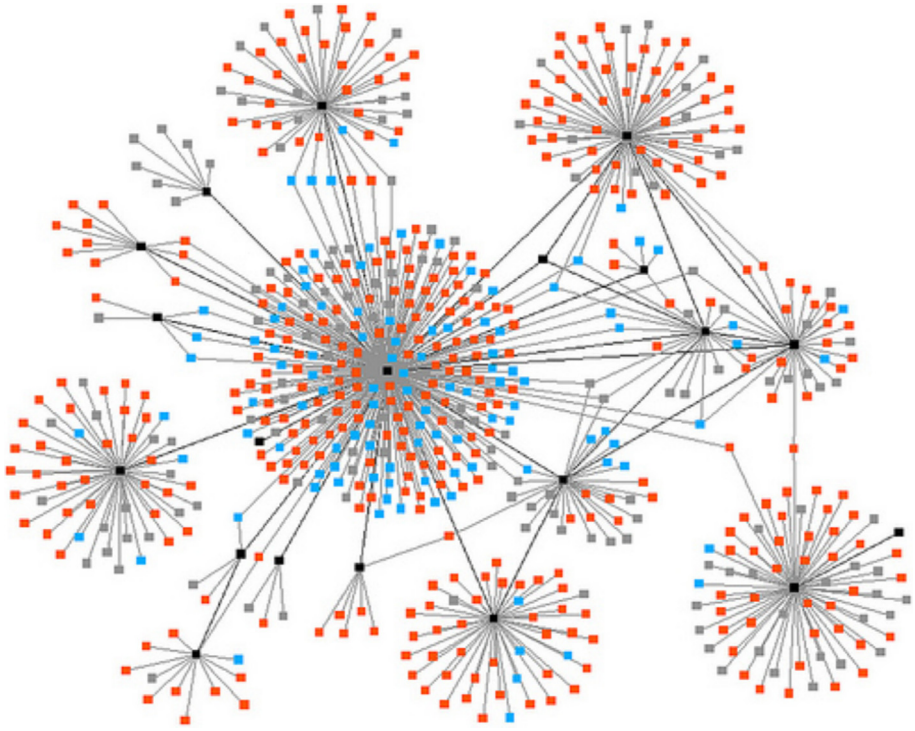

Fig. 4 – Hubs in a small network world.

This co-evolutionary process will show as if both the CAS and its environment are learning. In its biological origin, there is in the evolutionary process no conscious process like learning involved. We submit nevertheless that CASs that have consciously behaving agents can learn, and thus influence their fitness consciously – and thus may tilt the co-evolutionary process towards their perceived interest.

5.3.2. *The PDC does (co)-evolve and/or learn*

The PDC is as open as other CASs to coevolve in response to internal dynamics[82] and environmental stimuli. It continuously tunes itself in order to find states of adequate fitness.[83] The PDC is itself a result of ongoing social interactions. The environment provides pre-existing constraints, provided by culture, law, technology and so on. These constraints determine the space wherein the PDC can find adequate co-evolutionary forms.

When describing the constraints of provided by the environment, we follow Lessig's lead.[84] Lessig's work modeled how cyberspace is regulated and, as a part of that, how law might regulate cyberspace. What we will borrow from Lessig is the model he created to analyze regulation from the perspective of the subject that is being regulated.[85] His model helps us to examine the relations and interactions between the PDC and its environment.

In his book, Lessig represented the thing that is to be regulated by constraints as a "dot."[86] He identified four constraint-delivering forces: law, market/economy, architecture/technology and norms/culture. The resulting constraints try to regulate the dot. Lessig presents the constraints in a Figure.[87] We replicate it in Fig. 5.

We trim Lessig's regulatory forces and direct them to our PDC, and represent them as the environment with which the PDC co-evolves. An important regulating force mentioned by Lessig is what he calls "regulation by architecture."[88] We assume this to refer to the regulatory forces that stem from environmental and infrastructural conditions that in the context of behavioral choices most of-ten have to be accepted as stable, like the legislative system, the Berlin Wall, or the IPv4 protocol. However, these architectures are sensitive to change – be it in their own ways. One might consider a "dot" to be thrown into an environment that shows a structure that constrains its behavior, but into an environment that is itself a moving target – that even can possibly be moved by the dot itself.

Co-evolution of the law, its subject matter and the environment becomes problematic when the political system that can adapt the formal laws is too slow in its operation. Understanding what the problem is (and how to address it) would be useful. In the German Law Review article mentioned

[82] Of course, if a CAS has CASs as its constituting agents, it is concurrently the environment to these constituting agents and will also co-evolve with them.

[83] See also: Tussey (2005) at 155.

[84] Lessig (2006).

[85] Very much a realist perspective, at least initially.

[86] This is the dot we discussed in Section 2.

[87] Lessig (2006):123.

[88] Lessig (2006): 127.

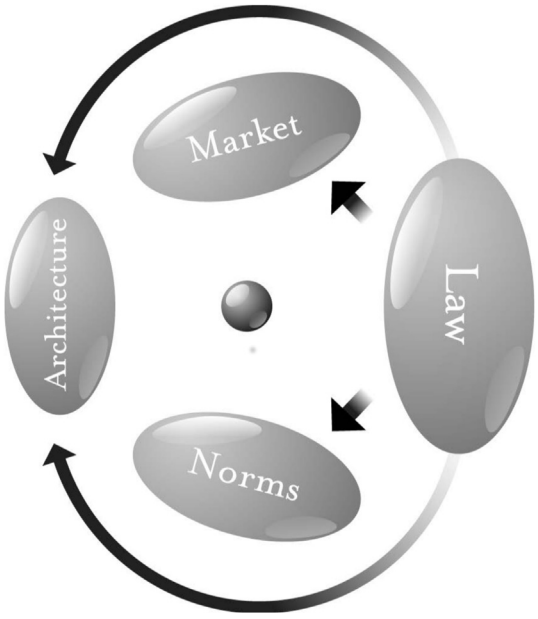

Fig. 5 – Lessig's regulatory forces interacting.

before, the first author adopted Incomplete Law Theory[89] to explore the dynamics of what we can now call the environment wherein the PDC must live. In her paper, she started from technology-constrained data protection law and ended by exploring the dynamics of technology and its wide, architectural influences on legal arrangements. Our observations and further evidence suggest that the most striking constraints for PDC- and PDC-agent behaviors do arise from the dynamics in technology. Agents, such as companies, are concerned with technological changes and these changes affect the agents' behaviors. Indeed, changes in technology have real consequences. And although their characteristics remain architectural in the sense of Lessig, their dynamics have sped up to a level where traditional legislatures cannot keep up with the pace required. It may well be, that some reactive change in the legal system as architectural environment is required.

Additionally, the PDC is influenced by the other elements in its environment. For instance, the mutation in social-economic backgrounds which were brought on by the 9/11 tragedy did feed into the "dot," which brought changes to the behaviors of units in the PDC and led to a tug-of-war of conflicting interests between national security values and privacy values: the protection of national security values implies that inroads have to be made into the protection of the right to be left alone.[90]

Moreover, the PDC is not an uneventful "dot" itself. Instead, it is an ever-changing one. Strategic changes of one unit may strongly affect the strategies of other units in it. As argued in Zhang and Schmidt (2013), we analyzed the interaction between Facebook and its Chinese counterpart RenRen and imagined RenRen and Facebook to compete (for instance on data protection issues) in a single commercial arena (as provided by the web). The mere suggestion of such competition suggests that we may presently witness the tantrums that will unavoidably accompany the conception, birth and emergence of a unified global complex adaptive judicial system for governing the web as a unified market.

Within the system, the different units aggregate, cooperate, interact and develop with a specific reference to personal data, while without the system it co-evolves and competes with other related systems. These outside relations of the PDC, construed as a CAS, can be mapped out as depicted in Fig. 6.

5.3.3. *Why considering that the PDC does (co)-evolve and/or learn is useful*

To legal scholarship it is useful to distinguish evolution and co-evolution on the one hand and learning on the other, especially when considering subject matter at the level of social ecosystems. (Co)-evolution refers to a blind mechanism that happens to lead to adaptation. Learning (and teaching) use conscious mechanisms, that result from conscious behavioral choices and result in social and scientific cultures (that help preserve, adapt and reproduce local knowledge bases).

We think that it is useful for legal scholarship to respect the distinction between the mechanisms of (co)-evolution and learning – even when these tend to get into a confusing tangle. Legal scholarship is founded in accepting the concept of conscious behavioral choice,[91] and not in accepting subconscious behavioral choices (sensitive to nudging) as definitive. As such, legal scholarship's primary domain is related to learning, to the learning of behavioral choices that do not subjugate to subconscious impulses. The issue of where the boundaries of the disciplines meet in these issues is important, and can only be understood in cooperation with multiple disciplines.

5.4. *The PDC-as a CAS-Summing up*

Our goal of looking at complexity theory is to find out whether interpreting the PDC as a complex adaptive system does improve our understanding of the data protection law's subject matter. We established.

- That the PDC is of systemic nature, showing several levels of aggregation and thus providing not only handles for interdisciplinary communications, but also providing several extra handles for monitoring the multi disciplinary consistency of our findings. An important aspect brought

[89] As described in Xu and Pistor (2002).

[90] In Bignami's "European Versus American Liberty: A Comparative Privacy Analysis of Anti-Terrorism Data-Mining", this conflict of interests is analyzed more in detail. By com-paring the legal arrangements over data protection issues in America and Europe, Bignami showed the fierce conflicts between privacy and national security, which led to the changes on the environment of the USA PDC (See Bignami (2007)).

[91] Consequently it does not consider (co-) evolution to be directly in its domain. However it can enter its domain via conscious behavioral choices that influence evolutionary processes.

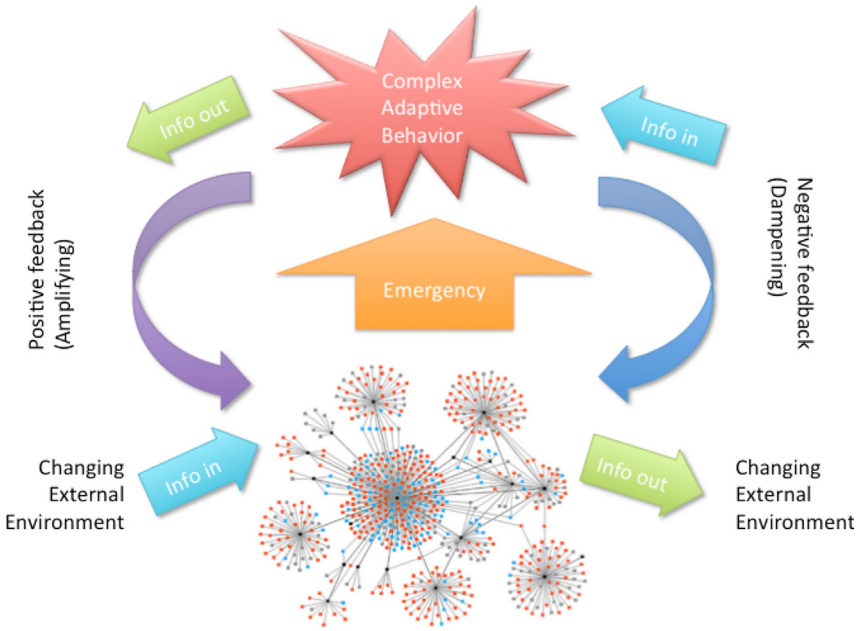

Fig. 6 – PDC as ecology.

to the fore by looking at agents in levels of aggregation makes explicit that the possibilities of scientific prediction of the behavior of agents that do not have consciousness is something quite different from the prediction of the deliberate behaviors of the subjects of the law, of economics and of the social sciences;

- That the PDC is a dynamic system – on the one hand through the non-deliberate mechanisms of (co-) evolution and on the other hand through the deliberate mechanisms that we classified under learning; and: as a complex adaptive system, we expect that the PDC may have to face the risks of critical transitions (and that legal arrangements may be designed to minimize such risks);
- That the PDC is a complex system, that operates without central control and in a manner that cannot be caught in a linear model – these aspects are the corollaries of agents that follow context dependent conditional rules in a network of direct and indirect feed-back loops. As a consequence, scientific understanding of the PDC has to remain very incomplete, yet is becoming larger through new practical possibilities for serious agent based modeling using serious computation capacity.

We consider these findings to have added to our understanding of the subject matter of the data protection laws.

We began by suggesting to look at data protection laws' subjects (and their environment) as a complex adaptive system in the hope that this will also allow us to provide a unified account of seemingly unrelated phenomena as characteristic CAS-properties in a single system.[92] Our research does also fulfill this hope. We added to our understanding of the PDC through combining our current knowledge with knowledge and experiences from different examples of CASs, and from different disciplines. Basic knowledge about CASs informs us that the PDC comprises a complex web of interdependent nodes (units or agents) that link to one another and that make some of them emerge as "hubs." These stylized but explorative considerations can be woven into a perspective that understands data protection law's subject matter as a CAS.

6. Thinking about ramification for policymaking and recommendations for further study

Previously, we discussed how a CAS perspective might move data protection law into new and interesting directions. From the CAS perspective, we recognized the PDC's systematic nature, the system's complexity, and the necessity of recognizing its co -evolutionary setting. The PDC hence can be understood as a CAS. However, challenges follow with findings.

First, we witnessed how difficult it would be to regulate a CAS by laws. It is nigh impossible for legislators to design an optimal data protection law in advance and then make it work for a substantial stretch of time. A pressing question comes to the fore: does our CAS-analysis push the PDC out of control and thus beyond the reach of useful governance by law?[93] We will answer this question in the negative. As Clark (1999): 47

[92] See also in Beckner and his colleagues' research on language. CAS theory also helps them to link seemingly unrelated phenomena together (Beckner et al., 2009).

[93] In fact, Law making and law enforcement is a multi-level affair: they are, for instance, often directly linked to unit behavior, yet have the ambition to nudge the emergent, overall behavior of the PDC as a whole towards improvement. We consider a distinctive characteristic of how laws are understood and enforced to be the assumption that they are backed by reason.

argued: this kind of system can be led, influenced and enabled in a variety of ways. Among these ways, legislation and legal enforcement are also included. As a matter of fact, CAS-theory has become more and more prominent because it helps to understand and influence what otherwise could only be qualified to be systems of unapproachable complication. Consequently, when considering legal arrangements for a PDC, the legislature is wise to bear the inherent CAS characteristics in mind. Data protection law cannot treat the PDC as anything else. As a "society's problem-solving mechanisms,"[94] legal arrangements are seeking to regulate a CAS. In these cases, Ruhl mentions "it is very different to solve problems in such systems unless you think like a complex adaptive system" (Ruhl (1997): 980).

Then, policymakers may ask the question whether and how CAS theory provides a promising perspective for better understanding of the "world wide web of privacy regulations" and the "world wide web of personal data users" (as our research taught us to think of them).

We cannot yet answer these questions. Our current work does, however, fulfill a necessary precondition for addressing them in future research. We have to investigate how legislators can address the regulation of a CAS like the PDC. In fact, adopting a bundled CAS approach – such as agent-based modeling (hereafter ABM) for (often power-law distribution based) stochastic simulation of CAS behavior, focusing on (e.g.) tipping points, cascades, critical transitions, scale-free and emerging phenomena – is still an extremely experimental approach for legal scholarship. Nevertheless, ABM is widely used to analyze the structure and development of CASs. Through simulating the actions and interactions of autonomous agents and assessing their effects on the system as a whole, ABM could help policymakers to find a clear set of specific rules associated with long-term sustainability. For example, in 1996, the American Sandia National Laboratory used ABM to successfully simulate the American economy. This model was widely used to improve economic policy analysis and to provide new insights into underlying economic principles (Pryor et al. (1996)). And after the 2007/2008 economic crises, the then newly established Institute for New Economic Thinking commissioned Doyne Farmer (Farmer and Foley (2009)) to design more elaborate agent based models of our economies. Inspired by explorations in other fields too (for instance Jeff Sabloffe. al.'s (Hosler et al. (1977)) work on the Maya culture's decline), we expect that ABM can provide a set of models that allow for induction of design principles that those involved in design and adapting legal arrangements for PDC could use.

Yet, such studies about law's subject matter, as CASs is a beginning rather than an ongoing or even finished construction. We did not model the possible behaviors of the PDC with agent-based means. Doing so would require an entirely new project (for which we hope to have paved the road). Consequently, our exploration of the PDC as a CAS as the subject matter of data protection law has opened doors to fascinating new projects, we think. Such projects may help to assess internal and external influences on the behavior of the PDC and furthermore to explore how a country (perhaps even emerging collections of countries) can actually develop norms, laws and accompanying institutions on personal data protection in order to domesticate this complex adaptive subject matter in its complex environment.

[94] See Ruhl (1997): 980.

7. Limitation of study

We find that even our limited exercise in applying CAS theory improves our understanding on data protection law's subject matter. Nevertheless, we are also keenly aware of the limits of our study.

First, many would suggest that both the PDC network and the data protection law surrounding it are CASs.[95] The same framework we adopted to analyze the CAS-characteristics of PDC could then be applied also to data protection law and its enforcing agents. Moreover, in our research we witnessed the difficulties of attempting to design static legal regimes to regulate the PDC. We are inevitably stuck in the co-evolutionary forces of the legal systems and the complex adaptive systems that they attempt to regulate. Efforts to build rigid legal regimes for control thus are destined to fail eventually, as the social systems under regulation evolve in ways that evade, work around or even exploit the legal system. The system that focuses on using the law for data protection is itself a CAS, bound in a co-evolutionary ecology, a multi-system, a "system of systems," so it is going to be adaptive over the long run if it is designed with adaptation capabilities as a primary attribute.

Second, our findings in the current article suggest that a deep question remains for further investigation: how do multiple CASs interact in ecological niches? And (so we claim) our findings in the current article also suggest that it may be premature to consider any legal system to be a CAS on face value, without further ado and without specifying what the nodes and the networks are that generate its identity-defining behavior.

We identified the PDC and established it to be a CAS. And we downplayed the wider information society and its structure, which may well be composed of multiple CASs and may well be interconnected with multiple other CASs, for instance, the music industry[96] and cyberspace.[97] Even the information society itself can be considered as a CAS.[98] The issue that the PDC lives in and lives with multiple CASs is of great importance. For instance, what is the relationship between the PDC and information society? Do they overlap each other? Does one contain parts of the other? How do their interconnections influence each? And how are they connected with CASs of even wider scope? Further work is needed to address these issues too.

8. Conclusion

In this paper, we investigated, through combining the PDC with the knowledge and experiences from different classes of

[95] Ruhl certainly would (see e.g., Ruhl (1997)).
[96] Tussey (2005).
[97] Paul (2010).
[98] Córdoba-Pachón (2010).

CAS, whether data protection law's subject matter, as a network of data users, exhibits the characteristics of a CAS and what this implies for our comprehension of data protection law.

The explorative review in Section 3 has provided indications about which kinds of subjects can be understood as CASs. Subsequently, through using some key CAS-properties and relating them to our PDC and its ecology, we are "informed" that these characteristics apply to the PDC and that thus the PDC can be understood as a CAS. From the CAS perspective, the human-created PDC is a large and dynamic system of interacting data users networked in a particular pattern of organization from which arises the ability to adapt to internal and external changes by self-organization, emergence and co-evolution/learning (Kim and Mackey (2013), Holland (1995)).

Our findings brought challenges to legal arrangements over data protection issues, since these try to tame a CAS. Evidence taken from case studies published in this issue as well as other sources suggested that data protection law's subject matter is (possibly) quite different from other law's subject matters. It faces critical transitions all the time in practice.[99] Thus – as we continuously have to regulate situations that the legislature could (and did) not imagine when framing the law – the purposes of data protection law, the reasons for its existence and the modalities of its regulation are requiring methods quite different from those that focus on the interpretation of material laws.

We suggest that the quality of future data protection law may benefit by considering CAS- theory's recommendations. We find Ruhl at our side here, as he has minded us that the problems presented in a CAS only can be addressed adequately when you think in terms of complex adaptive systems.[100] Thus, the problem needing attention is to adjust data protection law to tally with its subject matter.

Indeed, neither our findings point to standard method nor any well-organized road map for making legal arrangements. Notwithstanding that our understandings on CAS theory is in a state of evolution, our efforts thus far have already served to deepen our understanding of many problems that troubled data protection law. And they have operated as checks against some of the mistakes of current data protection laws. The finding itself could serve to describe human actors in more veridical terms and to deepen our understanding of many phenomena. It is against this background that we expect that regulation over data -protection issues stand to benefit from being also informed through the lens of CAS theory.

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[99] Some induced by innovative and exploding technical (e.g., The 'Cloud'), social/business (e.g., Google, Wikipedia, Twitter, Facebook, SMS, internet banking) and governmental services (e.g. , data retention).

[100] Ruhl (1997).

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