Toward measures of complexity in legal systems

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ABSTRACT

Law can be considered as a complex dynamical system evolving from network structures. Potential interactions at various scales can generate unpredictable effects. This *objective* complexity based on non-linear dynamics exists in any legal system: it can be just observed. We propose here guidelines to develop two measures of complexity in legal systems related to these dynamics. The first one - a "*structure-based*" measure - involves the network analysis of legal text organization and quotations in a given corpus. The second one - a "*content-based*" measure - relies on some evaluation of the diversity of "legal outputs" generated by any legal system. Anchored in the innermost part of a legal system, its construction appeals to various fundamentals of Legal Theory. It is also shown that these two measures are representatives of larger classes of legal complexity measures. Some potential uses of these measures are then briefly discussed.

Categories and Subject Descriptors

J.1. [**Administrative Data processing**]: Legal; F.1.3. [**Complexity Measures and Classes**]: Complexity Hierarchies; F2.2. [**Non numerical Algorithms and Problems**]: Computations on Discrete Structures

General Terms

Algorithms, Theory, Legal Aspects

Keywords

Complexity, Legal system, Measure, Network analysis, Legal outputs

1. INTRODUCTION

Even when limiting our scope to the production of legal texts (International Conventions and Treatises, European Directives, national laws, decrees, ordinances, by-laws, etc.), the growth of national and international legal corpus and the rapidity of changes are overall qualified as being more and more complex to manage. Impacts of this complexity on the degree of interpretability or on the intricacy of both legal hierarchies and legal network arrangements are considered as causing other unwanted by-effects on the intelligibility of the laws. The highest European and national institutions have regularly warned lawyers and legislators in different countries of this threat to the accessibility of legal knowledge.

Let us give two examples. In the U.S. law, according to Michelle White [11] "there were at that time 140 pages of IRS regulations interpreting section 704 (b) of the code and a mind-boggling labyrinth interpreting the original issue discount rules - 441 pages!". More recently, in December 2005, the French Constitutional Court has advocated that an article of a law can be considered as unconstitutional if its intelligibility and accessibility are surpassing a "reasonable complexity"[1]. In a 2006 Report, the French Council of State has proposed different ways to mitigate the by-effects of legal complexity and to put its development under control [4].

Quite a lot have been written in legal theory about complexity and law [8]. The "complex" qualifier attached to a legal system is rather not precise, or at best inspired by some analogy with characterizations of complex systems in mathematics, physics or ecology among others [1].

We here draw guidelines in order to develop both a "structure based" measure and a "content-based" measure of objective complexity in a legal system (Section 2). We then show how these measures could be designed as operational measures and used to put new lights on legal systems and on their evolution dynamics (Section 3). This provisional understanding of legal complexity is further clarified in Section 4 by considering converse and near-by concepts. Some of the assumptions underlying these measures of legal complexity are explicitly stated and discussed in Section 5.

2. COMPLEXITIES IN LEGAL SYSTEMS

We propose to be more precise to characterize complexity in legal domain. How to deal with measures of legal complexity? One traditional angle is to assess regulations, their number and abstruseness: there were a few measurement tools in this field. However, there is no consensus of what complexity is even in "hard" sciences (including biology, ecology, earth sciences, etc.). Then proposing a (non exhaustive) list of "building blocks" of what is complexity is subject and opened to critic and revision.

[1]Décision no 2005-530 DC du Conseil Constitutionnel en date du 29 décembre 2005.

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Our portrait of a generic complexity in systems includes the following items:

- A large number of interacting components;
- A partial knowledge of the (dynamical) links between components;
- A limited predictability of the system evolution and/or outputs, intrinsically rooted in the system dynamics due to the number of (quasi-autonomous) legal actors involved in the implementation and the interpretative process of legal texts;
- A dependency of the phenomenal system properties when components aggregates of different sizes are considered (scaling issues).

It should be noted that we intentionally do not separate the two main sources of our limited understanding of a complex system: a) its organization or structure intricacy and its intrinsic instability; b) our limited knowledge of the components ties and evolution rules. The four points of our list above suggest at least two possible *classes* of measures of complexity in legal systems. We develop here below only the concepts of one possible legal complexity measure in each class.

2.1 Structure-based measure

Let us start with an illustration. Some national legal corpus are organized in a set of codes. For example the French Environmental Code is divided in seven books. Each book is divided in titles and titles in chapters. Law articles involved in the management and governance of the environment are to be found in the different chapters. They are themselves composed of paragraphs (*alinéas*). However the tree-like hierarchical organization of this Code is connected to other tree-like structures. Several laws indeed quote other laws or other Codes, or may give reference to European or international legislations.

From this point of view, we can represent a given legal corpus as a network where *nodes* are laws connected by two kinds of ties (Figure 1). Ties of the first kind mark the order of succession between two nodes in the proper tree-like structure. This structure results from the cognitive organization of the legal matter in the given corpus. Law articles indeed are gathered together under the proper chapter heading and their ordering reflects a rational link between their legal content. This kind of ties expresses a "legal influence" between nodes in the sense that they show a dependency oriented *from ties to nodes*.

Quotations are the ties of the second kind. A law article refers to another law article embedded in a different legal context, because of its generic content with regard to the quoting article. The quotation can be done within the same Code or to another Code, as shown in Figure 1 with the y5-y3 tie and x4-y1 tie respectively. For example an article ruling the management of some body of water might refer to some article ruling the responsibilities attached to a territorial authority. This kind of ties expresses a "legal selection" oriented *from nodes to ties*.

Depending on the aim of the analysis, other information on nodes or ties can be preserved in the representation of a legal network. For example those laws (nodes) gathered in the same code can be endowed with a particular tag (e.g. a color) that will help the interpretation of the legal network structure. Another tag could mark the kind of liability constraints endorsed by the nodes or some group of nodes (e.g. most international legislations on the environment are not constraining for the signatory countries). Indeed tags can be bi-univocally chosen as soon as a typology of the liability constraints is set up. This approach can be applied to other legal concepts.

Finally we obtain some legal network that can be characterized by different kinds of mathematical measures. These measures are summarizing some various properties of the network structure, of its geometry or of its topology. Though it is not the purpose of this paper to develop in details such measures, several potential research issues are clearly identified.

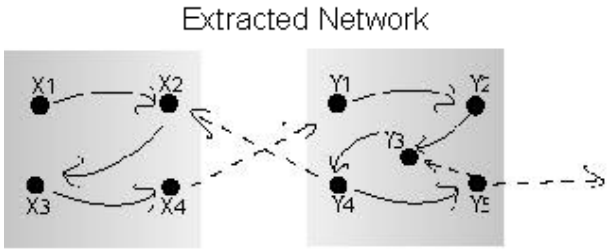

Figure 1: Generic example of a legal network.

Look at this Figure. Each Code is structured in a tree-like hierarchy: books have different titles divided in chapters gathering law articles symbolized by letters (x1, x2, , y5). Law articles are the leaves of the tree-structure (not represented) and the nodes of the network. Successive articles are linked by ties of "legal influence" (arrows: see text). Quotations between law articles are ties of "legal selection" (dashed arrows). Nodes and ties of the two kinds form a legal network (or graph) as illustrated in a lower panel that corresponds to the network extracted from the X and Y articles and ties above.

2.2 Content-based measure

However the structure-based measure is somewhat exogenous to the core of Legal Theory. It is an issue concerning legal knowledge engineering (document management). A much more ambitious and difficult task is to design a complexity measure based on the legal content of a given corpus. It should be noted that the proposed content-based measure has no relationship with the network structure of the considered legal corpus described in Section 2.1.

Our basic assumption is that a legal corpus or text is a compound of idiosyncratic contents named *norms*: it is not only a tautological statement. It means that legal engineers have to deal with a basic propriety of a normative statement: its aptitude to produce "*legal outputs*" or "*legal effects*". Let us take the norm of transposition in European law. A directive is binding on the Member States as to the result to be achieved but leaves them the choice of the form and method they adopt to realise the Community objectives within the framework of their internal legal order. If a directive has not been transposed into national legislation in a Member State, if it has been transposed incompletely or if there is a delay

in transposing it, citizens can directly invoke the directive in question before the national courts.

It means that national law has to be transposed from a European Directive in a certain delay. It implies also that implementation decrees will have to be published and that all local by-laws ought to be grounded on the transposed national decrees and laws. Many types of legal outputs can be already listed: penal sanctions, legal empowerment of specialized authorities, enactment of rules governing the application of a law, legal controls (of legality, of constitutionality), case law decision, provisional measures, experimental measures, etc.

We first propose to build a typology of the possible legal outputs, both completing the list above and refining the underlying classes into "*types of legal outputs*". In the list above, the "implementation decrees" belong to a class composed of different types of such decrees that depend on the administrative levels of their implementation. For example, in any legal system a mayor is entitled to draft by-laws in the general field of law and order due to "particular circumstances" in its municipality. However if a new directive on public health is published, a prefect (*préfet*) who is the State's representative in a *département* will be directly entitled to close all old public swimming pools in its jurisdiction.

Now (potentially) armed with such a large typology that relies on Legal Theory, we can observe all the legal outputs that are eventually generated by the application of some predefined legal corpus. The point is that we do not estimate the number of outputs themselves (e.g. the number of disputes) but the number of legal output types that are induced by the commentaries of jurists. This measure is similar to one of the measure of biodiversity in which the number of species is estimated over some territory or ecosystem (the number of individuals in each species is not discerning for this estimate of diversity).

3. OPERATIONAL CONCEPTS

Without entering in technical details, several algorithms exist that can be used in order to turn theoretical concepts of legal complexity into operational measures. Other aspects of these measures are also worth highlighting.

3.1 Structure-based measure

As noticed in Section 2 (fourth point of the list), scaling issues are often critical in the analysis of a complex system dynamics. In practice the observable scales of a system are within a range. In Figure 1 the larger scale is implicitly chosen as the level of the set of Codes. The smaller scale is given by the level of the law articles. This range of scales could be extended for example by refining the network representation with the decomposition of each article into its constitutive paragraphs or if-then norms. On the other side of the range, federal (if any) and international legal corpus that dominate the national Codes could be included as well in the network[2]. We intuitively understand that the complexity measure associated to a Legal System will depend on the range of scales under analysis.

Several characteristics of a network are potentially useful for the legal analysis. The *degree* of a node is its number of ties to others. In our picture of a legal network, a high degree will be associated to a law article often quoted. Statistics of node degrees (e.g. average degree, frequency distribution, etc.) over a complete legal corpus (network) or sub-corpus (sub-network) as well as the observed range of degree values are interesting characteristics of a legal system. The *centrality* of a node in a Code or in a larger corpus should be related to the importance of the corresponding article in the legislation. The same reasoning applies to a Code embedded in a national or international corpus. Some metric concepts can also be involved based on the estimation of the distance between two law articles - that is to say between two nodes. Then the average distance between nodes composing two Codes provides an estimation of their *closeness*. However these concepts - degree of a node, centrality, closeness, etc. - are just the basic notions of graph theory. Much sharper concepts (and tools) are to be integrated and interpreted in the "Legal Culture" frame.

[2]Such "inclusion" of a network A in a larger network B that preserves all its nodes and links corresponds to the notion of a sub-graph in the Graph Theory [5].

3.2 Content-based measure

The first task to be performed in order to use our proposed content-based measure of legal complexity is to build an exhaustive typology of all the potential effects of a given legal corpus. Some of these legal effects or outputs are likely to become themselves part of an enlarged corpus. Then the method consists in identifying a legal corpus of reference at a given date (or in a given state) and then in observing the legal effects induced by its application from its effective date, including its unexpected counterproductive side-effects when incentive norms are involved.

A large body of theoretical and applicative works exists that can be used to establish the typology of legal effects. In particular those studies developing a Legal Ontology [10] or Definitions [7] should be revisited with the objective of extracting classes and types of legal effects induced by some corpus. This in turn will allow to produce some formalized typology of legal outputs to be connected to dynamical models of the decision processes involved in various legal frames (legal drafting, case law, legal strategy of agents for problem solving, etc.).

Two assumptions are underlying the project to develop such a typology. Firstly, it is assumed that in a given legal order, it is possible (and desirable) to define a canonical representation of legal effects. For example, considering two implementation decrees for environmental purpose, we assume that the old versions, dates, procedures, signatures of successive texts are not pertinent for the typology. On the contrary, the knowledge of the precise level of authorities responsible for these decrees in the multi-level system of environmental governance is relevant for management, liability, socio-economical and other issues, i.e. for decision-making. As a consequence: the level of authorities is a criterion to design the typology. Any legal effect should be reduced to its canonical form in order to be assigned to a class and a type in the typology.

Secondly, classes and types should be generic. Considering for example sanctioning clauses, several classes (fines, imprisonment, ineligibility, etc.) and types (e.g. relative or absolute ineligibility) can be distinguished that will apply over most legal systems. The generic nature of some other classes might be restrained to particular families of legal system. For example it is no so clear whether classes organizing the powers of legal authorities will be able to

match legal effects of Common Law, Civil Law and Customary Law families. Put in another way, the design of a typology of legal effects is interesting for Legal Theory in itself, and should obey some parsimony principle. But even in the case where legal effect classes do not apply to the largest possible set of Law Families, the content-based measure using a diversity index allows to globally compare this complexity in different systems. Let us take the example of New Caledonia, a "*sui generis* collectivity" (in practice an overseas territory of France). LEGICALEDONIE is the legal database of this territory. This database, a "by-system" of LEGIFRANCE (French national legal database) was designed in order to integrate the pluralism of legal sources in the structure of the system since three legal systems coexist (New Caledonian, French, customary). To speak clearly, the legal outputs (even standardized) have to take into account "juri-diversity" as a chance to manage the diversity of legal cultures [3].

4. CONVERSE AND NEAR-BY CONCEPTS

We will quote some fundamentals of legal theory which are close to the notion of complexity.

4.1 Converse concepts

4.1.1 Complicated is not complex

The rapidly growing number of legal texts is often mentioned as an index of legal complexity. Under the pressure of several emerging societal, scientific and environmental challenges, new legal rules are adopted at different levels of governance. In parallel, new specialized domains are also developing. However, how complicated can such a system be it is not necessarily complex. No generic properties of complex systems (as for ex. those listed in Section 2) result from this growth of legal systems. On the contrary, a limited number of laws are susceptible of subtle and diverse interpretations. Seen differently, a detailed map of a complicated system is enough to find its way. There does not exist such an efficient map for a complex system.

4.1.2 Vagueness is not complexity

There is no accepted definition of legal vagueness. Its meaning can be tied to the context of use. When considering the kind of legal network described here above, vagueness is attached to the quotation of a particular laconic corpus (e.g. the Constitution and its dynamic interpretation) or to implicit quotations. In the first case, the quotation ties must be listed explicitly to each "node" of the corpus or selectively chosen with regard to their pertinence in the context: a reference to the French Constitution in the Environmental Code will probably point to the Environmental Charter added in 2004 or to a Constitutional Court's case. In the second case, it is one of the objectives of any codification commission to state explicitly the implicit quotations (for example, in the established expression: "this article repeals all the provisions contrary to the present law"). Such vagueness, that is not complexity, must be reduced.

Another sort of vagueness is associated to the degree of *interpretability* of a legal text. Vagueness attached to the terms or general meaning of a text may lead to opposite or antagonistic legal outputs. Such result expresses the too broad possible interpretation of the legal text or its ambiguity, especially in the *incentive* norms such as in Tax Law (as said by Michelle White [11]). Governmental legal institutions in different countries provide official documents and guidelines in order to facilitate the drafting of legislative texts and their insertion in the pre-existing legal corpuses [6]. The reduction of such vagueness is essential to prevent endless disputes and conflicting (though legitimate) interpretations, misuses or perverse effects of laws [9]. Neither is it complexity.

4.2 Near-by concepts

4.2.1 Legal Certainty

Legal certainty is a condition of legal order. The first dimension of legal certainty is the easiest access to the exhaustive body of applicable laws. These laws must be accessible but also updated. Legal interaction becomes insecure if the referential is different. One other dimension is the intelligibility of the rules. Law is a means for people to interact in society without unexpected effects. Law is also considered as the most efficient way for an agent to anticipate the behavior of other agents. It is the reason why certainty is always opposite to complexity. Automatically, legal complexity produces uncertainty in social interaction.

4.2.2 Normative density

Normative density [2] means that some parts of a legal corpus can be more interrelated than other parts. This phenomenon is easier to observe when the corpus is well structured such as a Code. This measure could be a useful indicator to compare analogical institutions. The codification - as structuration process of legal content - often highlights some structural differences or some legal emptiness inside a legal field. But these differences are not always an error. It can become an indicator for stressing sensitive aspects of normative process. For example, on the contrary of other local authorities in France, the status of Corsican local authorities is governed by no legal specific provision. It had been noted by the staff of *codificators* (code drafters) in charge of the making of *Code général des collectivités territoriale* (1996).

4.2.3 Legal order

For all these reasons, when legislators talk about complexity they claim a "counter-productive" aspect of an imaginary legal order. The ideal of legislators and jurists is to see legal order as static, rational and centralized. Legal knowledge should be treated more as distributed systems made of collection of entities, where any decision (control) starts from the analysis of local interactions and produces emergent links between entities at different levels.

4.3 Operational structure-based measure

An operational structure based measure of legal complexity has first to take into account the hierarchy of texts and agents. The place of the text in legal hierarchy is not trivial for the measure of legal complexity of a new law. A municipal by-law for example can have no effect on the other norms. But the modification of a decree can impact all a network of local decisions.

Data Bases take already into account the historical evolution of a norm in a network (see the LEGIFRANCE portal), or the duration (sunset law) or location (experimental law) of its application. Another periodical control should be able

to represent which legal texts have been over quotated in a jurisprudential data base. Conversely, why maps are not made where the weak quotation of texts should prove the quasi unusefulness of parts of legal corpus or norms?

Other networks could be taken into account: legal commentaries or professional belongings. Do not let us forget however that a lot of copyright issues (content-based measure) could emerge by the making of links between the networks; for example, due to some agreement between public and private publishers, it is forbidden for LEGIFRANCE to quote a relationship between legal texts and case law: this link is considered as an added value to the "raw material" and exceeds the minimum *public service* obligation.

4.4 Operational content-based measure

The content-based measure of complexity that we propose leads to a lower bound of the legal complexity. Indeed many potential legal effects attached to a corpus might never be realized. All possible effects or outputs will not be actualized. Rigorously, potential and actual complexity should be distinguished. This question is of particular importance when drafting laws. Today any law project should be submitted with an impact study. A typology of legal effects and a measure of current complexity associated to a given nearby or antecedent legal corpus in the same legal area should be helpful in sketching the main expectable legal effects. A further step can consist in developing prospective scenarios of induced effects - legal or non-legal. Similar approaches are under development in the field of environmental studies.

5. USING LEGAL COMPLEXITY MEASURES

Such partial or global measures of complexity are not interesting as such but can be useful to compare the structure and content (interpretability, density of norms, legal institutionalization, diversity of outputs, etc.) of different legal systems.

Beyond, a crucial issue of these measures is to build a tool able to compare the complexity of different national legal systems. Another interesting issue should be to compare the complexity of subsets of Legal systems. Is environmental law more central in some national legal systems? What about procedural laws? It could be also easier *to assess* the following World Bank *assessment*: " Legal tradition is also associated with the efficiency of contract enforcement (...) Countries in the French legal tradition have the most procedures (31), and the second-longest time and cost (300 days and 13.7 percent [of the total cost]) (...) Common-law countries, mainly wealthier ones, have the lowest procedural complexity"[12]? Finally, measures of network dependencies between parts of law could give a map of dependencies between laws: for example, many sensitive issues have been raised to decide if some infringements should be included into the penal code or in substantial code (environment, labor, etc.). However the main interest in constructing complexity measure is in the renewal of the investigations questioning the conception, organization and functioning of Legal Systems.

6. CONCLUSION

In this paper we mainly focus on some possible measures of objective legal complexity for lawmakers and legislators. We draw a road map to link knowledge management issues and the fundamentals in Legal Theory. We make the hypothesis that in the future, network analysis will be able to capture the complexity addressed by Legal Theory. Today, metric and topological concepts could be fruitfully used in conjunction with the proposed complexity measures in order to characterize and compare different legal corpus or juridical cultures in the European Union.

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